A Mobile Holistic Enterprise Transformation Framework

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A Doctoral Thesis submitted in partial fulfilment of the requirements of Staffordshire University for the degree of Doctor of Philosophy

March 2017

Abstract

Mobile phones and tablets shipments are surpassing those of the PC category, as well as in relation to Internet usage as of 2016; all details which have made mobile adoption a priority for many enterprises and a challenge for them as well. Many enterprises have fallen into a paradox of spending on creating and updating mobile services, and gaining less than expected in return. Reasons for this include the lack of vision, and the lack of a clearly defined, well communicated mobile strategy. Enterprise Architecture 'EA' facilitates a successful transformation by controlling and managing the transitions in order to arrive at a clearly defined future state. It is regarded as the science of change to many. However, EA frameworks are very comprehensive and require weeks of training and resources, and are often too generic for mobile transformation. Therefore, an EA-based mobile holistic enterprise framework has been developed to support enterprises in making mobile initiatives a priority. The proposed framework ensures a clearly defined, well-communicated, holistic future state that is continually evaluated, as opposed to many of the existing frameworks.

The proposed Mobile Holistic Enterprise Architecture Framework - 'MHETF' - is based on the realisation of the capabilities of smartphones that are aimed at individual average consumers (the backbone of the current mobile trend). The capabilities are categorised and translated into four sets of services categories for business use. They are linked to another two components of the framework which are: (i) the categorisation of goals and objectives that are incorporated into the Balanced Scorecard for evaluation at a later stage in planning, and continually referred to during transitions and (ii) the categorisation of the implementation forms (categorisation of end solutions' functionalities).

The framework is supported by EA inter-operability and maturity models to ensure continuity and alignment with the existing initiatives, the enterprise's strategic objectives, and the change required in the scope of transformation. An evaluation for the available enterprise architecture frameworks was carried out and resulted in the selection of The Open Group Architecture Framework (TOGAF). The decision was also commended by the participants in the case study evaluation due to their familiarity with this framework, which is being adopted as the Saudi E-

Government Standard in contrast to the other major frameworks of Zachman and Federal Enterprise Architecture (FEA). MHETF has been applied to three case studies in the Kingdom of Saudi Arabia; two applications for a leading national outsourcing company, and the third for the outpatient clinics in a large hospital in the capital city of Riyadh. The results have shown major improvements in the four goal areas of mobile transformation; productivity, processes, satisfaction improvement and facilitating new opportunities. Eventually, the final evolution has shown that the participants are satisfied with the framework overall, and indicates that the framework changed their perspective of the power of mobile applications significantly, is relatively easy to understand, and that they are planning to adopt it for future mobile initiatives.

Acknowledgements

Thanks to Almighty Allah for His favours, mercies and guidance that enabling me to complete this research

- I would like to express my deepest gratitude to my supervisors; my principal supervisor Professor Anthony S Atkins, and Dr. Clare Stanier for their continues support and guidance throughout my study, their encouraging comments and advice and contribution.
- I would like to extend my appreciation to Staffordshire University for accommodating and facilitating my research in the School of Computing and Digital Technologies and to the Ministry of Education for sponsoring my research while residing in the UK through their cultural bureau.
- Special thanks to my wife and sons for accompanying me for the duration of the study, and making the UK my second home.
- Thanks to all my friends for their prayers, support and encouragements.

Dedication

This Thesis is Dedicated to

My Mother and Father,

My Wife and Our Sons,

My Supervisors,

My Colleagues and Friends

Publications

Conference Papers:

Alqahtani, M. & Atkins, A. (2016a). A Mobile Enterprise Solution for a Communication Portal: A Case Study in Front Desk Outsourcing Company. *Procedia Computer Science*. [Online]. 94. p.pp. 207–214. Available from: http://linkinghub.elsevier.com/retrieve/pii/S1877050916317793.

Alqahtani, M. & Atkins, A. (2016b). A Mobile Enterprise Solution for Mobile Teams: A Case Study for Front Desk Outsourcing Company in Saudi Arabia. *Procedia Computer Science*. [Online]. 98. p.pp. 540–547. Available from: http://linkinghub.elsevier.com/retrieve/pii/S1877050916322232.

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Alqahtani, M. & Atkins, A. (2016d). Mobile Maturity Models for Mobile Transformation. *Procedia Computer Science*. [Online]. 83. p.pp. 1070–1077. Available from: http://linkinghub.elsevier.com/retrieve/pii/S1877050916302587.

Alqahtani, M., Atkins, A. & Stanier, C. (2015). 'Mobile Holistic Enterprise Transformation Framework'. *Procedia Computer Science*. [Online]. 56. p.pp. 433–440. Available from: http://linkinghub.elsevier.com/retrieve/pii/S1877050915017135.

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List of Abbreviations

3GPP	3rd Generation Partnership Project
ABB	Application Building Blocks
ADM	Architecture Development Method
ARM	Application Reference Model
ATM	Automated Teller Machine
B2C	Business to Consumer
B2E	Business to Enterprise
BRM	Business Reference Model
BSC	Balanced Scorecard
BYOD	Bring Your Own Device
CDMA	Code-Division Multiple Access
CEO	Chief Executive Officer
CIO	Chief Information Officer
CPM	Collaborative Planning Methodology
CPU	Central Processing Unit
CRM	Customer Relationship Management
D2D	Device to Device
DM	Document Management
DRM	Data Reference Model
E-tourism	Electronic Tourism
EA	Enterprise Architecture
EAFs	Enterprise Architecture Frameworks
ECM	Enterprise Content Management
EDGE	Enhanced Data Rates for GSM Evolution
EHRs	Electronic Health Records
ERP	Enterprise Resource Planning
ETA	The Estimated Time of Arrival
FDMA	Frequency Division Multiple Access

FEA	The Federal Enterprise Architecture Framework
FEAR	Finish Enterprise Architecture Research
FVM	The Fit and Viability Model
GPRS	General Packet Radio Service
GPS	Global Positioning System
GSMA	Global System for Mobile Communications Association
HCP	Health Care Professional
HQ	Head Quarters
HR	Human Resources
HSDPA	High-Speed Download Packet Access
HSPA	High-Speed Packet Access
HSUPA	High-Speed Upload Packet Access
HTML5	Hypertext Mark-up Language Five
ICT	Information Communications Technology
IERC	The IoT European Research Cluster
III-RM	Integrated Information Infrastructure Reference Model
IoT	Internet of Things
IRM	Infrastructure Reference Model
IS	Information Systems
IT	Information Technology
ITU	International Telecommunication Union
KPIs	Key Performance Indicators
LTE	Long Term Evolution
M-Banking	Mobile Banking
M-Health	Mobile Health
M-learning	Mobile Learning
M-Tourism	Mobile Tourism
M2M	Machine-To-Machine
MAM	Mobile Application Management
MCC	Mobile Cloud Computing
MCDM	Multi Criteria Decision Making

MDM	Mobile Device Management
METIS	Mobile and Wireless Communications Enablers for Twenty-Twenty Information Society
MHETF	Mobile Holistic Enterprise Transformation Framework
MIMO	Multiple Input and Multiple Outputs
mmWave	Millimetre Wave
MoD	Ministry of Defence
MoH	Ministry of Health
MS	Microsoft Office
MSP	Managed Service Provider
NASCIO	The National Association Of State Chief Information Officers
NFC	Near Field Communication
OTT	Over-The-Top
PC	Personal Computer
POI	Point of Interest
PRM	Performance Reference Model
QA	Quality Assurance
QAS	Quality Assurance Solution
RAM	Random Access Memory
ROI	Return on Investment
SAAS	Software as A Service
SAFE	Secured Application Framework for Enterprise
SBB	Solution Building Blocks
SCM	Supply Chain Management
SDK	Software Development Kit
SLA	Service Level Agreement
SMEs	Small and Midsize Enterprises
SMS	Short Message Service
SOA	Service-Oriented Architecture
SRM	Security Reference Model
SSL	Secure Sockets Layer

TANGO	The Timeless Architecture for Next Generation Mobility Framework
TLS	Transport Layer Security
TOE	The Technology Organisation Environment Framework
TOGAF	The Open Group Architectural Framework
TRM	Technical Reference Model
UMTS	The Universal Mobile Telecommunications System
US	United State
VoIP	Voice Over Internet Protocol
VPN	Virtual Private Network
WAP	Wireless Application Protocol
Wi-Fi	Wireless Fidelity
WiMAX	Worldwide Interoperability for Microwave Access
WLAN	Wireless Local Area Network

Chapter 1. Introduction

1.1 Introduction

In today's world, mobile shipments have surpassed both PC shipments and tablet shipments combined, and has become the second revolution in computing (Gartner, 2017). This was made possible by the advancement in technology, mobile computing, and the rise of reliable and fast mobile connectivity methods with the aim of unwiring users. This has changed the way that governments communicate with citizens, and how businesses and service providers operate and deal with customers, and other business and stakeholders.

This chapter introduces the motivation for the research study, the aim and objectives, the contribution to knowledge, and the research philosophy that was used. Other relevant issues including the outcomes of the research and are discussed in addition to the thesis structure.

As of 2016, there are about 7.6 billion mobile connections and '4.7 billion subscribers', of which included one billion 4G connections in 151 countries. It is estimated that by the end of the current decade, the global subscriber base will reach 5.6 billion, with over 70% of the world's population having a mobile subscription (GSMA, 2016a). The story of mobile computing is similar to the growth of PCs. Mobile devices have been around for over 30 years, and thanks to the advancement in cellular networks, phone manufacturing and software development, mobile systems and services have become extremely popular. Besides the growing demand by

consumers (IBMMobileFirst, 2013), the demand from governments and businesses is one of the main drivers of this growth, initially starting with the use of radio networks and portable devices and then moving to more advanced technologies as they were unveiled (Arnold et al., 2008).

With advances in infrastructure and software, mobile technology has introduced new features to businesses including freedom of movement, reachability and personalisation, and is being regarded less as an extension of the existing applications of an enterprise and more as a transformative avenue of power (Shouming & Xiaoping, 2008).

Many enterprises are spending more money to adopt the use of mobile technology with less value gained in return (AIIM, 2013). The challenging issue is not that companies are without a mobile strategy; the probability is that they have several well-received mobile applications. Rather, companies do not have the effective mobile road map to enable the realisation of where their company is and what is the target within a designated time-frame and budget (Castiglioni, 2012).

A survey conducted by the global community of information professionals - 'AIIM' - found that 67% of respondents consider mobile technologies to be important or really important, and 45% estimated that there was an improvement in productivity by no less than 33% if travelling and non-travelling staff could connect to the back office, as their speed in responses would increase by 3 to 4 times. However, less than 25% of the respondents have had progress towards mobile-enabled business processes in their organisations and 67% do not have mobile access to their document management systems (DM) and their enterprise content management (ECM) system (AIIM, 2013). And in term of strategy, 20% of the surveyed companies have had a mobile strategy for 5 years or more, and 78% increased their budget for mobile solutions in 2015 (Adobe, 2015).

1.2 Aims of the Investigation

The aim of the investigation is to develop a mobility adoption framework that enables enterprises to transform to mobility successfully. The research study aims to investigate the existing enterprise architecture frameworks and the use of mobile technology within enterprises,

and to investigate influential factors. The framework developed in this research will be used to assess the need for mobile services (internal services for staff and higher management or external services for customers), prioritise them, guide the process through implementation, and then to validate the results.

The goal of the framework is to reduce costs, save development time, give competitive advantages, increase the available level of resource utilisation and to manage any change through the transformation process. The framework provides a transformation plan for a future state that is powered by the capabilities of consumer grade mobile phones capabilities as depicted in Figure 1.1.
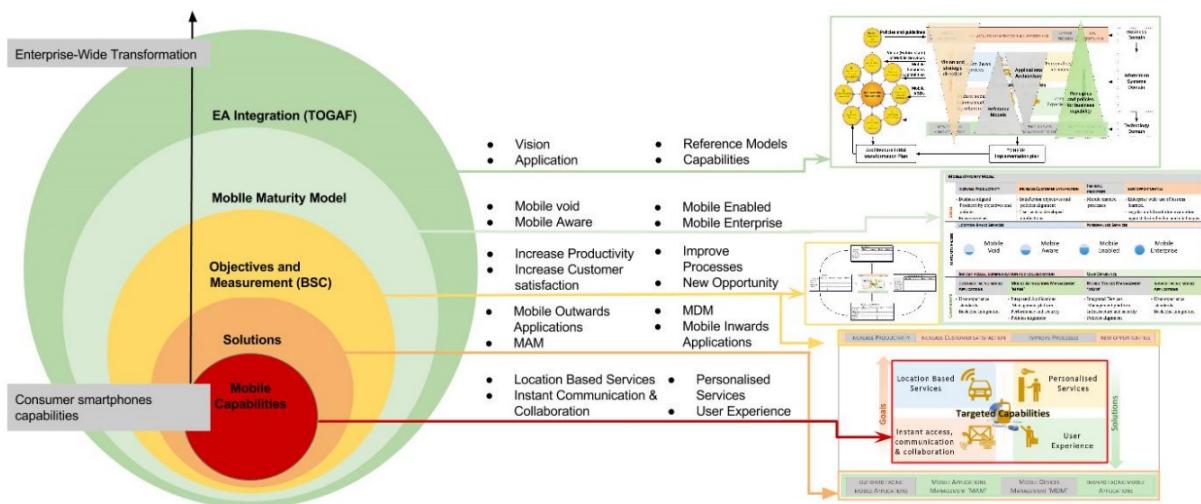
Figure 1.1. A Depiction of the Mobile Powered Enterprise Transformation.

1.3 Objectives of the project

The following objectives have been set in order to achieve the aim:

1.1. To conduct a literature research on:

    1.1.1. The trends and evolution of mobile technologies including 4G cellular networks and 5G.

    1.1.2. The applications of mobile solutions for businesses and governments.

    1.1.3. Current popular enterprise architecture models and frameworks adopted in the businesses and government bodies.

1.1.4. Current frameworks and models for mobile implementation in business and government.

1.2. To highlight the existing technologies in the reviewed applications and to investigate the current trends and needs.

1.3. To develop a mobile framework to provide guidance and a holistic view of mobile adoption.

1.4. To develop an assessment tool using Excel spreadsheets with accompanying induction workshops.

1.5. To validate and critically evaluate the framework through the use of case studies in real life scenarios of adopting mobile technologies and applications by enterprises.

1.6. To critically evaluate the research project as a whole

1.4 Contribution to knowledge

The main contribution of the research study is the proposed framework for mobile enterprise transformation. A holistic framework that provides guidance on a mobile adoption and relates this to business decisions could not be found in the literature. Consequently, a model is proposed to offer a holistic view of mobile enterprise transformation, and communicate the plans effectively to business-level decision makers, and developers alike. The framework is independent of technology, although its focus is on consumer-grade mobile phones (the core of the current mobile trend), and it provides guidance and decision model support throughout the transformation through an assessment tool. Additionally, for professionals who want to create an enterprise wide mobile strategy, and carry out the transformation in a coherent and a comprehensive approach that insures maximum utilisation of resource, and streamlined processes, at minimal cost, the framework is interoperable with enterprise architecture frameworks. Enterprise Architecture has been suggested as a business strategy in general (Ross et al., 2006). The research employs enterprise architecture techniques for the design of the future state of mobile transformation and the governance of implementation, in order to respond to some of the issues limiting mobile adoption.

The Mobile Holistic Enterprise Transformation Framework (MHETF) was integrated to the Balanced Score Card to assist in in defining objectives, measures, targets and initiatives to

provide quantifiable measurements of potential success criteria suggested from the frameworks analysis of the case studies.

The framework was derived initially from the literature, including the assessment of 8 case studies, and a review of current advances in mobile technologies, an investigation of mobile transformation, the enterprise architecture and its role in enterprise transformation and mobile strategy and validated using an additional 2 case studies from the literature. The framework was also further validated using three case studies, two of which were in the workshops conducted with a consultancy company that is a major contractor to the government of Saudi Arabia and the third is from a major hospital located in Riyadh capital city in Saudi Arabia.

The framework proposes a 6 phases process to mobile transformation, including an assessment tools (Excel) and the template needed to implement it, and a Mobile Maturity Model to describing the different phases of maturity in for a mobile enterprise.

1.5   Research methodology

Positivism, realism, interpretivism and pragmatism are considered to be the four main philosophical types of research. Saunders et al. (2009) suggested an Onion diagram (Figure 1.2) that depicts the underlying layers of the research methodology and relating strategies to the research approach and research design, which includes the research strategy, choices involved, time horizon and the data collection methods. The research question will subsequently inform on the choice of research strategy, the collection techniques and analysis procedures involved, and the time horizon (Saunders et al., 2009).
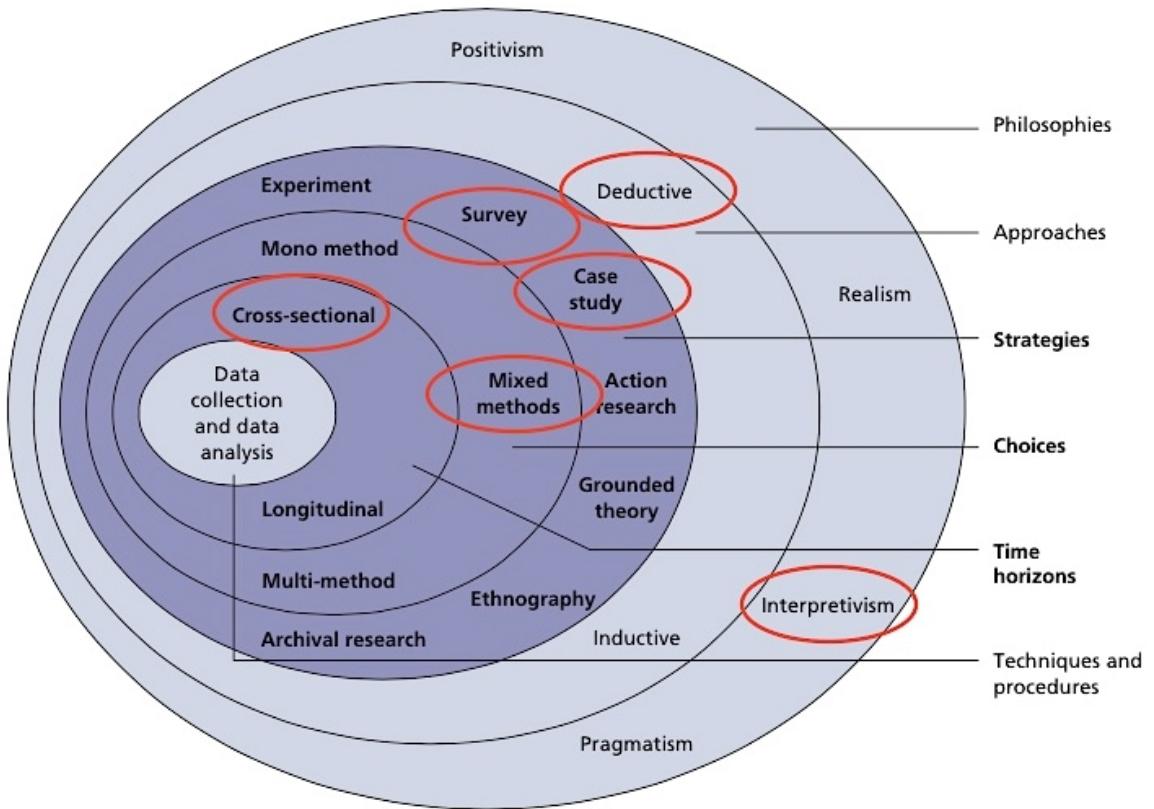
Figure 1.2. The Research Onion Diagram With Annotations Showing the Relevant Choices for This Research (Saunders et al., 2009).

1.5.1 Research Philosophy

The choice of philosophy is primarily between positivism, interpretivism and pragmatism. A positivist approach prefers to work with an observable social reality and the end product. On the other hand, interpretivism advocates what is necessary in order for the researcher to understand the difference between humans in the role as social actors. It emphasises research among people rather than objects, such as trucks and computers, and their understanding of the world from their individual point of view (Saunders et al., 2009).

The choice of philosophy is based on ontology, epistemological assumptions and axiology (Kulatunga et al., 2007). Another factor to be considered are the data collection techniques (Saunders et al., 2009).

- Ontology (Objectivism versus subjectivism):

Objectivism is concerned with the existence of social entities independently of any social actors. The second aspect of ontology is subjectivism, which holds to the view that social phenomena are created from the perceptions and consequent actions of social actors. For the interpretivist philosophy, it is necessary to explore the subjective meanings motivating the actions of the social actors in order for the researcher to be able to understand said actions (Saunders et al., 2009).

- Epistemology (Resources versus feelings and attitude):

Epistemology is concerned with what constitutes acceptable knowledge in a given field of study. A resources researcher (usually a positivist) is concerned with facts rather than impressions, and claims to be external to the process of data collection in the sense that there is little that can be done to alter the substance of the data collected (Saunders et al., 2009). On the other hand, a 'feelings and attitude' researcher is concerned with the 'feelings' involved. An example would be a researcher framing questions to be asked and interpreting respondents' answers in interviews (Saunders et al., 2009).

- Axiology (from value laden to value free):

The spectrum extends from value free, where the researcher does not impose any value or judgment on the subject of research to value-laden, where value judgments are made (Kulatunga et al., 2007). Interpretivism would appear to be the appropriate philosophy for a value-bound axiology [Table 1.1].

Table 1.1. Applicability of Interpretivism Philosophy Characteristics Based on the Definition from Saunders et al. (2009)

Factors	Ontology	Epistemology	Axiology	Techniques
Definition	The researcher's view of the nature of reality or being	The researcher's view regarding what constitutes acceptable knowledge	The researcher's view of the role of values in research	Data collection techniques most often used
Characteristics of Interpretivism those are closest to the research type	Socially constructed, subjective, may change multiple times	Subjective meanings and social phenomena. Focus upon the details of situation, a reality behind these details, subjective meanings motivating actions	Research is value bound, the researcher is part of what is being researched, cannot be separated and so will be subjective	Small samples, in-depth investigations, qualitative
Applicability	The adoption of mobile technology is driven by the employees and customer demand and measured by their satisfaction	The adoption of mobile technology is about enabling people doing business on their smart phones. Reality should be examined through their perspective.	The research is neither value laden nor value free. It is value bound.	The primary research includes the use of an in-depth case study

1.5.2 Research Approach

For the research study in question, the choice is between deductive and inductive approaches. In the deductive approach, the researcher develops a hypothesis and designs a research strategy to test it. In the inductive approach, the theory is developed based on the collected data (Saunders et al., 2009). The study uses an inductive approach. The framework is based on the secondary research and observations from the review case studies. The framework is validated and formulated via the case studies from the literature (10) and by three commercial case studies hosts.

1.5.3 Research Design

In part, the adopted philosophy was influenced by practical considerations. However, the main influence is likely to be the researcher's particular view of the relationship between knowledge

and the process by which it is developed (Saunders et al., 2009). Contemporary phenomenon is often investigated through the use of case studies which provide multiple sources of evidence. Additionally, Case studies allow for answers to be found to the 'what', 'why' and 'how' types of questions. The data can be collected using a number of methods that may include questionnaires, interviews, observations and documentary evidence (Kulatunga et al., 2007).

There are three factors influencing the selection of the method: the type of research question, the level of control that the researcher has over the events, and the level of focus on contemporary versus historical events (Yin, 2009). The selected method for the research study, according to these factors, is the case study. The case study focuses on 'how and why', whereas the survey focuses on 'who, what, where, how many and how much'. Triangulation provides an important way of ensuring the validity of case study research where many methods are combined. In addition, data sources, theory and investigators may also be triangulated (Johansson, 2003). As case studies are often described as expensive, time consuming, and difficult to generalise from, they are known to facilitate rich conceptual/theoretical development (Hodkinson & Hodkinson, 2001).

The method followed in this research study is the case study, including a survey at the end to evaluate the results. The time horizon for the case study is cross-sectional since it is not going to capture data over a period of time as the projects are being developed. These exploratory case studies are additional to the 10 used to develop and internally validate the framework.

The case study contributed to the design of the framework and used for evaluation in an iterative cycle. The criteria of project selection was set and three cases selected accordingly. The purpose of using the case study from multiple case study types is to further enhance and validate the framework, and to make sure that it works cross-industrially. The case study was carried out in a major company and a hospital in Riyadh, Saudi Arabia, which is a contractor for the government as part of a country-wide electronic services initiative.

1.6 The Context of Case Study

Beside the benefit of validating and extending the framework with real life scenarios, the case study was selected for this project because "it has the ability to cater for this sort of scenario

where boundary between phenomenon and the context is not clearly evident and the context is required to be understood" (Kulatunga et al., 2007). The case study is comprised of two parts. The first part is about the topic of interest which is adopting mobile services, and that is done by applying the framework onto three projects. However, the second part is the evaluation of the framework and to what level the participants agree on the proposed benefits.

Based on the literature, a discussion on any relevant issues is presented including any issues and the strength points of the mobile adoption of electronic services in general and mobile services in particular.

1.7 Case Study Criteria

The projects should vary in the following criteria:

1- Internal and external: at least one internal project should be included to verify the applicability of the framework to internal user and the inward facing applications.
2- Public and private ownership.
3- Projects with mobile users.

Other influential factors include the willingness of the project manager to contribute to ensure meeting the deadline of the case study, and the acquisition of the required data.

1.8 Data Collection

Through a series of workshops, and through the analysis of the available documentation, there were identified any relevant issues or advantages for implementing the framework in the current context. The information from the case studies were collected throughout the workshops, in addition the Balanced Scorecard was used to measure the difference of the outcome between the implementation of Plan 1 (which was drawn up before the framework) and Plan 2 (which was drawn up using the framework), to quantifiably assess the value of the framework.

The evaluation of the framework is the following phase in which data is collected through a survey to evaluate the effectiveness of the framework. The purpose of the case study is to validate the proposed framework (internal validity), and to explore the/any opportunity to expand it and to generalise it in the context of Saudi Arabia (external validity).

- Internal Validity

The framework is unique in various aspects; it is a holistic tool that simplifies mobile transformation. The proposed benefits of the framework were tested through capturing the base line by interviewing the managers of the selected projects. The testing is also done during the workshop by comparing the designed plans for project transformation for each individual project, before and after the workshop. And lastly, it is tested by an evaluation assessment survey (Appendix A) that assesses if the framework delivers on the proposed benefits that it claims from the involved professionals' perspectives.

- External Validity

In this phase, the design of the framework is tested by applying it to three different projects with different characteristics. Then the quantifiable results from the application of the framework were compared to the current results, which is the outcome of the current practices for mobile adoption, using any existing techniques and frameworks. The difference represents the value achieved by adopting the framework.

1.9 Ethical Implications

The research project was conduct with compliance to the standards of Staffordshire University, in accordance with the principles of the Concordat to Support Research Integrity issued by Universities UK. Collected data were stored and analysed confidentiality, and reported anonymously.

Workshops participants were made aware of the purpose and the benefits of the study and have joined voluntarily, and were aware they could withdraw with no consequences. The ethics form was submitted and approved by the Research Degree Sub- Committee of Staffordshire University prior to conducting fieldwork.

1.10 Thesis Structure

The thesis is divided into eight chapters as illustrated in Figure 1.3 The chapters are outlined as follows:

- Chapter 1: Gives a background of the topic, the aim and objectives, the research approach, philosophy and thesis architecture.
- Chapter 2: Reviews the current trend of mobile technology that is based on the consumer grade mobile devices, introduces the concept of mobile-powered enterprises, and is followed by examples of successful mobile solutions.
- Chapter 3: Introduction to the Enterprise Architecture, and a comparison of the existing frameworks from the perspective of mobile Enterprise.
- Chapter 4: This chapter offers a review of the existing models and frameworks, and introduces the proposed framework.
- Chapter 5: In this chapter, the application process of the framework is introduced as well as the supporting models including the interoperability model for Enterprise Architectures, a Mobile Maturity Model and guidelines on the use of Multi-Criteria Decision-Making (MCDM).
- Chapter 6: This chapter presents the case studies used for framework validation, and the results measured from the Balanced Scorecard perspectives.
- Chapter 7: This chapter presents the evaluation of the proposed framework by analysing the responses to the survey.
- Chapter 8: Conclusion and future work.

Chapter 1
Introduction: Background, Aim and objectives, and research approach

Chapter 2
Evolution of Mobile Phones Technology consumer mobile devices and Mobile Enterprise

Chapter 3
Enterprise Architecture Review and comparison of Enterprise Architecture Frameworks

Chapter 4
Proposed Framework Review of existing frameworks and outline of proposed framework

Chapter 5
Application of Proposed Framework Proposed process and supporting models

Chapter 6
Case Studies Results and Validation outline of case studies and application results

Chapter 7
Framework Evaluation Analysis of the participants feedback

Chapter 8
Conclusion and Future work

Figure 1.3. Thesis Structure

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Summary

This chapter presents the background and motivation behind the framework, outlining the need for a mobile enterprise framework, followed by the aim and objectives of the research. The following section is the research approach, detailing the selected philosophy in which interpretivism appeared to be the most appropriate.

The data collection has been done through a field case-study done in Saudi Arabia, and the accompanying framework validation. The chapter also gives an outline of the thesis structure.

The next chapter reviews the improvement in the cellular networks from analogue voice calls, until the high-speed mobile broadband that it offers today, the capabilities of smartphone devices, and how enterprises are embracing these technologies with evidence and examples of the value and shift that better mobile technology could introduce to different fields and industries. Finally, a brief review of trends in computing with an effect on mobile or vice versa is presented.

Chapter 2. Literature Review of Mobile Evolution

2.1 Introduction

It has been reported that adults in the UK spend two hours online on their smartphones; twice as long as they do on laptops and PCs. About 62% use their smartphone for social media, 57% use them for instant messaging, 34% for VoIP calls/video, 34% for picture messaging services and 24% of online users in the UK use Twitter on their smartphone (Ofcom, 2015). Moreover, in spite of poverty, mobile phones are even more popular in poorer countries and Africa is one of the fastest-growing mobile markets in the world, second only to Asia, although growth was slowing down by the end of 2015 due to affordability issues. In 2016, mobile technologies accounted for 6.7% of Africa's GDP and created 3.8 million jobs in 2015 (GSMA, 2016b).

In some poorer countries, mobile phones have brought major productivity and knowledgebase value (Kefela, 2011) and are becoming a source of revenue for poorer families, based on initiatives in countries such as Bangladesh (World Bank Group, 2009). In fact, the adoption of consumer tools and applications in the workplace is more prevalent in emerging markets (Harris et al., 2011), (Poushter, 2016).

Mobile phones are more popular today due to the advances in mobile phone operating systems that have made them easier to use. This has taken place concurrently with breakthroughs in smartphone manufacturing (West & Mace, 2010).

Enterprises are keen to adopt mobility and extend their services to consumers' smartphones; simplicity and ease of use, low cost and high productivity of mobile technology have raised the bar for the quality of electronic services. Enterprises are keen to provide context-aware services to the mobile engagement and intelligence, creating apps for individuals at their point of need, and managing and securing mobile applications, devices and networks (Nicol, 2013).

2.2 The Mobile Evolution

This chapter reviews the concept of Mobile enterprise and presents eight cases of mobile solutions across multiple industries, assessing the benefits of each case against the identified goals of mobile transformations.

However, a review of cellular networks is also included in Appendix B, from all voice networks in what is known as the zero generation to the fourth generation with implementations of 'all data' subscriptions, with the Internet being at the core of the network. In addition to a review of the main technologies used in each generation, illustrating their capabilities and covers the rapid advancements in mobile phone technology over the last three decades, along with other related technologies influenced or supported by mobile technologies.

2.3 Mobile Enterprise

Enterprises utilised mobility even before it was introduced to the consumer through mobile operators; some companies with mobile teams used to communicate through radio frequencies before the first mobile phone was introduced (Bhalla & Bhalla, 2010).

Enterprises continued to leverage the latest advancements in mobile industry and remained one of the main drivers. They used text and multimedia messaging for marketing campaigning and user notifications, WAP browsing and video calling. This trend continued in the leap mobile computing took in 2007 when Apple launched the first iPhone, when enterprises were able to

extend more of their services to mobile users on the move in a reliable and secure way that paved the way for the expansion of smartphones (Nicol, 2013).

Being powered by freedom of movement, ubiquity and reachability of users anywhere are the main benefits of mobile services (Shouming & Xiaoping, 2008). According to Accenture's survey, 20% of all smartphone mobile usage is of a business nature (Stieglitz & Brockmann, 2013). Respondents to another, more recent study reported an average gain of about one hour of productive work time resulting from smartphone usage and an efficiency increase of 34 percent on average (Frost & Sullivan, 2016).

The value can be categorised based on supply chain activities: upstream, downstream and internal operations (Picoto et al., 2010), or based on the categorisation of mobile services into business to enterprise 'B2E' and business to consumer 'B2C', as shown in Table 2.1.

Table 2.1. Values of B2E and B2C Mobile Services, Adapted From (Nicol, 2013)

Business to Enterprise	Business to Consumer
Increase worker productivity	Improve the quality of service.
Increase revenue	Improve customer satisfaction.
Extend existing applications.	Deepen customer engagement and loyalty
Reduce fuel, gas or fleet maintenance costs	Drive increased sales through personalised offers
Increase employee responsiveness and decision-making.	Increase competitive differentiation
Resolve internal IT issues	Improve brand perception.
Reduce expenses	Understand customer behaviour
Attract and retain talent.	Reduce cost of delivery
Improve work life balance	Use new value-added services

2.3.1   Mobile Enterprise Definition

Mobile technology is not a simple change; it is a platform that has the potential to transform enterprises (Joshi, 2010), (SAP, 2014). Mobile-enabled operations have facilitated a sharp break with the past. This break is a major difference between transformation and incremental changes (Kasteel, 2009). It empowers employees and customers to get information when and where it is

needed, enabling users to make immediate decisions, whether through real-time dashboards, video monitoring or other intelligent systems, analysing the situation through factors such as location, time and other standard or customised sensors and presenting the information accordingly (Dhar & Varshney, 2011). Mobile offers business transformation through applications and high-speed connectivity to employees, vendors, customers and other enterprises, impacting a wider array of business processes than ever before and generating new mobile business models (Isaac & Kennedy, 2007).

Mobile is a key technology in ubiquitous computing and shares its characteristics, including decentralisation or modularity and comprehensive networking, embedding of computer power in objects of daily use, mobile support for the user through information services anywhere and at any time, context awareness, adaptation of the system to current requirements and automatic recognition and autonomous processing of repetitive tasks without user intervention (Friedewald & Raabe, 2011).

In addition to the changes mobile introduces in processes, it increases productivity and efficiency since smart mobile objects eliminate the avoidance of media breaks between the real and the digital worlds, causing less human interaction and fewer human errors to reduce cost, which is made possible by objects being able to provide data about their current and past content (Strassner & Schoch, 2002). Organisations that are both prioritising mobile technology initiatives and implementing a mobile strategy across the company are enabling increased productivity while remaining in control of their end users' use of mobile devices, applications and company data (IBMMobileFirst, 2013).

Enterprises are keen to adopt new technologies to improve efficiency and reduce costs, and they differ in the level of adoption of these technologies based on return on investment (ROI) analysis (Nicol, 2013). However, Maan (2012) points out that key imperatives to any enterprise are evolving the customer experience, increasing the productivity of the workforce and adding agility to business by providing information upon request where and when they are needed and providing alerts.

Shadow systems, feral systems, grey IT, rogue IT and hidden IT are equivalent keywords used in literature for Shadow IT in which IT staff may implement tools without management oversight to fulfil a business requirement (Zimmermann et al., 2014). On the other hand, it is end user choice to switch to the flexible set of tools and personal devices they are familiar with to perform work-related tasks (Intel, 2013), (Ortbach et al., 2013), (Harris et al., 2011). The change from a top-down approach to bottom-up IT innovation shifts focus to the perspective of individuals (Ortbach et al., 2013). Employees often have more experience with their technologies, consider them superior to corporate technology and work to consolidate private and corporate devices (Dernbecher et al., 2013). Consumerisation of IT is not only used to enhance productivity; in fact, it is reported that it helps to keep talent in the company and improve innovation through the variety of ways employees use technology to approach, tackle and solve problems (Harris et al., 2011), (Ortbach et al., 2013). The use of smartphones is the most radical change of client computing in business in decades; it will require a rethinking of the most fundamental business processes and adoption of an IT consumerisation policy that represents a sweeping change for corporate IT departments (Koch et al., 2014).

A user-centric approach provides fresh insights into improving productivity and accelerates access to emerging solutions, offering the most important feature in allowing users access to corporate data on any device, from any location, at any time (Intel, 2013). In addition to the technology awareness which allows employees to choose, IT consumerisation is powered by the consumer solution improvement in terms of user experience and the availability of ubiquitous internet access and location-based services, and the falling costs of devices and wireless services.

Many enterprises are considering mobile at some level, from having a mobile friendly website to fully embracing mobile at the strategic level. Therefore, a definition is needed to describe a mobile enterprise and differentiate it from other enterprises that are utilising mobile. Maturity models allow enterprises to benchmark themselves against each other or cross-industry best practices (Khoshgoftar & Osman, 2009). Therefore, to define the level of maturity in which an enterprise can be called a mobile enterprise, a mobile maturity model is required.
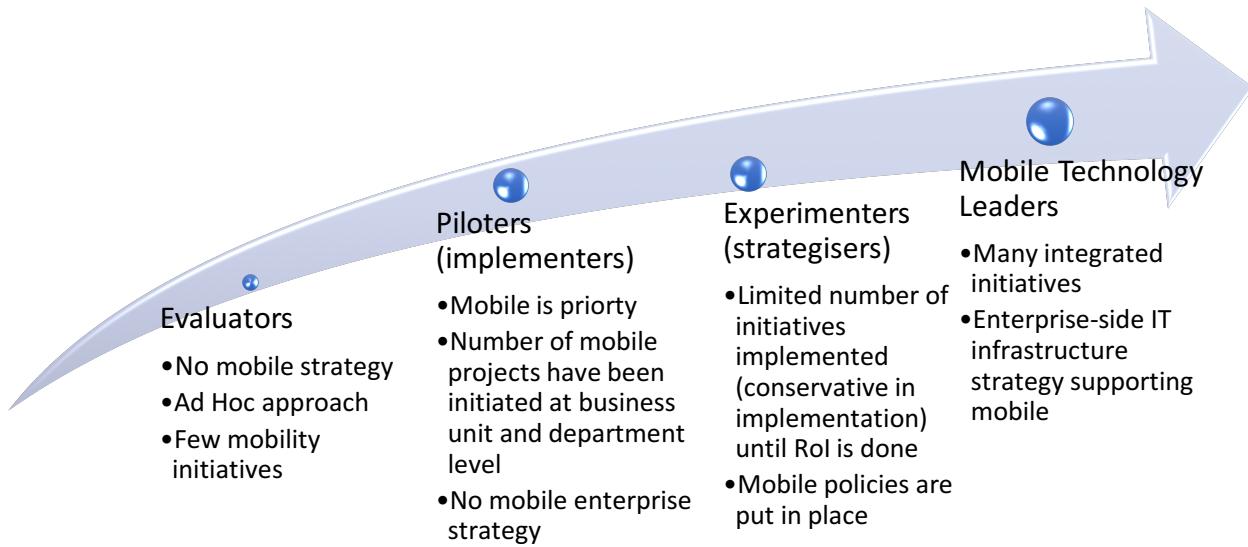
Figure 2.1. IBM 'Mobile First' Maturity Model and 'Mobile Enterprise' (IBMMobileFirst, 2013).

Several mobile enterprise maturity models have been proposed, mostly by vendors; their descriptions of the final phase can be applied to the concept of mobile enterprise although the IBM initiative for Mobile First's definition of MobileFirst Enterprises is the closest since it describes the phases at the strategic level [Figure 2.1], which best fits the purpose of defining mobile enterprise. Other maturity models contribute to the definition by describing the mobile enterprise from different perspectives, such as the software development environment perspective, the services, data, capabilities and technology specific perspectives. Table 2.2 shows the collective description of a mobile enterprise from different perspectives.

Table 2.2. The Different Perspectives of Mobile Maturity Models and Definition of Targeted State (To Be).

Model Owner	Model Perspective	Definition of mobile enterprise based on the description of the last phase in different mobile maturity model
IDC's Mobile Maturity Model	Mobile software and solutions **development** based, provides a clear description of the development environment and expected outcomes.	Mobility solutions will drive and sustain **competitive advantage;** in addition to employees, it enables suppliers and distributor. An **agile** end-to-end mobile application lifecycle strategy is deployed, and **mobile development** is integrated into application development (Song & Anderson, 2013).
IBM Mobile Infrastructure Maturity Model	**Strategic** based, focuses on mobile strategy development and drivers of mobility initiatives.	These organisations have an enterprise-wide and **strategic approach** to IT infrastructure supporting mobile and have a **greater number of mobility technology initiatives** underway. These initiatives are being well **integrated** across the organisation.' (IBMMobileFirst, 2013).
Service2Media Mobile Maturity Model	Strategic and technical based focused on the **transition** phase to Mobile First.	Organisation-wide **strategic focus on mobile** and **integrated platform capabilities and ubiquitous** connectivity. They will have **a policy-driven and 'factory' approach to mobile innovation** (Oosten, 2014).
BPTrends Enterprise Mobility Maturity Model	Comprehensive strategic and technical **capabilities** based.	**Enforced mobile Polices**, strategy drives roadmap; **mobile enables processes innovation**, fully **managed devices** with enterprise workflow (Paradkar et al., 2012).
The Ektron Mobile Maturity Model	**Technology specific** based, focuses on web design as the point of engagement with users.	**Mobile strategy** and vision, it **leverages devices' capabilities**, **touch-centric** and extensively uses **HTML5** (Ektron, 2013).
PwC Maturity Model	**Service** based maturity model	**Anytime, anywhere** mobile e-commerce enables **new channels** (Isaac & Kennedy, 2007).

2.3.2   Mobile Applications

It is a business imperative to adopt mobility in handling business needs in order to stay competitive and agile (Maan, 2012). The use of mobile has evolved from being a simplistic point solution to strategic and large-scale enterprise-wide implementations enabling organisations to establish new core competencies, gain and sustain competitive advantages, and define new markets by rethinking how business is organised, how people interact and collaborate, how corporate resources are accessed and how adaptable an enterprise is (Basole &

Rouse, 2006). Mobile enterprises gain the most from mobile. Transforming to a mobile enterprise provides major benefits (Seidel, 2013) including the following:

1. Attracting customers to transform the value chain and increase productivity.
2. Turning interactions into an opportunity for return on engagement and investment.
3. Providing a consistent brand experience by connecting mobile apps to systems of record for continuous, trusted transactions.
4. Delivering innovation to meet increased demands, lower costs, gain visibility.

These benefits are reflected in the attributes of transformative mobile solution attributes. Adopting mobile solutions has the potential to transform businesses; transformative solutions are based on extending traditional back-end data and services with a system of engagements marked by intelligence, context and engagement (Nicol, 2013). Mobile solutions should have all four attributes to be transformative:

1- Deepen the relationship with the customer/user.
2- Improve business processes.
3- Improve employees' productivity.
4- Provide the opportunity for new business solutions (Nicol, 2013).

In contrast to Nicol's (2013) and Seidel's (2013) paradigm of identifying benefits, others have suggested flexibility as one of the main advantages (Silvius, 2006). The proposed model consolidates factors and attributes by incorporating flexibility and scalability into the four identified categories. The current trend is powered by the consumerisation of IT, with the goal of achieving productivity objectives, customer satisfaction and relationship objectives, process improvement objectives and objectives related to offering new opportunities for mobile transformative solutions. The working definition of the transformative mobile solution is that it should generate values for each of the identified four goals, although the available information for the cases reviewed in this chapter do not always indicate if these factors were aimed for or achieved clearly. Table 2.3 outlines the four categories and shows the template headings which are used for the assessment of the following mobile initiatives.

Table 2.3. Identified Factors for Transformative Effect Evaluation.

	1	2	3	4
Attributes	**Improve employees' productivity**	**Relationship with customers**	**Improve business process**	**Provide the opportunity for new businesses**
Impact on	**Employees**	**Customers**	**Business/IT (Current State)**	**Business/IT (Future State)**

Mobile has transformed many enterprises and the way they do business. In fact, mobile Internet was the first on the list of technologies that 'will transform life, business, and the global economy' (Manyika et al., 2013). However, measuring change through the identified attributes is complicated since it requires qualitative real-life data analysis. However, since the beginning of the current mobile trend, it has been realised that for ubiquity solutions, only some of the cost can by analysed in advance and benefits can be estimated to a certain degree (Strassner & Schoch, 2002). The following is an initial validation of the four attributes/goals of mobile transformation through several examples of mobile applications in different fields, showing the importance and potential of mobile with emphasis on the transformative aspect of mobile solutions by attempting to apply the four attributes of transformative solutions to each of them.

2.3.2.1   M-Health

M-Health is the practice of public health and medicine using mobile devices including smartphones and mobile phones, PDAs or other mobile devices (Cipresso et al., 2012). Current applications of M-Health include: education and awareness, remote data collection [Figure 2.2], remote monitoring, communication and training for healthcare workers, disease and epidemic outbreak tracking, diagnostic and treatment support (Vital Wave Consulting, 2009). Two cases are selected for discussion.

Figure 2.2. A Mobile-Phone-Based Multimodal Microscope for On-Site Diagnostics (Kühnemund et al., 2017).

- Case 1: Remote monitoring in Iraq and India

A network of wireless sensor nodes worn by a patient to record vital signs for patient safety, utilising low power and high data rate protocol using ZigBee and Bluetooth connectivity to transmit between nodes, and to monitor vital signs for patients in rural areas or in clinics with shortages in talent or equipment (Mulvaney et al., 2012).

- Case 2: An application which has been launched in Tanzania, Nigeria, UAE and Saudi Arabia

A critical issue of high maternal mortality rates in some countries; in Afghanistan, for instance, it is 1,400 per 100,000, Tanzania 790, Nigeria 840 and Niger 820, respectively. In 2008, about 358,000 women died, and 4,000,000 out of 20,000,000 children born every year.

The mobile solution provided healthcare to pregnant women in rural regions of Africa, which was developed in partnership with Qualcomm, D-Tree International and Great Connection Inc.

It uses mobile devices such as mobile phones and tablets and a mobile ultrasound device to deliver images to doctors in major hospitals. All participants are end users of the app and they all gain financial benefit from its ecosystem, as shown in Figure 2.3 The app manages the

pregnancy period, keeps the mothers connected and provides other support services (George, 2013).
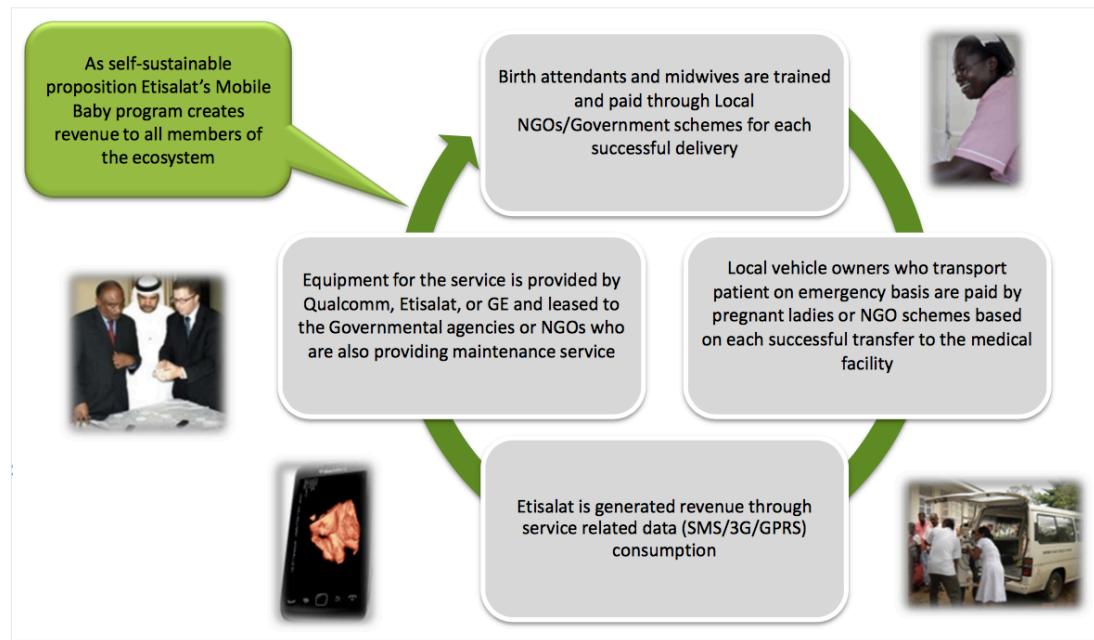
Figure 2.3. An Overview of the Proposed Solution.

Table 2.4 shows the transformative effect of mobile adoption and evaluates this against the factors which constitute the goals of mobile transformations. The evaluation shows the value added to each category and the objectives they serve. Main objectives as documented or discussed in the case are heightened.

Table 2.4. Transformative Effect Evaluation.

Solutions	Factor 1 **Improve employees' productivity**	Factor 2 **Relationship with customer**	Factor 3 **Improve business process**	Factor 4 **Provide the opportunity for new businesses**
Case 1: **The solution is transformative**	The sensors are filtering 'HSP''s patients list based on the data collected, resulting in eliminating any unnecessary tasks	Every patient is monitored 24/7 knowing a health care professional 'HCP' is there when s/he needs one	Instead of regular check-ups on patients, a health care provider will be concerned most of the time with patients in need	The solution enables the hospital to expand in remote areas, and remote health monitoring capabilities could be of interest to care centres for older people, for example.

Case 2:	'HCP' could	End users are	The solution should	The system establishes
The solution is transformative	overcome the place barrier and save transportation time, to care for more women in labour.	in a fragile state and this mobile solution is designed to save their lives	provide guidance to the users through pregnancy, and facilitate services on-the-go like taxi mobile payment for those who cannot pay taxi fees to get to a hospital.	relationships with new mothers and a way of remote monitoring. The potential, for example, to support after the birth, since this mortality rate is high in many countries as well.

2.3.2.2 M-Banking

Mobile banking is different from M-payment (the use of mobiles to conduct a payment) and consists of three other sub-applications: mobile accounting, mobile brokerage and mobile financial information (Tiwari & Buse, 2007). M-banking facilitates seamless payment and account managing with no time or place constraints. Three cases are selected for discussion.

- Case 1: The mobile service of bank La Caixa

The bank introduced the use of contactless mobile tap to start using ATMs right away, to reduce risks of exposing personal key numbers and faster processing of cash withdrawal (Catalunyacaixa, 2012), (Sebag et al., 2016).

- Case 2: The mobile service of bank La Caixa

People are concerned about using their card details on online payments. The secured online payment method requires the assigned identification number and phone numbers rather than credit card details (Catalunyacaixa, 2012), (Sebag et al., 2016).

- Case 3: An app developed by Barclays Bank, in the UK.

The bank developed the 'Pingit app' as shown in Figure 2.4, which allows users to pay others seamlessly and receive payment using their phone numbers, saving clients' time and increasing satisfaction (Barclays, 2012).
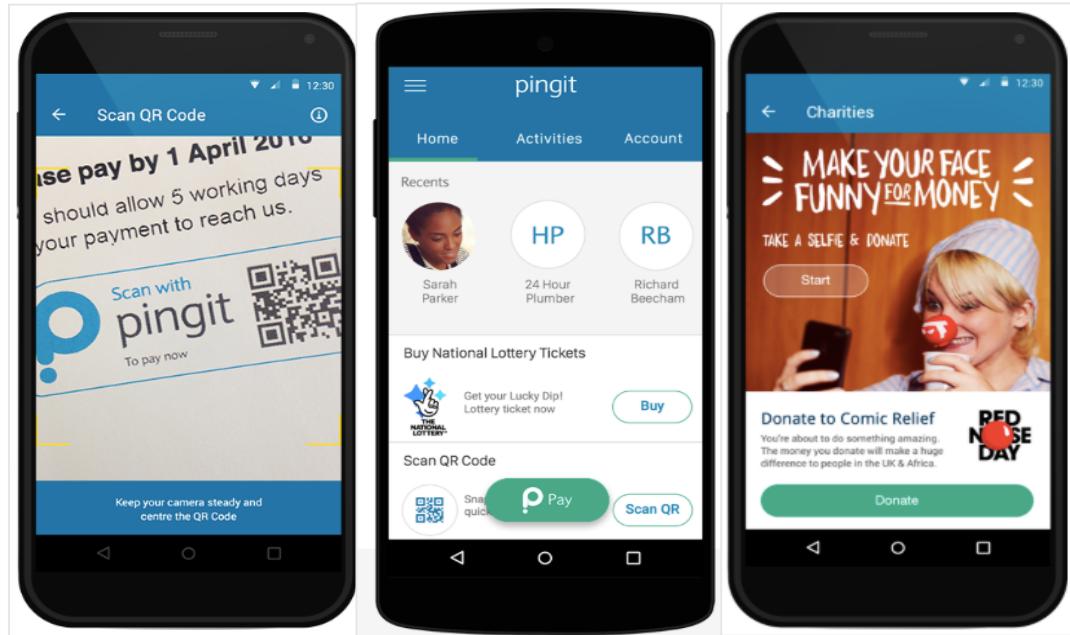
Figure 2.4. Some Pingit App Applications

Table 2.5 shows the transformative effect that mobile adoption has on organisations and evaluates their initiatives against the selected factors which constitute the goals of mobile transformations. The evaluation shows the value added to each category and the objectives they serve. Main objectives as documented or discussed in the case are heightened.

Table 2.5. Transformative Effect Evaluation.

Solutions	Factor 1 **Improve employees' productivity**	Factor 2 **Relationship with customer**	Factor 3 **Improve business process**	Factor 4 **Provide the opportunity for new businesses**
Case 1: **The solution is possibly transformative**	The literature did not give sufficient evidence on improvement in productivity.	It responds to customers' needs, thus deepening the relation with them.	It reduces security threats and increases the cash flow through eliminating users' security concerns and reducing transaction time.	The end user capability for customer recognition and contactless cash withdrawal could be extended for example to mobile contactless payments at shops.

Case 2: The solution is possibly transformative	The literature did not give sufficient evidence on improvement in productivity.	It responds to customers' needs, thus deepening the relation with them.	It reduces security threats and increases the cash flow through eliminating users' security concerns and reducing transaction time.	Capability to provide customers with temporary payment details could be extended for services such as a virtual wallet for online shoppers.
Case 3: The solution is possibly transformative	The literature did not give sufficient evidence on improvement in productivity.	It responds to customers' needs, thus deepening the relation with them.	It reduces security threats and increases the cash flow through eliminating users' security concerns and reducing transaction time.	Identifying recipients through their phone numbers could provide opportunities for customers; it is a new capability and it can be exploited.

2.3.2.3 M-Learning

M-learning is serving the needs of learners in a quickly changing world, helping them to acquire knowledge and skills via mobile phones; using mobile technologies to transform educational institutions' learning resources; creating active M-learning communities and solutions for corporate training, as well as life-long learning (WSA, 2013). Attewell (2010) has identified over 70 benefits in current implementations of M-learning. Benefits beside eliminating time and place constraints include:

- The ability to collect evidence in different ways according to their skills.
- Support for differentiated learning.
- Increasing interest, engagement and motivation.
- Support for different ways of learning.

Two cases are selected for discussion.

- Case 1: A programme implemented in a school in New Mexico

Teachers use mobile devices to assess kindergarteners' reading progress regularly and tailor instructions, helping children to develop oral fluency. Within the first three years, the share of students reading at benchmark levels rose from 29% to 93% (McKinsey & Company, 2012).

o Case 2: A programme in primary school in India

The students in rural areas with low-income needed support to learn English. The school in the case used mobile phones and English teaching games. Local teachers provided support and researchers devised a simple game to develop listening comprehension, word recognition, sentence construction and spelling. The test results for students who used the mobile phone games were much better with an improvement of nearly 60% (McKinsey & Company, 2012). Table 2.6 shows the transformative effect that mobile adoption has on the organisation; following the same pattern with previous cases, the main objectives documented or discussed in the case are heightened.

Table 2.6. Transformative Effect Evaluation.

Solutions	Factor 1 **Improve employees' productivity**	Factor 2 **Relationship with customer**	Factor 3 **Improve business process**	Factor 4 **Provide the opportunity for new businesses**
Case 1: **The solution is transformative**	Teachers have more time to perform other tasks and focus on those who need help the most.	It deepened the relationship with children and became a part of everyday life.	The learning process is different for children; it offers them a better experience in learning and it adapts the lesson to their needs and reduces the dependency on teachers.	The capability of having apps that are fun to use and allows for progress monitoring is very useful; it could be used in various ways such as commercialising these products for the public.
Case 2: **The solution is transformative**	It saves travel time for students and teachers have more time to perform other tasks and focus on those who need help the most.	For those in rural areas, it became their main source, and it deepened the local students' relationship, too.	The learning process is different for children; it offers them a better experience in learning and it adapts the lesson to their needs and reduces the dependency on teachers. It improved the chances of rural area students to almost match those of local school students.	The capability of having apps that are fun to use and allow for progress monitoring is very useful, and it could be used in various ways such as commercialising these products for the public.

2.3.2.4 M-Tourism

The tourism industry growth in 2012 was faster than any other industry in the world; 1 in every 11 employed people in the world is supported by travel and tourism (WTTC, 2013). M-tourism

is showing cultural assets and heritage informatively, using mobile technology and providing guidelines. Six tourism service categories have been proposed which benefit the most from M-tourism: travel planning, transportation, reservations, search engines and directories, health and safety information and context-aware services (Goh et al., 2010). Tourist information on sites and objects are displayed in many languages, enabling tourists to find attractions such as the Nokia City Lens as shown in Figure 2.5, where attractions can be presented live on the view from the camera (NOKIA, 2015). Other benefits include having real-time access to public transport information and extending some of the E-tourism services to the mobile (WSA, 2013). Two cases are selected for discussion.

Figure 2.5. Nokia Live View App (NOKIA, 2015).

- Case 1: A tourism guide mobile app in Canada.

The mobile solution is a bilingual mobile app to present information on local attractions, accommodation, restaurants and stores. It offers other services such as:

- o A complete schedule of events
- o A description of the region, its neighbourhoods and must-see attractions
- o A host of handy tips once visitors have arrived
- o Location of tourist information offices and public washrooms

Visitors will even be able to use the app to view and locate points of interest around them easily (Québec City Tourism, 2012).

- Case 2: Mobile app for an online agency in China.

A mobile app which is built in an innovative way providing better engagement experience to users to allow them to search and book holidays on the app. Chinese online travel agency 'eLong' reported its financial results for Q3 2013, with mobile now having a significant impact on the business. The CEO maintains 'mobile bookings … now comprise more than 15% of our room nights. We will continue to invest in mobile and execute our mobile and online hotel strategy' (eLong, 2013), (CIW Team, 2014).

Table 2.7 shows the transformative effect that mobile adoption has on the organisations in cases 1 and 2 and evaluates these against the selected factors which constitute the goals of mobile transformations. The evaluation shows the value added to each category and the objectives they served. Main objectives documented or discussed in the case are heightened in green.

Table 2.7. Transformative Effect Evaluation.

Solutions	Factor 1 **Improve employees' productivity**	Factor 2 **Relationship with customer**	Factor 3 **Improve business process**	Factor 4 **Provide the opportunity for new businesses**
Case 1: **The solution is transformative**	Less time is spent on distributing tourism guides and updating old ones. More time can be spent on capturing information about the city and feeding the app.	It deepened the relationship with tourists, allowing them to reach information right where and when they need it and enabling them to make decisions on their itinerary on the sport.	The Quebec City Tourism is focusing more on updating its mobile app, filling it with activities and attaching more than the old prints.	The ability to capture and distribute the city's information through a creative mobile app paves the way for many opportunities. The city president maintains financial support that directly contributed to furthering local technological expertise is one of the city's top strategic goals.
Case 2: **The solution is possibly transformative**	Mobile users used to phone to book; with a reliable mobile, booking is made much easier.	The app deepens the relationship with customers, allowing them to search and book right where and when they need to.	The literature did not give sufficient evidence on possible changes in processes.	The capability of delivering the offers to the mobile platform, through creatively built apps. Could allow for other services to be provided through mobile.

2.3.3   Mobile Enterprise Transformation

A survey conducted by the global community of information professionals (AIIM) found that 67% of respondents consider mobile technologies to be 'important' or 'really important', 45% estimate an improvement in productivity of no less than 33% if travelling and non-travelling staff could connect to the back office, and the speed in responses will increase by three to four times. However, less than 25% have made progress toward mobile-enabled business processes, and 67% do not have mobile access to their document management systems (DM) or their enterprise content management (ECM) systems (AIIM, 2013).

The challenging issue is that although companies may have several well-received mobile applications, they do not have an effective mobile road map to enable the realisation of where their company is and what is the target in a designated time and budget (Castiglioni, 2012). Other issues with mobile adoption include scalable and flexible mobility solutions with changing business needs, the lack of standardisation in mobile offerings from mobile platform vendors and fragmented mobile platforms and diversity issues (Maan, 2012). When organisations adopt mobile, a huge change is introduced. Mobile can fundamentally change business processes and models to generate new revenue streams, lower costs or redefine the organisation's role in the value chain (Buckellew et al., 2013). The change should be influenced by business and IT strategies, and it will affect the people, the applications, the technology and infrastructure and the business process (The Open Group, 2011a).

Enterprise architecture, 'EA', creates a formal link between the corporate strategy, visions and objectives and the initiatives roadmap (Curry et al., 2009). According to Bandyo, "the application of an 'EA' approach is considered relevant and appropriate since the ecosystem within which the development of m-commerce solutions occurs comprises a set of interrelated perspectives based upon the integration of mobile devices, technologies, and business processes" (Hameed & Shah, 2010), (Bandyo-padhyay, 2002).

During the implementation, EA maximises resources by making functions reusable as they do not pay off unless they are reused. EA facilitates this by showing the full image and the mapping

of an enterprise with all of its resources and capabilities (Castiglioni, 2012). An effective EA results in a more efficient business and IT operation, improved return on existing investment and reduced risk for future investment and faster, simpler and cheaper procurement (The Open Group, 2011a). With the rapid development of mobile technologies, the need for an EA framework that supports and guides the adoption of mobile within an enterprise is increasing. Many enterprises are spending more money to adopt the use of mobile with less value in return (AIIM, 2013).

Summary

This chapter reviewed the latest advancements in mobile networks and smartphones, starting from the various standardised cellular networks generations from the beginning of commercial deployment of cellular networks to 5G. Without those advancements in cellular networks, 'the backbone of mobility', the current trend of mobile application and services would not have been possible. Opportunities for new applications expand with every generation. The second section reviewed another aspect of the mobility trend which is smartphones; the devices and the shift in the way they are perceived to be used, from a secondary, luxury utility for business use during the first generation of cellular networks to must-have, very capable devices. Mobile technologies play a major role in some of the other trending technologies of value to enterprises, such as cloud computing, social networks, IoT and Big Data.

With the current mobile trends and popularity of smartphones, enterprises are extending their services to their staff, stakeholders and customers, either to gain a competitive advantage or in response to the demand of mobile-first users. Benefits of mobile applications were discussed in the chapter and categorised into four main goals of mobile initiatives, to achieve a profound transformative effect. The chapter discussed the current wave of applications, using examples from different industries and assessing them against the four identified categories, for initial validation, and illustration of mobile benefits cross-industry.

Enterprise-wide transformation are very complex and require a systematic approach to ensure profit maximisation and high utilisation of resources. The next chapter (Chapter 3) reviews the top frameworks of EA frameworks which facilitate the transformation from an as-is to a future state, to be adapted for the mobile transformation.

Chapter 3. Enterprise Architecture for Mobile Transformation

3.1 Introduction

When organisations adopt mobile technology, a substantial change is introduced. Mobiles can generate new revenue sources, lower costs by changing business processes and models, and reshaping the supply chain (Seidel, 2013). The change should be influenced by the business itself and any IT strategies and it will affect the people, the applications, the technology and infrastructure and the business process as a whole (The Open Group, 2011a). Less than 60% of the organisation's objectives are reached which shows the gap between formulating a strategy and implementing it. (Land et al., 2009).
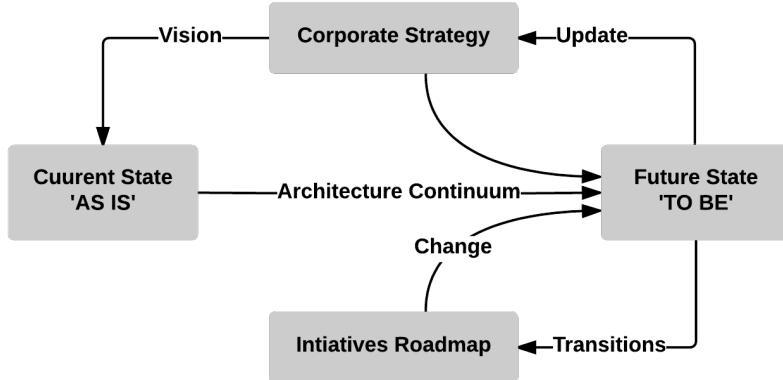
Figure 3.1. Enterprise Architecture the Link Between Strategy to Results.

Enterprise Architecture (EA) forms a formal link between corporate strategy, visions and objectives and the initiatives roadmap (Curry et al., 2009) as depicted in Figure 3.1. In the Information Age, there are many reasons for applying Enterprise Architecture, including the following:

- To reduce the rapidly increasing complexity of enterprises and change (Zachman, 2008b).

- During implementation, EA maximises the utilisation of resources by making sure any reusable functions are reused to make sure that they pay off. EA ensures mapping which includes the full picture of an enterprise with all of its resources and capabilities (Castiglioni, 2012).

- In a time of growing trends in mergers and acquisitions, EA brings flexibility and consistency across multiple tiers. The business tier by aligning the organization's operating models, strategies, IT objectives and IT transformations from a functional perspective. The information tier from '*business processes, data management'* and the application tier by ensuring a minimal amount of overlap and easy integration (Bhogill & Covington, 2011).

EA is also important for governments initiatives, such as in the US, where laws such as the Clinger-Cohen Act of 1996 mandate the federal government to develop EA for Chief Information officers (CIOs). There are professional conferences and communities devoted to EA, such as The National Association of State Chief Information Officers (NASCIO). The US Ministry of Defence (MoD) is the largest spender on the development of enterprise architecture frameworks (Sessions, 2007a).

An effective Enterprise Architecture implementation results in more efficient business and IT operations, an improved return on existing investment, reduced risk for future investments, and faster, simpler, and cheaper procurements (The Open Group, 2011a). In fact, it is been suggested that EA should move towards being a quality management function for transformations similar to lean or six sigma that is used in operative areas of enterprises for quality management (Lange & Mendling, 2011).

As EA facilities transform to a future enterprise state, the proposed framework for Mobile Transformation (MHETF) is specific to draw a future state that is powered by mobile capabilities as shown in Figure 3.2. This is supported by an interoperability model (as shown in chapter 5) to provide the ability for the framework to work in conjunction with existing EA programs. The proposed framework covers the same enterprise domains that EA covers to different extents, and works by producing a future state that allows for transformation plans to be developed with clarity on the objectives and acquired mobile capabilities. It also forms the base of a mobile strategy that covers future iterations and document concerns, recommendations, and constraints throughout planning.
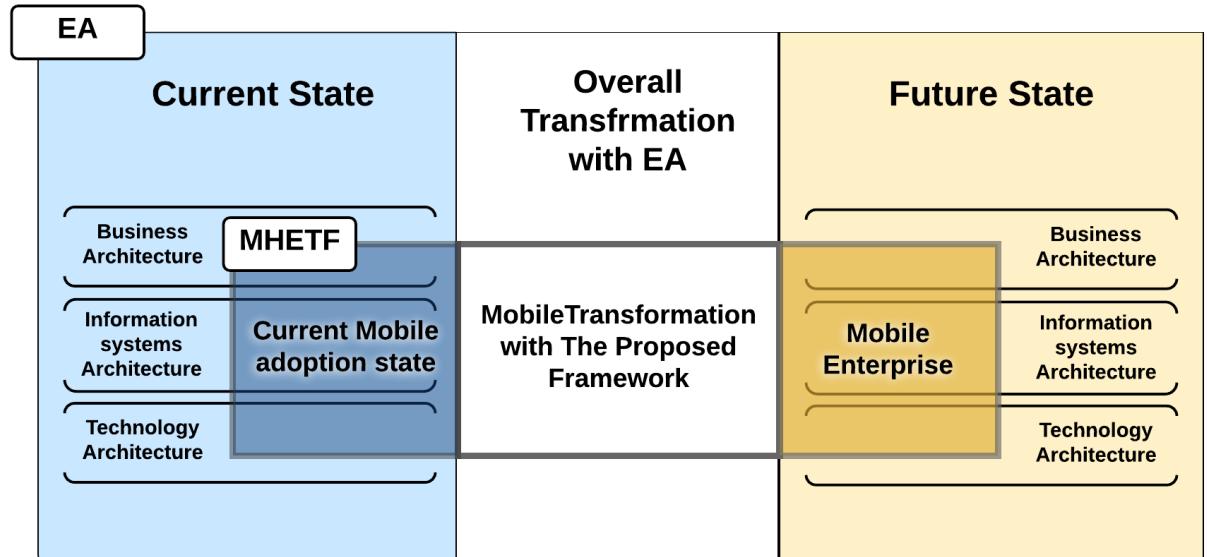
Figure 3.2. The Proposed Framework Relation to EA

3.2 Enterprise architecture (EA)

The cost involved and the success of the business depends increasingly on its information systems which requires a disciplined approach in relation the management of those systems (Zachman, 1987). John Zachman marked the beginning of the field of Enterprise Architecture (EA) when he published his paper 'A Framework for Information Systems Architecture' in 1987. *'As large companies involve complex business and information technology structures and processes, they experience difficulties in coordinating disparate groups to function together towards their business goals in a dynamic environment';* emphasising that *'enterprises can neither accommodate complexity nor high rates of change without a blueprint like Enterprise Architecture (EA)'* (Zachman, 1999). The word architecture is defined as *'fundamental concepts or properties of a system in its environment embodied in its elements, relationships, and in the principles of its design and evolution'* (IEEE and ISO, 2011). Business architecture supports business changes with a more holistic perspective to close the gap between business strategy, operations and IT implementation (Harishankar & Daley, 2011). The theoretical underpinning for this research is derived from the field of Enterprise Architecture.

Enterprise architecture is still in its infancy, so there is not a settled definition for it. The term is used to refer to a *'set of conceptual frameworks, processes and tools used to manage an enterprise's information system infrastructure'* (MacCormack et al., 2015).
The IEEE defines it as *'the fundamental organization of a system embodied in its components, their relationships to each other, and to the environment, and the principles guiding its design and evolution'*. Lankhorst defined it based on its components as well - *'a coherent whole of principles, methods and models that are used in the design and realisation of an enterprise's organizational structure, business processes, information systems and infrastructure'* (Addison, 2010).

Other's definitions are based on its role within an Enterprise *'a high level, strategic technique designed to help senior managers achieve business and organisational change'* (Jiscinfonet, 2011). The Open Group defines it as the effort *'to optimize across the enterprise the often fragmented legacy of processes (both manual and automated) into an integrated*

environment that is responsive to change and supportive of the delivery of the business strategy' (The Open Group, 2011a). This is based on how it is supposed to perform that role. Finish Enterprise Architecture Research 'FEAR' defined it as '*Enterprise architecture describes how organisations' information systems, processes, organisational units and people work as a whole'* (Liimatainen et al., 2007). EA also has been used as '*a complete model of the enterprise; a master plan which acts as an integrating force between aspects of business planning such as goals, visions, strategies and governance principles; aspects of business operations such as business terms, organization structures, processes and data; aspects of automation such as application systems and databases; and the enabling technological infrastructure of the business such as computers, operating systems and networks*'. (Schekkerman, 2005).

In addition to traditional IS/IT-related architecture artefacts, Enterprise Architecture should include purely business related artefacts such as organizational goals, products and services, customer markets, performance indicators and business processes, to support business continuity planning, change impact analysis, risk analysis, compliance management and other important business activities (Winter & Schelp, 2008).

The Enterprise architecture role within an enterprise can be analysed from three different perspectives (Land et al., 2009). These are outlined as follows:

- A regulation-oriented perspective: the perspective of governing the design of an enterprise. The focus is on principles leading to rules, guidelines, and standards, focusing the enterprise's design freedom in the direction of its success.
- A design-oriented perspective: this emphasises the comprehensive and cohesive specification of an enterprise. The focus is on essential design decisions, as well as its core structures. This perspective produces models that describe the design of actual systemic artefacts and their interrelations.
- A patterns-oriented perspective: perspective forms a bridge between the regulative and the design perspectives. To meet the regulations set out in the regulative perspective during design activities, suitable patterns can be applied. Covington and Jahangir (2009) suggested the following four components of for any Enterprise Architecture effort:
1. The Current State Enterprise Architecture model.
2. A Future State Enterprise Architecture reference model for the '*proposed business*

strategy'.

3. A gap analysis that identifies the shortfalls of the current state in terms of its ability to support the objectives and strategies of the business.

4. An architectural roadmap.

EA also '*seeks to achieve desired future change through design. It holds that by understanding existing information assets, business processes, organisational structures, information and application infrastructure (the -as is- state) it is possible to do something different, something new and innovative (the -to be- state)*' (Addison, 2010).

EA ensures that the enterprise goals and objectives are addressed holistically and across all IT projects by taking an enterprise-wide perspective across the services, processes, information, applications, and technology (Covington & Jahangir, 2009). Enterprise Architecture relates to organisational goals, mission and objectives all the way through to the business tasks and activities. Solution Architecture relates to the requirements needed and the external world in relation to a system in terms of hardware and software, and software architecture relates to requirements, fixed systems hardware and infrastructure to software (Schekkerman, 2005).

Enterprise Architecture offer three distinctive advantages (Land et al., 2009) outlined as follows:

1. Designing a coherent conceptualization of a solution first. This ensures that programs to realize the solution are complementary to each other instead of overlapping or having incompatibility.

2. It enables the management to underpin their decisions about the sequence of projects more fundamentally and explicitly.

3. It offers guidance and boundaries for the realization. Without the use of architecture, projects will use the best solution alternatives for the project and possibly not the best for the coherent solution.

EA management is the discipline of managing the whole enterprise architecture and the artefacts building the enterprise architecture. It is a continuous and iterative process identifying the company's business strategy needs and controlling and improving the existing ones in addition to the planned IT support for an organization and considering IT, business processes, business goals, strategies, etc. in order to build a holistic and integrated view on the enterprise (Hämäläinen & Liimatainen, 2008).

3.2.1 Benefits of Enterprise Architecture

The benefits of EA can be defined as *'Without EA, it is very hard to relate solutions to business context. EA makes it possible to migrate in an iterative manner with a clear understanding of the ultimate situation and long-term goals'* (Kasteel, 2009). '*EA provides a strategic, top-down view of an organization to enable executives, planners, architects, and engineers to coherently co-ordinate, integrate, and conduct their activities'*, and the EA framework provides *'the strategic context for this team to operate within'* (The Open Group, 2011a). In any complex organisation, EA should be the central authority and control necessary to effectively govern any involved IT resources with the aim of fulfilling and optimizing the organization's overall needs (Lee et al., 2016).

EA delivers insights and an overview of the business and IT; it is helpful in mergers and acquisitions. EA supports systems development as well as managing IT portfolios and delivering roadmaps for change. In addition, EA assists in decision-making, managing complexity, and IT budget prioritization (Hämäläinen & Liimatainen, 2008). Words such as relations, dependencies, alternatives, alignment, visibility, consistency and compliance are common when Enterprise Architecture benefits are discussed, which harmonizes with the definition of Enterprise Architecture as the blue print of an enterprise in the age of complex systems and rapid change. On the other hand, the existing research hardly discusses the practical aspects of EA (Andersen & Carugati, 2014). More recent studies have identified the factors that facilitate the success of EA. They have, however, failed to include empirical tests of the factors' effects (Lee et al., 2016). Additionally, there is not an agreed definition of it is supposed to be, or what components to include. Most frameworks share the goal of reducing complexity and maximising reusability, however, they have their own definitions, and provide different level of guidance. One reason of this is that EA is still considered to be at its infancy (MacCormack et al., 2015).

EA does not always produce the desired results (Future state). A famous case is the EA Government initiative in the US, where it is claimed that the government is the largest spender on Enterprise Architecture in the world. However, the results indicated that only 20 out of 90 agencies have started using an effective Architecture. The study also indicated that more agencies have decreased in maturity than the ones that have increased in maturity in relation to

the uptake levels of EA (Sessions, 2007a). Analysts estimates the influence of EA practitioners is $1.1 trillion in relation to IT spending worldwide (Gartner, 2013a).

One reasons for the reported underperforming EA programmes is not tailoring the EA to the needs of the specific decision-makers, which was reported in 2008 to have impacted over two-thirds of existing EA projects (MacCormack et al., 2015). Not only are the decision makers' needs are important, documenting the case where the architecture needs to be developed and only using it for that case is another reported reason (Land et al., 2009).

Another pitfall of EA is that the value of it is often not clear to stakeholders, therefore, a good communication strategy is vital to the success of the EA adoption effort, one that communicates success stories, measurements and the EA programme plan, taking enough time to educate the business (Pettey, 2009).

Enterprise architecture was perceived to be a tool used to gain an insight in to the current situation, since it provides an overview of the current relationships between strategy, business and IT and translating missions, visions and goals to principles to be used within any projects. In addition, it is a way to find the best alternative, since EA provides faster insights in feasibility and side effects, or impact, considering alternatives. With a better insight of any future state, it is looked at as an instrument of transformation, with the use of roadmaps and by defining transition architectures or certain plateaus (Kasteel, 2009).

Some have argued that by standardizing across different technologies, vendors, platforms, and application architectures, the complexity of their operations can be reduced, the number of skills required to maintain their IT systems will be controlled, waste is lessened and this enables the reuse of IT components and services (Boh & Yellin, 2007). Brown (2004) selected six commonly reported EA benefits for review, outlined as follows:

1. Documentation of the enterprise.
2. Support for intergradation business processes across the enterprise.
3. The ability to unify and integrate data across the enterprise and to link it with external partners.
4. Increased agility by lowering the 'complexity barrier'.

5. Maximize the reuse of enterprise models to reduce solution delivery time and development costs.

6. Drive continuous business/IT alignment by to creating and maintaining a common vision of the future and ensuring they are shared by both the business and IT communities.

Shah and Kourdi (2007) attempted to categorise the benefits of EA under domains, business-related benefits and IT-related benefits. The business benefits are outlined as follows:

1. Support for capturing knowledge from staff and IT.

2. The ability to establish models that third party solutions providers can conform to.

3. Faster adaptability for of change and new components due to faster knowledge accusation.

4. Support for understanding and modelling business processes, including reviewing and re-engineering processes which will improve operating procedures.

5. Provide decision makers with a holistic view of an enterprise across multiple businesses and technical layers.

IT-related benefits are among others:

1. 'Facilitate the scoping and coordination of programs and IS projects, manage complexity and describe the interdependencies in a usable manner'.

2. Technical resource oversight to overlook redundancies.

3. Knowledge modularity which enables knowledge sharing and visualisation across enterprise levels.

4. More responsiveness in relation to IT resources and systems that are more aligned with the business.

These benefits are possible when Enterprise Architecture achieves its goals. The goals are both internal and external, and are categorised into four classes which are outlined in Figure 3.3. Overall, the following performance indicators were considered by a number of researchers; reducing the cost of IT, preventing IT resource duplication, enhancing interoperability, increasing efficiency of IT management, and improving the alignment between business and IT strategies (Lee et al., 2016).
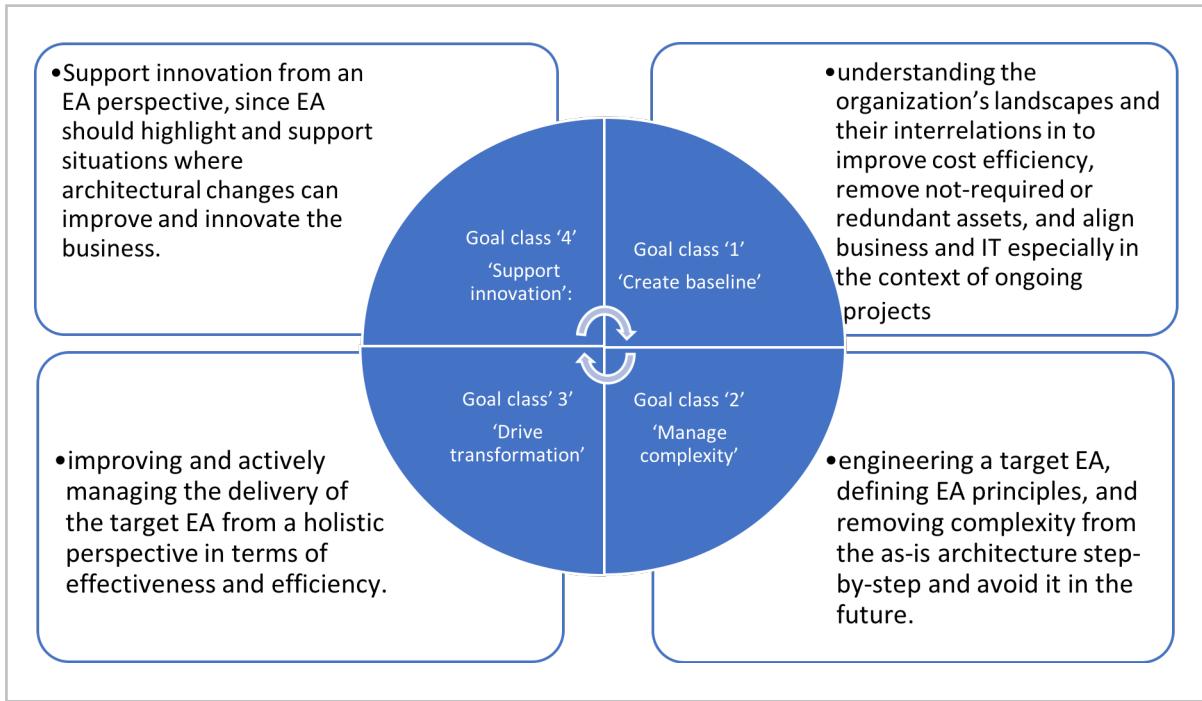
Figure 3.3. Benefits of Enterprise Architecture (Lange & Mendling, 2011)

3.2.2   Enterprise architecture Frameworks

According the American Heritage Dictionary, there are multiple definitions to a framework – it is a '*structure for supporting or enclosing something else, especially a skeletal support used as the basis for something being constructed', 'an external work platform; a scaffold', 'a fundamental structure, as for a written work' and 'a set of assumptions, concepts, values, and practices that constitutes a way of viewing reality'* (Pickett, 2011). Both definitions combined can help to draw a clearer picture of the framework in general, describing it from a different perspective.

The Enterprise Architecture framework is *'simply a logical structure for classifying and organizing the descriptive representations of an Enterprise that are significant to the management of the Enterprise as well as to the development of the Enterprise's systems'* (Zachman, 1996). The Enterprise architecture framework is '*a conceptual tool to guide a systematic development of EA in terms of building blocks and how the blocks fit together'* (The Open Group, 2011a).

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Those are broad definitions of Enterprise Frameworks, and there is no distinctive definition of enterprise architecture framework, or its role. The Open Group's more matured and specific definition argues that the framework should describe a method '*An architecture framework is a foundational structure, or set of structures, which can be used for developing a broad range of different architectures. It should describe a method for designing a target state of the enterprise in terms of a set of building blocks, and for showing how the building blocks fit together. It should contain a set of tools and provide a common vocabulary*'; Additionally, it should also include a '*list of recommended standards and compliant products that can be used to implement the building blocks*' (The Open Group, 2011a). Others claim that it should contain more than that, claiming that it should provide '*a collection of best practices, standards, tools, processes, and templates to assist in the creation of the Enterprise Architecture and architectures of various scopes*' (Bhogill & Covington, 2011). Zachman suggested that in order for a framework to be neutral, it should be defined totally independently of any tools or methodologies and so then any tool or any methodology can be mapped against it (Zachman, 1996). Framework components often include an enterprise architecture for strategic direction, business architecture for the business environment, activities and operations, information architecture for the business's processes, information flow and enterprise interactions, Information-System architecture for the applications '*capabilities*', and technology infrastructure architecture for the principles, platforms and the distribution of applications and data (Schekkerman, 2005).

EA Frameworks provide order to ensure completeness, accountability and tractability of the consequences of decisions, and a deeper understanding of relationships within (Land et al., 2009). In practice, enterprise architecture frameworks enable planning and problem solving, and provide the underlining documentation and specification (Shah & Kourdi, 2007).

3.3   Popular EA Frameworks

Many Enterprise Architecture frameworks have been developed. Some are open source, and others are vendor-specific [Figure 3.4]. IEEE have a list of 64 known frameworks (IEEE and ISO, 2011). And 37 were established by 2016 (IEEE, 2016). However, according to Sessions (2007), over the last 20 years, 90% of EA frameworks in the field are using 4 methodologies 'frameworks', and they are:

- The Open Group Architectural Framework (TOGAF), the most cited framework in the field (MacCormack et al., 2015).

- The Zachman Framework, the first framework to appear in the field.

- The Federal Enterprise Architecture Framework; 'FEA'.

- Gartner 'Vendor specific framework'.

In a later study, a survey was conducted on a sample of industries ranging from the government (Federal, State, and Local) to IT organizations, including banking, financial services and healthcare. 78% of the surveyed enterprises that have adopted Enterprise Architecture frameworks have adopted TOGAF (McMillan & Cameron, 2013). In a different study in 2011, TOGAF was adopted by about 66% of their sample (Lange & Mendling, 2011). According to the Open Group, TOGAF was adopted by 80% of the global top 50 companies, and 60% in the top fortune 500 (The Open Group, 2015). In addition, most comparison studies between popular frameworks have commonly selected TOGAF, Zachman, and FEA due to their popularity. In a survey of framework comparisons, FEA and Zachman were in most of them, and TOGAF was in every one of them (Odongo et al., 2010). Zachman often has a different view of Enterprise Architecture from TOGAF and FEA. TOGAF is aimed to enterprises in general, and the FEA is tailored for the public sector.
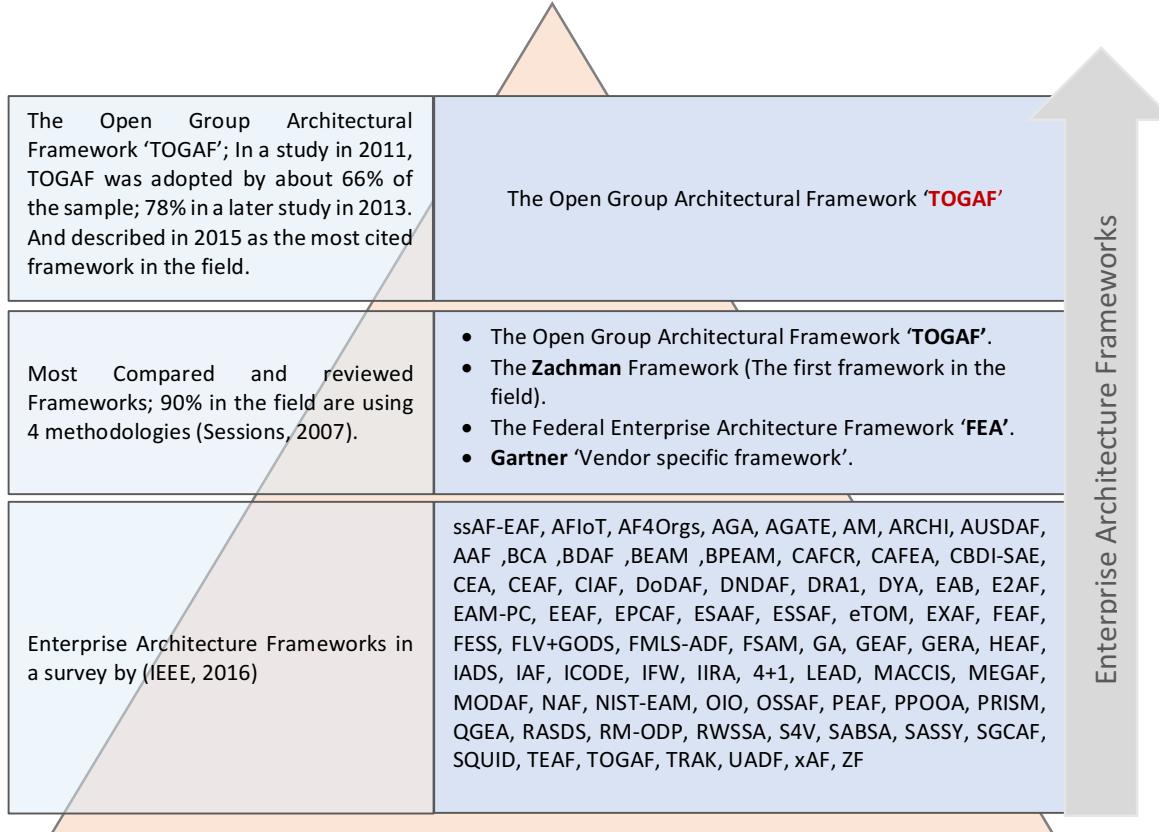
Figure 3.4. Enterprise Architecture framework popularity

These frameworks were selected to be evaluated in this chapter. They vary in nature, are open source, and are well documented and supported which means that they are more likely to have longevity. The frameworks were selected for the following review and evaluation, with the aim of understanding the current frameworks, and deciding on which one to adopt to be used in conjunction with the proposed mobile framework.

Other vendor-specific frameworks were excluded since they are supposed to be implemented by the vendors themselves, which will further complicate the evaluation by adding vendor-related criteria to the selection of the framework, such as the initial decision of whether an external party *'vendor'* should be involved in the architecture effort. The following section starts with a brief description of each of the selected frameworks, followed by the evaluation.

3.3.1 The Open Group Architecture Framework (TOGAF)

TOGAF is a proven enterprise architecture methodology and framework that is used to improve business efficiency. It is a detailed method and contains a set of supporting resources for

developing an Enterprise Architecture.

TOGAF addresses enterprises in four different domains: business architecture, application architecture, data architecture and technical architecture. In addition, it creates the enterprise architecture within a 'Continuum' that has the generic architecture - 'Foundation Architecture' - which applies to all enterprises, the 'Common Systems Architectures', 'Industry Architectures' and the specific architecture called 'Organizational Architectures' that only applies to the given enterprise. One of the most popular components of TOGAF is its ADM methodology that guides the development through the continuum phases (The Open Group, 2011a). TOGAF's latest version, 9.1, has identified the following as the main components of the framework (The Open Group, 2011b):

3.3.1.1 Architecture Development Method (ADM)

The ADM is a '*generic method for architecture development, which is designed to deal with most system and organizational requirements*'. However, the ADM components can be tailored as appropriate to the individual enterprise's needs if ADM is not applicable.

The order of ADM phases is shown in Figure 3.5 although, the documents which have not been created will be created within the ADM Cycle.
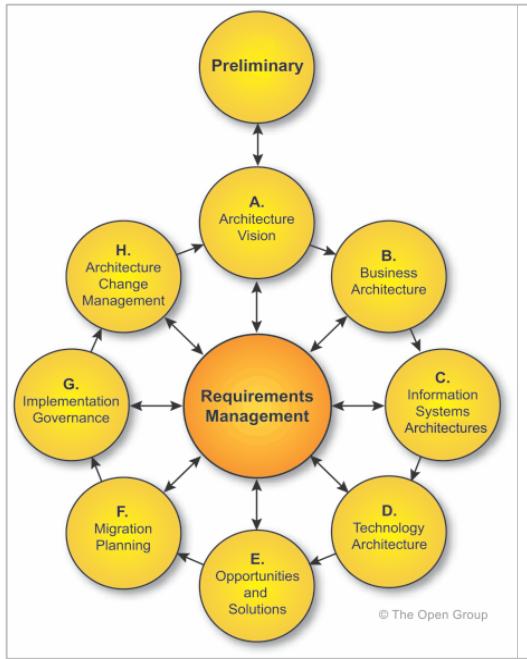
Figure 3.5. Architecture Development Cycle (The Open Group, 2011b)

The ADM is designed to facilitate integration when needed. It can be used with other known frameworks if any deliverables are defined. It is a corporate process that is a part of the governance model. It complements and support other standard program management processes such as those for authorization, risk management, business planning and budgeting, development planning, systems development, and procurement. ADM can be used by small-to-medium enterprise, just as well as the large and more complex ones, comprising an overall collaborative framework across multiple enterprises.

The ADM cycle (Figure 3.6) starts from the 'preliminary' phase to set the scope and governance, establish the team and the organisation, and tailor TOGAF to its specifications. In the following phase 'A', the Statement of Architecture Work is approved, the vision is created and Communications Plan is set. The next phases are 'B', 'C', and 'D', capture the current and future state for each level and identify any gaps. Followed by phase 'E' where the gap analysis from the previous phases are consolidated, architecture transitions are identified and the Architecture Roadmap is created. In phase 'F', the implementation and migration plan is generated, and the projects are started, and monitored in phase 'G'. Changes are approved in phase 'H' by the Architecture board. Future transitions are also identified.

Phases	Description
Preliminary	This phase is about defining 'where, what, why, who, and how we do architecture' in the enterprise, through defining the 'enterprise', 'key drivers and elements', 'the requirements for architecture work', 'the Architecture Principles that will inform any architecture work', 'the framework to be used', 'the relationships between management frameworks' and Evaluating 'the enterprise architecture maturity'.
A. Architecture Vision	Based on the assessment of resources and competencies, this phase defines the scope and constraints of the architecture effort 'and the value that can realistically be expected to accrue to the enterprise from the chosen scope of architecture work'.
B. Business Architecture	In this phase, the Target Business Architecture should be developed that describes how the enterprise needs to operate to achieve the business goals, and respond to the strategic drivers set out in the Architecture Vision, in a way that addresses the Request for Architecture Work and stakeholder concerns, in addition, it should Identify candidate components for Architecture Roadmap based upon gaps between the Baseline and Target Business Architectures.
C. Information Systems Architectures	In this phase, the Target Information Systems (Data and Application) Architecture should be developed, describing how the enterprise's Information Systems Architecture will enable the Business Architecture and the Architecture Vision, addressing the Request for Architecture Work and stakeholder concerns, additionally, it should Identify candidate components for Architecture Roadmap based upon gaps between the Baseline and Target Information Systems (Data and Application) Architectures.
D. Technology Architecture	In this phase, the Target Technology Architecture should be developed, that enables the logical and physical application and data components and the Architecture Vision, addressing the Request for Architecture Work and stakeholder concerns, in addition it should Identify candidate components for Architecture Roadmap based upon gaps between the Baseline and Target Technology Architectures.
E. Opportunities and Solutions	In this phase, the initial complete version of the Architecture Roadmap should be generated, based upon the gap analysis and candidate Architecture Roadmap components from Phases B, C, and D. additionally, if incremental approach is required, delivering business values in iterations through transition architecture.
F. Migration Planning	In this phase, the Architecture Roadmap and the supporting Implementation and Migration Plan is Finalized and coordinated with the enterprise's approach to managing and implementing change in the enterprise's overall change portfolio, additionally, business value and cost of work packages and Transition Architectures is should be understood by key stakeholders.
G. Implementation Governance	In this phase, the conformance with the Target Architecture by implementation projects should be ensured, and appropriate Architecture Governance functions for the solution and any implementation-driven architecture Change Requests are performed.
H. Architecture Change Management	The goal of this phase is to 'ensure that the architecture achieves its original target business value'. Including the cohesive control of architecture changes. By ensuring that 'the architecture lifecycle is maintained, the Architecture Governance Framework is executed', and the enterprise Architecture Capability meets current requirements.

Requirements Management

Figure 3.6. ADM cycle, compiled from TOGAF Documentation (The Open Group, 2011b).

3.3.1.2   ADM Guidelines and Techniques

These are collection of guidelines and techniques available for use in applying the ADM in different scenarios. The latest version 9.1 contain four guidelines, outlined as follows:

1. Applying Iteration

   The suggested iteration as shown in Figure 3.7 within the ADM cycle, is Architecture Capability 'Preliminary to Phase A', Architecture Development 'phase B to Phase D' and later 'phase B to Phase F', Transition Planning 'Phase E to Phase F', and Architecture Governance 'Phase G to Phase H'.
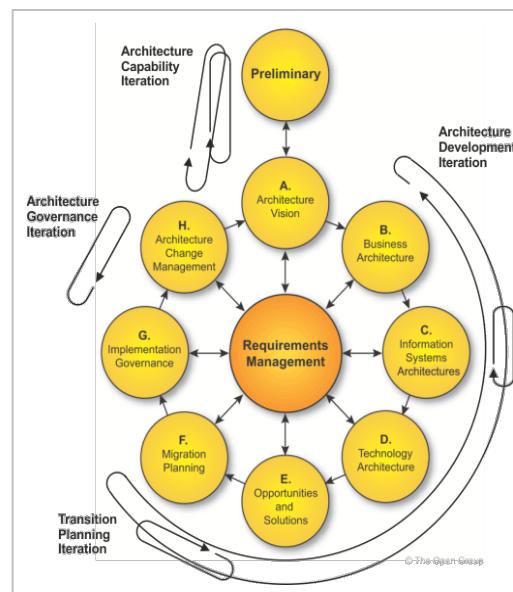
Figure 3.7. ADM Iterations

2. Applying the ADM across the Architecture

   It divides the Architecture Landscape into three levels of granularity:

   - Strategic Architecture: '*an organizing framework for operational and change activity'*, allowing for direction setting at an executive level.
   - Segment Architecture: '*an organizing framework for operational and change activity'*, allowing for direction setting and the development of effective architecture roadmaps at a program or portfolio level.

- Capability Architecture: '*an organizing framework for change activity and the development of effective architecture roadmaps thus realizing capability increments*'.

3. Security Architecture and the ADM

The accepted and supported areas of concern for the security architect by TOGAF throughout the ADM phase are:

- Authentication: '*The substantiation of the identity of a person or entity related to the enterprise or system in some way*'.

- Authorization: '*The definition and enforcement of permitted capabilities for a person or entity whose identity has been established*'.

- Audit: '*The ability to provide forensic data attesting that the systems have been used in accordance with stated security policies*'.

- Assurance: '*The ability to test and prove that the enterprise architecture has the security attributes required to uphold the stated security policies*'.

- Availability: '*The ability of the enterprise to function without service interruption or depletion despite abnormal or malicious events*'.

- Asset Protection: '*The protection of information assets from loss or unintended disclosure, and resources from unauthorized and unintended use*'.

- Administration: '*The ability to add and change security policies, to add or change how policies are implemented in the enterprise, and add or change the persons or entities related to the systems*'.

- Risk Management: '*The organization's attitude and tolerance for risk. (This risk management is different from the special definition found in financial markets and insurance institutions that have formal risk management departments.)*'

4. Using TOGAF to Define and Govern SOA's

Service-orientation is '*a way of thinking in terms of services and service-based development and the outcomes of services*'. Service-Oriented Architecture (SOA) is '*an architectural style that supports service-orientation*'.

TOGAF provides support for SOA throughout the ADM cycle, with the main benefits of SOA EA including:

- Supports planning and analysis by providing '*consistent abstractions of high-level strategies and deliverables'*.

- Tackling a single businesses problem from various perspectives.

- Achieving a future state through clearly designed road maps.

- Linking assets and IT to the business.

- Facilitate '*impact assessment, risk and value analysis, and portfolio management'*.

- Documentation of '*principles, constraints, frameworks, patterns, and standards'*.

- '*Governance frameworks and processes that ensure the appropriate authority for decision-making'*.

3.3.1.3   Architecture Content Framework

The Content Framework provides '*a structural model for architectural content that allows the major work products that an architect creates to be consistently defined, structured, and presented'*. It enables TOGAF to be a standalone framework; however, if the Architect opts to use another framework with the TOGAF ADM, the content framework provides pointers and a useful reference for that purpose.

The content framework describes the end-product of the architectural effort. Inputs and outputs are defined in detail, contextualising each deliverable in a holistic architecture view of the enterprise to provide an underlying structure for the ADM. The content framework includes a content meta-model that defines the building blocks in a given architecture and relates them to one another.

The Content Framework categorises the products into three categories as shown in Figure 3.8, which are outlined as follows:

- Deliverables: '*is a work product that is contractually specified and in turn formally reviewed, agreed, and signed off by the stakeholders'*. It documents the outputs of a project to be archived at completion or '*transitioned into an Architecture Repository as a reference model, standard, or snapshot of the Architecture Landscape at a point in time'*.

- Artefacts: '*is an architectural work product that describes an aspect of the architecture'*. They are generally classified as *catalogues '(lists of things), matrices (showing relationships between things), and diagrams (pictures of things)'*. Artefacts form the content of the Architecture Repository and an architectural deliverable may contain many artefacts.
- Building blocks: '*represents a (potentially re-usable) component of business, IT, or architectural capability that can be combined with other building blocks to deliver architectures and solutions'*.
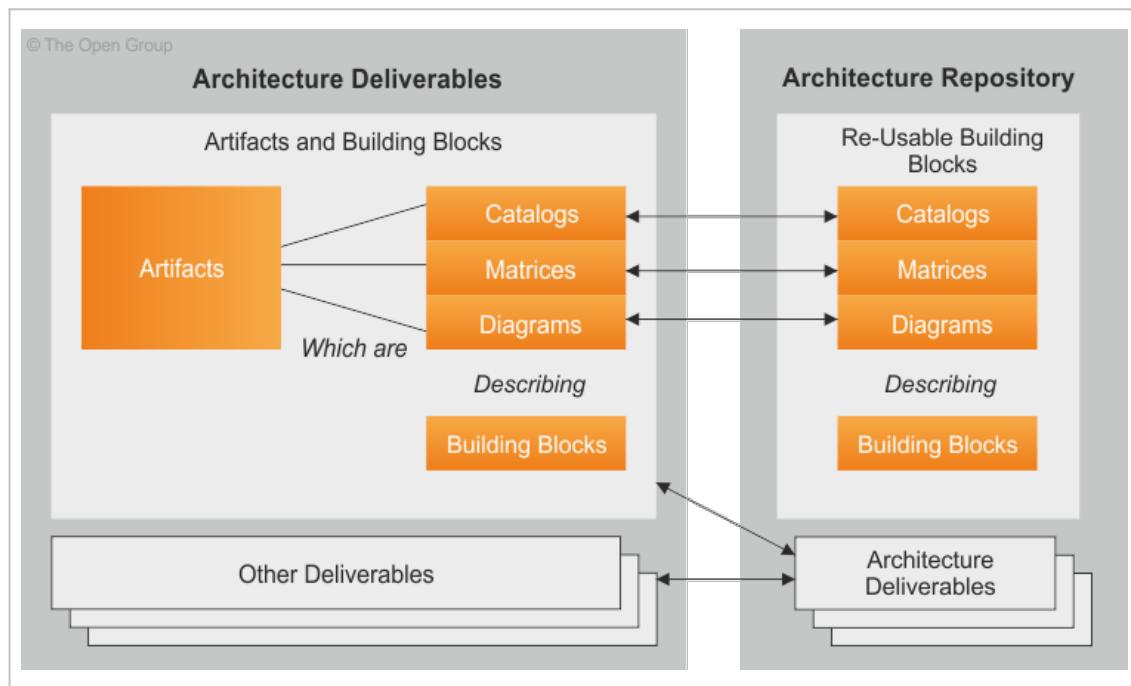
Figure 3.8. TOGAF Products categorisation (The Open Group, 2011b).

3.3.1.4   Enterprise Continuum

The Enterprise Continuum classifies and represents all available assets as illustrated in Figure 3.9. This includes assets within the enterprise or the relevant assets in the wider view such as business strategies, products, legislation, market factors, commercial factors, and research.

The Enterprise Continuum serves as a view of the '*Architecture Repository that shows the evolution of related architectures from generic to specific, from abstract to concrete, and from logical to physical'*. It is method for '*classifying architecture and solution artefacts, both internal and external to the Architecture Repository, as they evolve from generic Foundation*

Architectures to Organization-Specific Architectures'. This enables the re-usability of the architecture's assets and artefacts, thereby maximising investment.
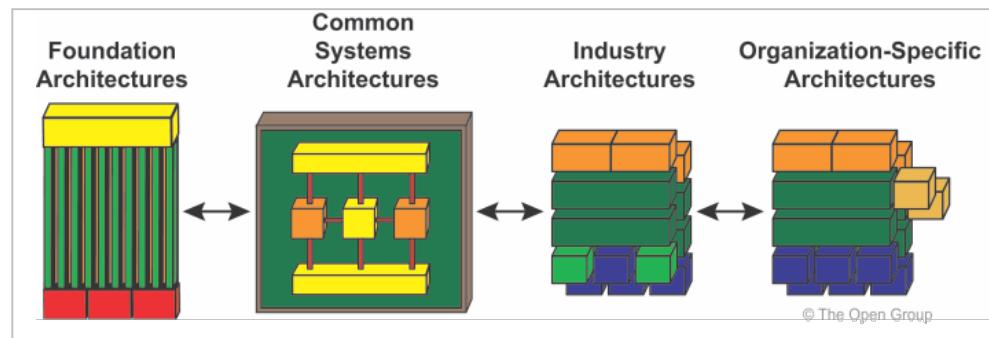
Figure 3.9. Enterprise Continuum (The Open Group, 2011b).

3.3.1.5 TOGAF Reference Models

TOGAF frameworks propose two different reference models to be used in the development organization's architecture as shown in Figure 3.10 and outlined as follows:

1. TOGAF TRM - 'Technical Reference Model': a fundamental architecture that more specific architecture can be built on top of. The TRM fits in the Foundation Architecture within the Enterprise Continuum. It provides a foundation on which more specific architectures and architectural components can be built.

2. TOGAF III-RM - 'Integrated Information Infrastructure Reference Model': this reference model is based on the TRM; it enables the vision of Boundaryless Information Flow to be realised.
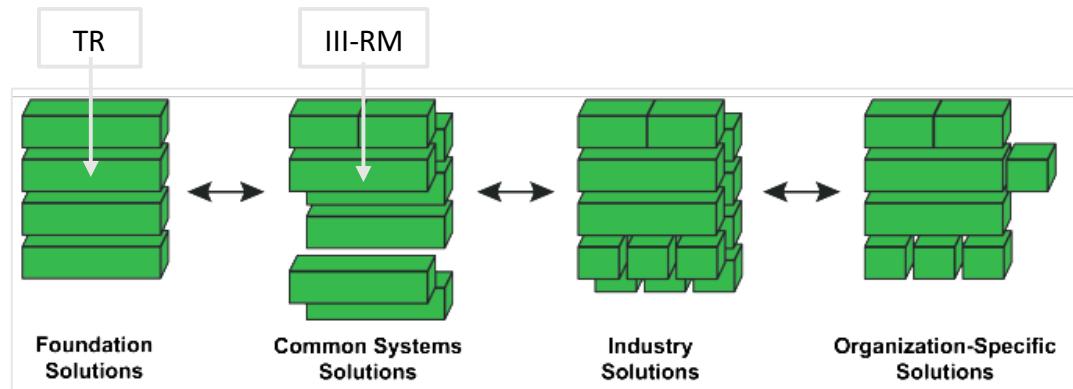
Figure 3.10. Solution Continuum (The Open Group, 2011b).

3.3.1.6   Architecture Capability Framework

The Architecture capability frameworks provides '*a set of reference materials for how to establish such an architecture function'*. It provides guidance in Architecture governance including the architecture board, setting up the architecture development contracts and ensuring the compliance of individual projects with enterprise architecture. It also provides Architecture Maturity Models, which describe the practices of an enterprise and categorises them into levels, to improve measurements and to manage improvement efforts. Additionally, it provides an Architecture Skills Framework to give a view of the competency levels required for any specific roles.

The main electronic government program in Saudi Arabia - 'Yesser' - has relied heavily on TOGAF in their effort to develop a National Enterprise Architecture (Yesser, 2017). The intention is to conduct case studies in Saudi Arabia.

3.3.2   Zachman

The integration of answers to questions (What, How, When, Who, Where, and Why) enables the comprehensive, composite description of complex ideas. The Zachman framework is the application of these descriptions in Enterprise Architecture (Zachman, 2008b). The Framework is '*a logical structure for classifying and organizing the descriptive representations of an Enterprise that are significant to the management of the Enterprise as well as to the development of the Enterprise's'* (Zachman, 1996). The EA Framework is *'a normalized schema, one (meta) fact in one place'* (Zachman, 2003).

The Zachman framework does not suggest a methodology, and according to Zachman, it should not in order to stay natural. '*It implies nothing about implementation processes (methodologies) or tools whether they are top-down, bottom-up, left-to-right, right-to-left, or where to start'*. (Zachman, 2008b). This led some to suggest that it is not a framework; it is instead a taxonomy that classifies documents of architectural work to tackle complexity of architecture and suggests questions to explore (Sessions, 2007a). However, lately Zachman started to call his framework an ontology, suggesting that it supports the Enterprise Architecture in the same way that the periodic table supports chemists. Although it is simple, it is used for complex chemical equations. (Zachman, 2008a), (Sessions, 2007b).

The Zachman Framework is depicted in Figure 3.11 as a bounded 6 x 6 'matrix' with the Communication Interrogatives as Columns and the Reification Transformations as Rows. The Cells - '*the intersection between the Interrogatives and the Transformations*' - represents the Framework classifications. According to Zachman, this matrix provides a set of descriptive representations for anything, particularly Enterprises (Zachman, 2008a).
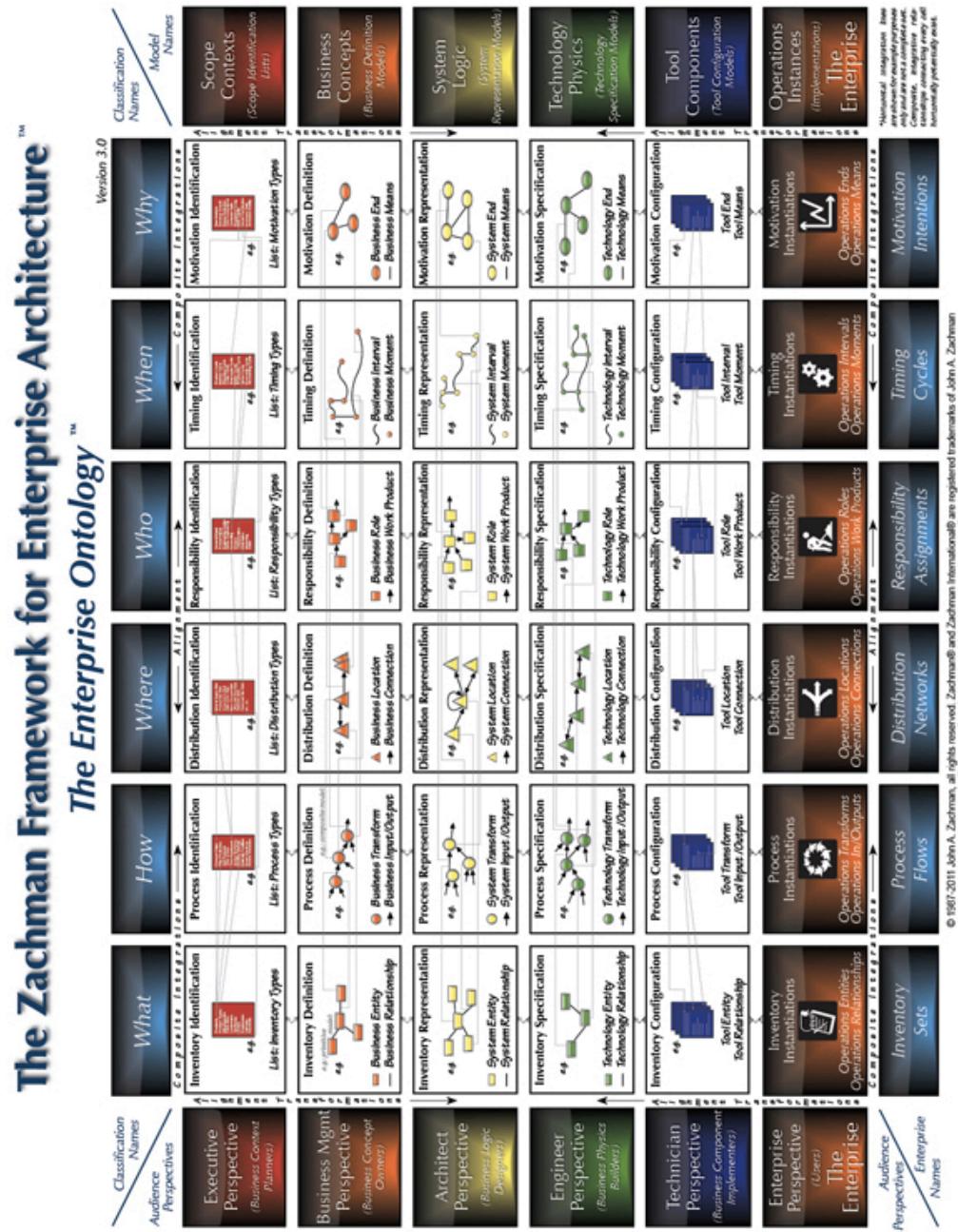
Figure 3.11. Zachman Framework (Zachman, 2008a).

The rows in Zachman framework represent the audience perspectives identifying the models needed to enable each of the audiences to view the enterprise from their own perspective. These models will be specific to one Communication Interrogative in every column of 'what, how, where, who, when, why'. The perspectives are: the Enterprise perspective - '*the planner'*, Business Management perspective - '*the owner'*, Architect perspective - '*the designer'*, Engineer Perspective - '*the builder'*, Technician perspective - '*the Implementer'*, and the Enterprise Perspective - '*the user'*.

Figure 3.12. Zachman's first representation of the later to be a framework (Zachman, 2011a).
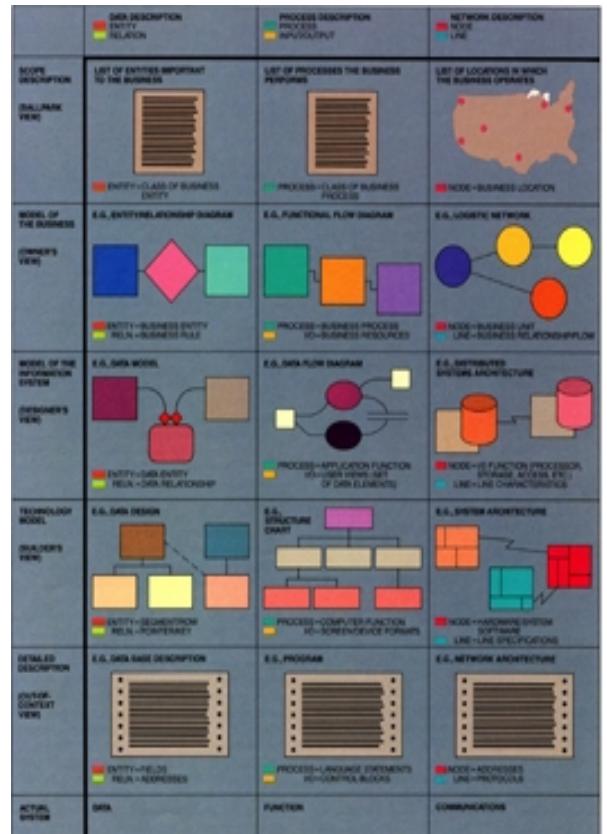
Figure 3.13. First Version of Zachman's Framework (Zachman, 2011a).

Although the Zachman framework originated in 1987, it only evolved to the latest 'Version 3.0' as shown in Figure 3.11 in 2011. The framework has evolved over time, starting from a crude representation in 1984 as shown in Figure 3.12 and Figure 3.13, although the Communication Interrogatives may seem vital to the framework now, they did not appear in the first version of the framework (Zachman, 2011b).

The answer to the Questions 'what, how, where, who, when, why' constitute the complete description of anything, and the descriptions '*similar to Artefacts in TOGAF'* include Bills of Material ('What the object is made of'), Functional Specs ('How the object works'), Drawings ('Where the components exist relative to one another'), Operating Instructions ('Who is responsible for operation'), Timing Diagrams ('When do things occur'), and Design Objectives ('Why does it work the way it does') (Zachman, 2011a).

3.3.3   Federal Enterprise Architecture (FEA)

The lastest version of Federal Enterprise Architecture (FEA) aims to '*accelerate agency business transformation and new technology enablement by providing standardization, analysis and reporting tools, an enterprise roadmap, and a repeatable architecture project method that is more agile and useful and will produce more authoritative information for intra- and inter-agency planning, decision-making, and management'*. The federal enterprise architecture defines Enterprise Architecture as 'a*n established process for describing the current state and defining the target state and transition strategy for an organization's people, processes, and technology'*.

Whereas the previous versions of the federal framework used the segments concept to transition the architecture's development and provide guidance rather than a methodology, the last version introduced the Collaborative Planning Methodology. This is a systematic, and repeatable methodology. In addition, the framework has a Consolidated Reference Model that has a number of interrelated reference models based on the perceived domains of the architecture work: Strategy, Business, Data, Applications, Infrastructure and Security.

Released in May 2012, the Common Approach to Federal Enterprise Architecture (Figure 3.14) classifies the levels of scope of Enterprise Architecture as having eight levels: International, National, Federal, Sector, Agency, Segment ('*focuses on a particular service area or business unit'*), System, and Application. In addition, it comprises of eight elements: Governance, Principles, Method, Tools, Standards, Use, Reporting, and Audit.
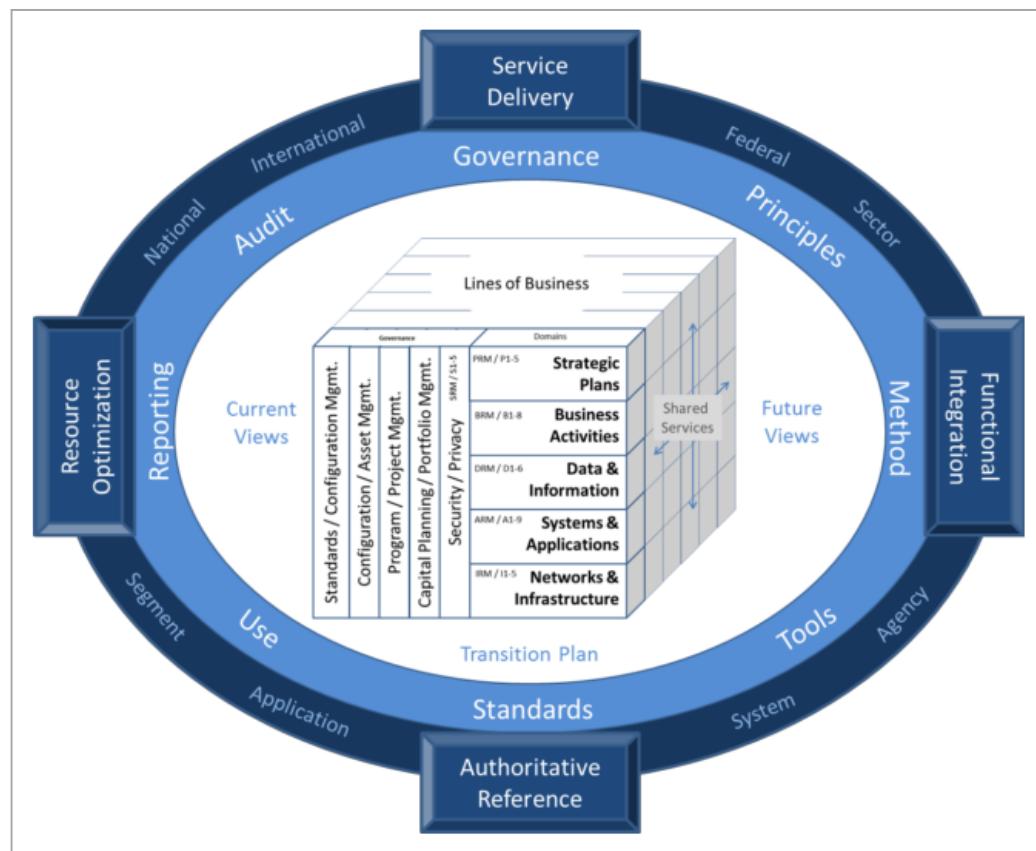
Figure 3.14. The Common Approach to Federal Enterprise Architecture (Office of Management and Budget, 2012).

3.3.3.1   FEA elements:

1. Governance: '*which identifies the planning, decision making, and oversight processes and groups that will determine how the EA is developed, verified, versioned, used, and sustained over time with respect to measures of completeness, consistency, coherence, and accuracy from the perspectives of all stakeholders'*.

2. Principles: FEA provides general principles such as Future-Ready, Investment Support which serves as criteria for future investment and architectural decisions, and Design and

Analysis Principles to guide the architecture projects across strategy, business, and technology domains.

3. Method: the framework provides the Collaborative Planning Methodology (CPM) [Figure 3.15]. It is an iterative process between the 'Organize and Plan' and 'Implement and Measure' phases. The first phase consists of the following three steps:

    1. Identify and Validate:

        In this step, the major drivers for change should be understood, and what needs to be achieved should be identified and assessed. Then the architect defines, validates, and prioritizes the mission and goals of the various stakeholders.

    2. Research and Leverage:

        In this step, the external organisations and services with similar needs to the ones identified in the first step are to be researched and analysed in order to be leveraged.

    3. Define and Plan:

        An integrated plan is developed in this step, to meet the needs identified in the first step. The changes could cover the *'Strategy, Business, Data, Applications, Infrastructure and Security'* domains.

    The second phase consists of the following two steps:

    1. Invest and Execute:

        In this step, the investment decision is to be made to implement the integrated plan that was developed in the previous step.

    2. Perform and Measure:

        The framework then operates with the new changes in place and measures the performance outcomes against any identified metrics.

4. Tools: such as a Repository website and visual representation of architecture, with views of all of the *'architecture, strategic planning products and performance measures, configuration management and quality standards'* in addition to *'security and risk solutions for physical, information, personnel and operational needs'*.

5. Standards: common methods of the analysis, design and documentation essential to the optimisation of resources.

6. Use: the focus area that is improved by the architecture in term of analysis and activities.

7. Reporting: to implement regular reporting on both capabilities and options from an architectural perspective for the overall progress.

8. Audit: the need for periodic audits to ensure '*quality work, consistent methods, and increasing levels of capability and maturity*'.
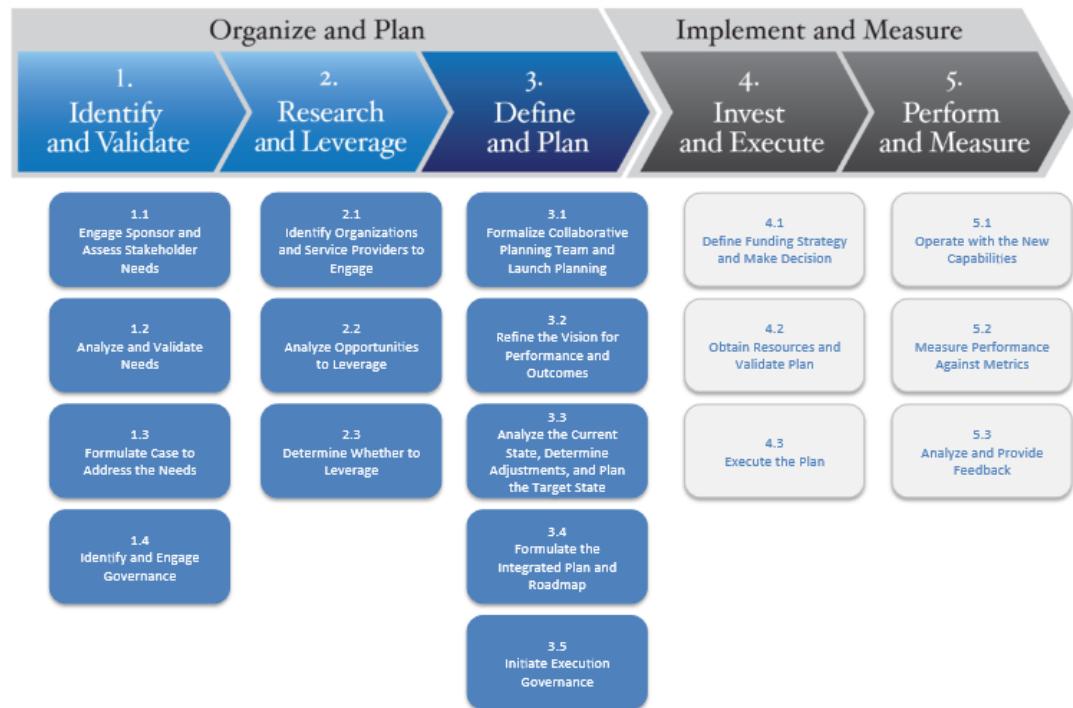
Figure 3.15. Collaborative Planning Methodology 'CPM' (Office of Management and Budget, 2012).

3.3.3.2 Reference Models:

The reference models comprise of '*a framework for describing important elements of federal agency operations in a common and consistent way*'. The following are the six reference models involved in the common approach to Federal EA as shown in Figure 3.16:
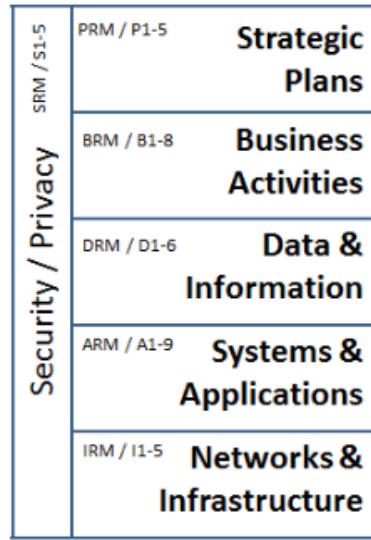
*Figure 3.16. FEA reference models (Office of
Management and Budget & Plan, 2013)*

1. Performance Reference Model - 'PRM': Supports the '*analysis and reporting of the architecture in the strategy sub-architecture view of the overall EA'*. It enables the use of EA to measure the success of investments and their impact on strategic outcomes.

2. Business Reference Model - 'BRM': Supports the analysis and reporting of the architecture in the business services sub-architecture view of the overall EA. It provides a '*functional of Federal Government organizations and their lines of business, including mission and support business services'*.

3. Data Reference Model - 'DRM': '*The model provides a standard means by which data may be described, categorized, and shared'*. This model focuses on the available information and any information gaps, thus resulting in an increased integration and reused opportunities of information and semantic interoperability, while maintaining the appropriate use of the information, security and privacy.

4. Application Reference Model - 'ARM': to facilitate analysis and the reporting of architecture in the '*applications sub-architecture view of the overall EA'*. It advances in the fields of reuse, and technology and service component standardisation.

5. Infrastructure Reference Model - 'IRM': Supports the analysis and reporting of the architecture in the '*host infrastructure sub-architecture view of the overall EA'*. It enables the delivery of voice, data, video, and mobile service components and capabilities.

6. Security Reference Model - 'SRM': The model supports the analysis and reporting of the *'architectural analysis and reporting across all the sub-architecture views of the overall EA'* (Figure 3.14). The model facilitates a roadmap for security and privacy integration with EA.

3.4 Enterprise Architecture Frameworks Comparisons:

In the age of complex IT systems, it is vital that organizations have an established Enterprise Architecture programme to manage complexity and change through constituting a baseline, and ensuring that there is alignment across all technological facets (Jacobs et al., 2011). Therefore, in large enterprises, the mobile initiative should be supported by a solid Enterprise Architecture programme, if it is not initiated by it in the first place. The following evaluation is aimed mainly at the small and midsize enterprises ('SMEs') to serve as a decision-making tool that influences the adoption of enterprise architecture framework that guides the transformation towards being a mobile enterprise. Many comparisons have been done on the selected framework in an attempt to develop a systematic approach or a framework for EA framework selection (Sessions, 2007a), (Odongo et al., 2010), (Abdallah & Galal-Edeen, 2006), (Ohren, 2004), (Mccarthy, 2006), (Winter et al., 2010), (Franke et al., 2009), (Magoulas & Hadzic, 2012), (Raadt et al., 2008), (Tang et al., 2004), (Urbaczewski & Mrdalj, 2006).

These papers attempt to compare the popular frameworks from different perspectives; Table 3.1 highlights most factors used in the Framework comparisons, and the perspective of comparison (Odongo et al., 2010).

Table 3.1. Perspectives and factors of Enterprise Architecture Frameworks comparisons; compiled from (Odongo et al., 2010).

Perspective	Factors
Goals	Architecture definition and understanding, The architecture development process, Architecture transition strategy, Architecture evolution support, Architecture assessment, Architecture models, Design trade-offs, Design rationale, Standardization, The architecture knowledge base, Architecture verifiability.
Inputs	Business drivers, Technology inputs, Business requirements, Information, system environment, Current architecture, Quality requirements.
Outcomes	The business model, System model, The information model, The, computation model, The software configuration model, The processing model, The implementation model, The platform, The quality design, The transition design, The design rationale.
Views	The scope, The owner, The designer, The builder, The subcontractor, The user.
Abstractions	The what, The how, The where, The who, The when, The why.
System development life cycle	Domain identification, Planning, Analysis, Design, Implementation, Maintenance.
Guide	Meta model, Procedure model, Modelling Technique, Role, Specification document, Process completeness, Maturity model, Reference model guidance, Practice guidance, Governance guidance, partitioning guidance, Prescription catalogue, providing guidance on architecture Descriptions, Product definitions, Architecture development, Information reference, resources, Tool builders, compliant architecture views, EA development process, Transition strategy and plan, Product and repository issues.
Quality	Alignment, Integration, Value creation, Change Management, Compliance, Taxonomy Completeness, Vendor neutrality, Time to value, Information availability, Business focus, EA focus, Explicit Detail of Products.
Miscellaneous	Basic organizational approach and views, Integrated EA product specifications Descriptions, EA strategic vision and goals, Architecture principles, Product specifying standards, EA security issues, Tool support, EA repository issues, Explicit specification, Architecture domain, Analytical approach, Stakeholder, Application domain development, Conformance.
Requirements	Methodology domain supporting, Developing interface, Automating EA development and, Extending and customizing, Analysing and Manipulating, providing repository, Costing and Vendor Supporting.
Principles	Integrating enterprise systems, Developing organization solutions, Developing physical plant, Developing non-physical plant, Enterprise focus, Performing standard assessments, Assessing products, Assessing new technologies, Tailoring model views, Developing standard profiles, Developing architecture descriptions, Evaluating objectives against requirements, Determining enterprise problems, Architecture information Repository, Mapping of interfaces and services, Addressing migration issues.

For the following evaluation, the following three influential criteria were considered in identifying the evaluation factors:

1- The evaluation should be beneficial to SMEs, as enterprises often tend to select a framework at an early stage before the decision on investments has been made, and that includes investments in training and resources. This means that a simple, straightforward and practical evaluation is needed in which the terms of enterprise architecture are used less, and little differentiators with no large impact of goals of architectural work are avoided.

2- Since there is not an agreed singular definition for Enterprise Architecture, the selected frameworks are different, in their view of the Architecture and how it should be done. Comparing them quantitatively may incur the risk of mixing apples with oranges since what is best for an organization may not be the best for another (Magoulas & Hadzic, 2012). However, the following evaluation was done on the fit for this study.

3- The factors were selected for the study, which are of importance for enterprise architecture frameworks that are to be used as a transformation tool to mobile enterprise and a next generation platform.

The following evaluation Factors have been identified from the literature by the author:

1- Ease of use.
2- Support in term of resources, training and continued improvement.
3- Guidance (Process and Methodology).
4- Adopting time.
5- Support for Service Oriented Architecture 'SOA'.
6- Reference Models.
7- Stakeholders Management.

3.4.1 Ease of use

Simplicity is an important factor especially for 'SMEs', due to the high cost of Enterprise Architecture development and the time needed to build new capabilities for the in-house development of Enterprise architecture.

Forrester viewed a simple framework as the more practical and less conceptual framework and also less exhaustive, putting FEA on the top of a simplicity ranking followed by TOGAF,

claiming that both could be implemented by a novice, followed by Zachman, which should be implemented by an expert (Schekkerman, 2006).

Multiple factors used in other comparisons could be grouped together to represent simplicity in total including practices, governance and partitioning guidance, perceptive catalogue and process completeness - thus ordering the three frameworks in terms of simplicity in the same order (Sessions, 2007a). However, some could argue that TOGAF is simpler by being the one framework focusing on decision making (Urbaczewski & Mrdalj, 2006). Another comparison considered FEA as being easier to use and easier to learn than TOGAF (Rouhani et al., 2013). Although Zachman may seem simpler due to its straightforward idea based on the intersections between the integrative questions and the domains, it is suggested that the Zachman framework has too many views included in it, which makes it difficult to implement. In addition, not all views are described in detail and the relationship between the different views is not transparent in all cases. The framework is a mix of views including the domains of the enterprise architecture, and the different stakeholders (Rohloff & Siemens, 2005).

3.4.2 Support in term of resources, training and continues improvement

The first skill CIOs founds a gap in talents in Enterprise Architecture (Gartner, 2013b). The availability of resources and information about a framework is an important concern. Making sure that the framework is well supported and updated is another concern. The investment in learning and implementing the framework is future-proof because of the cost implied in changing frameworks, time itself as a whole and training or hiring employees. The more the framework is used, the more information is available, practices and lessons learned are shared, and common mistakes are flagged up. More importantly is the effort put into insuring the constant improvement of a framework, publishing materials and updates and certifying practitioners.

The selected frameworks are three out of the four frameworks accounting for 90% of the used EA Frameworks around the world. In term of use, they are all popular. However, they may differ in the kind of support and attention that they receive. Table 3.2 compares them in terms of support.

Table 3.2. Support comparison between the selected frameworks.

TOGAF	FEA	Zachman
TOGAF is maintained by The Open Group, which has about 400 members, led by HP, IBM, Oracle and PHILIPS. Thus, versions come out in faster rate keeping framework up to date, current version is 9.1. Probably no other framework is get the attention and momentum of TOGAF. The Open Group certify trainees, arrange event around the world and publish related content (The Open Group, 2011a).	A project of the USA feral government started in 2006. However, it is influenced by previous attempt by government in 1999 (FEA). These initiatives have made the US government one of the largest spenders on Enterprise architecture in the world. (Sessions, 2007a). The office of Management and Budget provide additional resources, templates, best practices and success stories, and web-based dashboards for agencies to monitor their progress.	Zachman international, which has published 3 versions so far, it started in 1987 and the latest look after Zachman framework in 2011. Besides certifying trainees, Zachman international look into proposed methodology and certify them (Zachman, 2011b). And Zachman international work with other partner in to develop other frameworks.

3.4.3 Guidance 'Processes and Methodology'

In an interview with John Zachman, he stated that '*Other frameworks tend to be focused on implementation or methodologies as opposed to classification and therefore, facilitate manufacturing as opposed to facilitating engineering*' (Sessions, 2007b). The Zachman framework does not suggest a methodology for implementation, whereas one of the core components of TOGAF is its methodology - 'ADM' - and in the case of FEA, this has the Collaborative Planning Methodology ('CPM').

The Collaborative Planning Methodology ('CPM') is '*a full planning and implementation lifecycle for use at all levels of scope 'International, National, Federal, Sector, Agency, Segment, System, and Application*' (Office of Management and Budget & Plan, 2013).

On the other hand, the TOGAF Methodology of 'ADM' appears to be more technical. It provides a set of architecture domains (business, data, application, and technology), a set of recommended deliverables, a method for managing requirements and guidelines on tools for architecture development (The Open Group, 2011a).

Earlier comparisons did not favour FEA in term of methodology, however, the methodology has improved over time, to a '*simple, repeatable process consists of integrated, multi-*

disciplinary analysis that involves sponsors, stakeholders, planners, and implementers' (Office of Management and Budget, 2012). However, some may criticize FEA for the guidance offered in requirement management (Rouhani et al., 2013).

3.4.4 Support for Service Oriented Architecture (SOA)

'*SOA will form the basis of the IT platform in the future'* (Schekkerman, 2005). SOA is a '*set of principles and methodologies for designing and developing software in the form of interoperable services'* (Office of Management and Budget & Plan, 2013). SOA can be both an architecture and a programming model, and can be a way of thinking about software development. It enables shared services between applications through published and discoverable interfaces, and indicates where the services can be invoked over a network. When implemented using a Web service technology,, it creates powerful applications with a flexible programming model, thereby reducing cost and time (Channabasavaiah et al., 2004). SOA is more popular today with the high demand for external services derived by Cloud and Mobile. In other words, SOA-based applications are a more mobile friendly infrastructure. IBM listed SOA for mobile in the top mobile trends in 2013 and stated '*this may be the single most important trend'* (Nordbeck, 2013)**.** Another survey showed that although 21% of the respondents are using SOA, 52% are planning to implement it fully (Mann, 2012).

TOGAF provides a clear and direct method to implement SOA using TOGAF's ADM. It has an SOA maturity model, governance and supporting strategy, and business, technology and information architecture (The Open Group, 2009).

On the other hand, the importance of an SOA Meta model is stated in the FEA and a separate Federal Service Oriented Architecture is proposed. While it does not propose a methodology, it also provides best practices and the future road map in-depth (Council CIO, 2008). The Zachman framework makes no mention of 'SOA'; multiple attempts have been made to complement it with a Meta model.

3.4.5 Adopting time

This factor evaluates in terms of the time needed before a framework is operational. Many factors can prolong the time that is needed to implement an Enterprise architecture program.

The FEA is the most comprehensive framework. It is not easy to be scaled down to an organization size, and the support for it outside the USA is limited. Therefore, if the enterprise is not a part of the US government nor a part of larger governmental initiative, then it will face some difficulties in adopting the formwork.

The Zachman framework is simple, and easy to comprehend, and many are qualified in implementing it. However, since it does not suggest a methodology and until a clear process is put in place, it cannot be utilized. On the other hand, many professionals around the world are certified in TOGAF. It has a methodology that can be tailored and is easy to scale. It is popular and widely used in different industries, therefore, it can be claimed that it is faster to implement.

3.4.6   Reference Model

Generally, enterprise architecture aligns the implementation within the business and IT captures the gap between the current and future status of the organization and introduces change to multiple layers of the organization. Framework reference models are '*designed to facilitate cross-agency analysis and the identification of duplicative investments, gaps and opportunities for collaboration within and across agencies'*. Collectively, the reference models comprise a framework for describing important elements of the FEA in a common and consistent way 'FEA'. It is '*an abstract framework for understanding significant relationships among the entities of an environment, and for the development of consistent standards or specifications supporting that environment'*. A reference model is '*based on a small number of unifying concepts and may be used as a basis for education and explaining standards to a non-specialist, it does seek to provide common semantics that can be used unambiguously across and between different implementations'* 'TOGAF'.

The Zachman framework does not provide a reference model. On the other hand, TOGAF provide two reference models for business and IT. The most extensive is the FEA since it provides five reference models, including performance, business, service component, technical, and data reference models. Other specific reference models exist for special needs, for example, the mobile reference model which is offered by a vendor-based framework (DeBeasi, 2012).

3.4.7 Stakeholder Management

TOGAF provides clear guidance on managing stakeholders and their involvement in architectural work. It provides a model that categorises the stakeholders into categories and describes the way to deal with each category. It introduces the concepts of view, which is presenting each of the various stakeholders with a view of the architecture that responds to their needs. On the other hand, Zachman has the concept of manifestation to describe what TOGAF called 'views', and describes the stakeholder by using the term 'Audience'. However, it does not guide the architect on how to deal with stakeholders. Zachman has describe the roles and responsibilities at a high level (Zachman, 2011a).

Since the FEA framework is primarily designed for government agencies, their framework is less focused on managing stakeholders and keeping them satisfied. However, it has an extensive description role and numerous responsibilities throughout the architectural work [Figure 3.14]. In summary, the six factors which are derived from the literature and outlined in this section are ranked between one and four in every category. The results are shown in Figure 3.17. It can be seen that TOGAF is the most comprehensive fit to these factors.

Factors	1	2	3	4	5	6	7	Total
TOGAF	2	4	4	3	4	3	4	24
FEA	3	3	3	1	4	4	3	21
Zachman	4	2	1	4	1	1	1	14
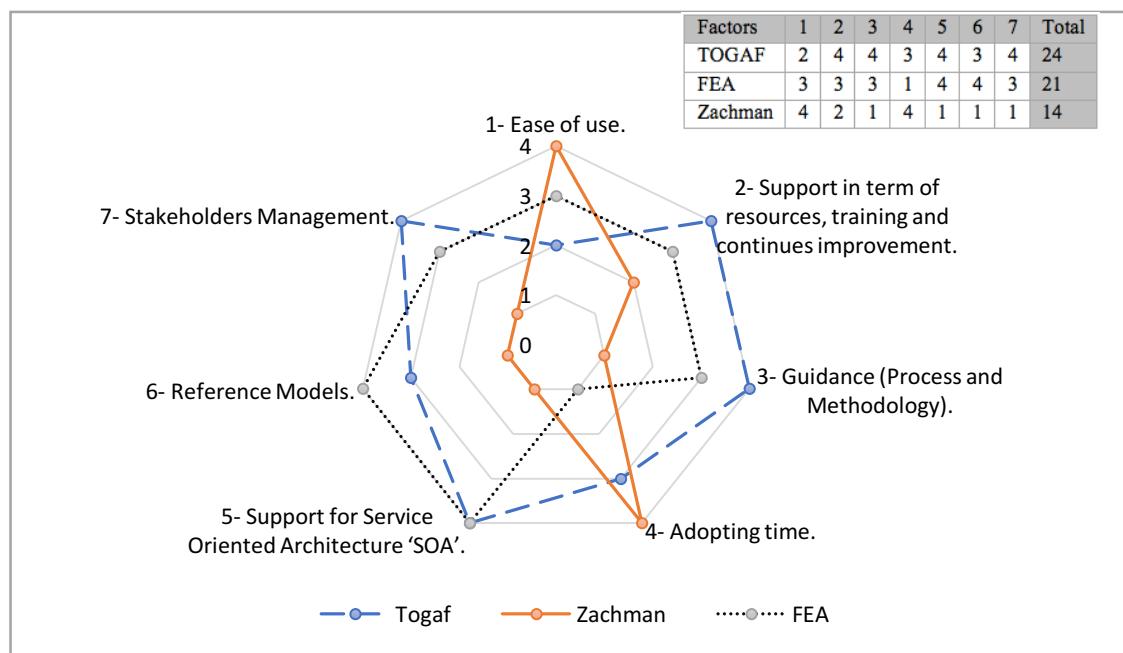
Figure 3.17. A Comparison Between the Selected Enterprise Architecture Frameworks.

Summary

In summary, this chapter presents the need for enterprise architecture during the enterprise transformation to mobile technologies and has reviewed the popular frameworks. The three frameworks have been proven to be very useful, especially for mid-sized enterprises aspiring to plan a controlled change. Additionally – except for Zachman – they provide guidance on the way that any change should be managed and controlled, ensuring a clear end goal and a blue print that describes clearly the future state of the planned transition. Based on the comparison carried out in this chapter, TOGAF is the better option in all of the seven factors. It can be argued that for a government-wide initiative, EAF might be the better choice, as it is designed for governments and categorised around the services extended to its citizens, covering a wide range of public services.

With the mobile revolution and the rapid advancements in the consumer grade hardware and software available, it could not be regarded as an extension to existing electronic services. If an enterprise is keen to turn being mobile into a competitive advantage and sound investment that ensures a return on investment, the need for a framework to guide the changes in mind is rising, in order to support transformations and to ensure the maintenance of the enterprise's architecture in the mobile era.

The main electronic government program in Saudi Arabia ('Yesser') has relied heavily on TOGAF in their effort to develop a National Enterprise Architecture. The intention is to conduct case studies in Saudi Arabia. Therefore, the author during his PhD studies has qualified as a TOGAF Certified Practitioner [Appendix C] to develop an Inter-operability model to support the proposed framework. The next chapter (Chapter 4) introduces a framework that is inspired by Enterprise Architecture and facilitates for the drawing up of a current and future state of the scope in which the mobile initiative takes place in addition to allowing for control over the change to be established in the transition plan. The framework is supported by an inter-operable model to be used in conjunction with and to leverage the possibility of the existence of an enterprise architecture program in the enterprise itself.

Chapter 4.   Proposed Framework

4.1   Introduction

Mobile is being shipped more than PC, and lately, mobile application stores are selling more, with an increased focus on business applications. In a survey conducted in New Zealand between 2013 and 2015, the use of mobile technology for business increased by 15%, in a bigger leap than with any other app type (Research New Zealand, 2015). According to a recent survey, 42 of the surveyed organisations are expected to increase their spending on mobile applications by 31% (Gartner, 2016b). Technically astute workers continually shape IT Consumerization and younger generations in the workforce have a range of innovative mobile devices (Intel, 2013).

Chapter 2 reviewed the advancements in mobile technology, and how mobile is becoming an irresistible and acceptable method for conducting business. The workforce is becoming increasingly mobile, and technology experts predict that mobile is the next major computing platform (Rampoldi-hnilo et al., 2009). M-Business will continue as a transformational force and it will emerge as a powerful new approach for conducting business (Picoto et al., 2010), (Harvard Business Review, 2015).

Organisational adoption is forecasted within the next few years for mobile business apps that support general business activities and mobile enterprise apps that provide access to internal IT systems (GSMA, 2016a). Research has revealed that 23% of all online retail sales in Q2 2013 came from mobile devices (Capgemini, 2014). Social platforms and the marketers that use them to engage consumers will clearly need to adopt a 'mobile first' strategy (GlobalWebIndex, 2013).

Smartphones are at the core of IT consumerization and the mobile trend (Intel, 2013), (Harris et al., 2011). Smartphones are not only used by customers, but many employees also have their smartphones and are expecting the enterprise allow them access. The solutions to extending enterprise applications to mobile devices are becoming critical. Employees using mobile applications expect the same functionality, available information and behaviour as applications on stationary platforms (Garcia-Gonzalez et al., 2010), (Harvard Business Review, 2015) Failing to respond to these latest trends could soon be a disadvantage in terms of communicating to the customers, and the way that current and potential employees perceive the company (Stieglitz & Brockmann, 2012).

More than 80% of organisations consider increased mobility to be at least within the top 10 of their strategic objectives (Callewaert et al., 2013). However, in a worldwide survey by 'IBM', less than half of the organisations surveyed demonstrate characteristics of a well-defined mobile strategy (Buckellew et al., 2013). Deployments will evolve from opportunistic to strategic, and most companies are still opportunistic in the way that they approach mobility (Marsh, 2013). Strategy and proper implantation are critical. IT assets may result in a positive IT impact (e.g., new services, redesigned business processes) when they are appropriately used for work activities (Stieglitz & Brockmann, 2012). Complexity and cost are two of the main reasons for companies having any hesitance towards mobile adoption (Mastrianni, 2013).

4.2 Mobile Enterprise Frameworks

Many frameworks have been suggested to provide guidance to the process of adopting mobile in enterprises, such as the 'SAFE' framework that suggests a methodology for mobile application development to ensure the separation between the Application's development and the Enterprise, allowing for policies and features to be added or changed without affecting the

devices and operating systems (Castro et al., 2013). The **T**imeless **A**rchitecture for **N**ext **G**eneration **M**obility Framework 'TANGO' Framework suggests a unified architecture for offline enterprise application and online Enterprise application, or mixing both. This means that developers do not have to deal with multiple architectures and possible discrepancies (Wu et al., 2010). Many other frameworks and models for various aspects of mobility exist, such as Mobile Business Intelligence application (Gianmario et al., 2014) Security Framework (Hasan et al., 2013), a framework that facilitates the integration of mobile apps into existing infrastructure (Kirkham et al., 2006) has been developed.

Although these frameworks are essential to guide and facilitate the adoption of a mobile platform, they are not fully effective unless they are seen from a strategic perspective. In an IBM survey, 81% stated that mobile capabilities are fundamentally changing the way that their organisations do business (Buckellew et al., 2013). A strategic framework that helps enterprises explore their potential with mobile and decides on key changes in the business is needed. Businesses are looking for wider, deeper and more strategic ways to impact their business positively (Marsh, 2013). Many attempts have been taken in that regard. Some of older studies around the year 2000 were focused on showing how mobile could be beneficial to enterprises by identifying the areas where mobile could become critical, such as location-sensitive applications, time-sensitive applications, and the extent of control over information whether by the provider or the receiver (Balasubraman et al., 2002). Another analytical framework suggested the following areas where mobile could be of value; time-critical needs, immediate and urgent arrangements, spontaneous needs and decisions (generally for products and services straightforward decisions), entertainment needs, efficiency needs and ambitions, and mobility-related needs when users are 'on the move' (Anckar & Incau, 2002).

More recent studies have been conducted on different applications of mobile in different industries, such as Health (Pimpre & Bhagat, 2014), and (Chi et al., 2016) Tourism (Anuvareepong, 2016) and (Constantino & Rocha, 2012), education (Abdullah & Alsharaei, 2016), or even analysing the benefit of a certain application of smartphone (Ceipidor et al., 2013). However, since this mobile trend is based on the consumer device of 'smartphones', the capabilities of the devices utilised are the same, although they are being used differently in each industry. Therefore, a generic framework is needed to help enterprises adopt mobile and to

create mobile strategies. Mobile is most beneficial when there is a clear mobile strategy in place (Buckellew et al., 2013).

4.2.1 Mobile First

A Mobile-First mind-set is important as enterprises are recognising that they must be designed and engineered around how customers and employees interact with the software (Gosh & Daugherty, 2015). IBM has introduced the initiative of Mobile First, where they called on enterprises to have a clear mobile strategy and for the mobile platform to be regarded as a primary platform for electronic services. The IBM initiative calls for the adoption of mobile to be considered at a strategic level, gives guidance on creating a mobile strategy, and outlines some aspects to be considered in mobile development including recommendations to enhance productivity and the mobile experience, suggesting processes for mobile to enhance, security polices and leveraging mobile devices capabilities (Buckellew et al., 2013). However, the IBM report does not provide guidance for the implementation or integration of business strategy.

Another approach provides a set of recommendations, success factors, and guidance on the so-called 'new IT platform' that supports mobility along with other new trends. However, it regards mobile as a transformation to enterprises. It puts forward a comprehensive mobile enterprise maturity model. Mobile Maturity Models describes the enterprise level of maturity in adopting mobile, and the ultimate state is called 'Mobile Enterprise' which helps in creating the vision since it draws the future state of the enterprise to facilitate the change for (Marsh, 2013).

4.2.2 Mobile Platform

Many attempts have been made to outline mobile characteristics and capabilities. Sørensen identified mobile capabilities regardless of the mobile device used, and their use or value to the business to differentiate mobile services from other electronic services (Sørensen, 2014). Six enterprise mobility capabilities were identified as follows:

1. *Connectivity*: Mobile phones are always connected.
2. *Portability*: mobile phones are portable, and the relationship between the mobile phone and the user's geographical movement is closer.
3. *Intimacy*: moving from mainframes in the last century, to mobile. Mobile is the closest to the human body, and presumably that strengthens the relationship with the user.
4. *Pervasiveness*: Mobile's ability to relate directly to the environment through its sensors.

5. *Memory*: when the device remembers the user choices and is partly responsible for maintaining aspects of the process.

6. *Priority*: when the device is maintaining the priority aspects of the process.

Although the identified characteristics of mobility are very inclusive and comprehensive, Sørensen did not elaborate on how these capabilities could be converted into value. It focused on the research in mobility more than the implementation; it does not guide implementation or suggests critical success factors. Another classification is the taxonomy of mobile enterprise categories (Unhelkar & Murugesan, 2010) which are outlined as follows:

1. *Mobile broadcast*: large-scale information broadcast, such as advertisement and promotions.

2. *Mobile information*: information requested by the user, such as job vacancies and timetables.

3. *Mobile trans-action*: eases and executes transactions, such as the transactions related to Customer Relationship Management (CRM).

4. *Mobile operation*: internal operations, such as inventory management and Supply Chain Management (SCM):

5. *Mobile collaboration*: for collaboration between employees and various functional units.

This classification was taken into consideration in designing their framework. However, the framework was describing a taxonomy from a theoretical point of view, and did not provide any tools to allow the enterprise to utilise it.

Picoto and others (2010) categorised the mobile impact on enterprise performance into three categories; Ubiquitous Data Access, Business Process Improvements Based on Mobile IT, and since employees want to share documents and tasks, that will additionally require a Unified Communication Strategy (Picoto et al., 2010).

Identifying enterprise mobility capabilities and values is a more straightforward approach; it paves the way for exploring mobility on a business level regardless of technology. Ubiquitous access to data, the mobile support of business processes, unified communication, and employee satisfaction are suggested as added values (Stieglitz & Brockmann, 2012).

4.2.3 Drivers for Mobile Adoption

Looking at the drivers and objectives of mobile adoption helps in transitioning to a mobile-enabled enterprise, the drivers do not only facilitate the measurement of mobile benefits, but they are also as important in the planning phase and supporting mobile with business strategies alignment. Picato's considered mobile enterprise drivers and investigation on the impact of enterprise mobile applications on downstream dimensions, internal dimensions, and upstream dimensions, customer satisfaction, sales increase and expansion into new areas and other downstream dimensions impact were reported. In the internal dimensions, improved efficiency, productivity, communication, business processes, control, flexibility and decision-making was reported. However, on the upstream dimensions, no positive impact was reported (Picoto et al., 2010). The Technology Organisation Environment Framework (TOE) was suggested to be used by enterprises to investigate the impact of managing mobile devices within its organisation, and the technological and environmental context (Ortbach et al., 2014).

Internal and external characteristics of the enterprise are represented and recognised as drivers for IT innovations in the TOE framework. The study found a positive impact on the company size and the culture of 'Bring your own device' on the enterprise's decision to adopting Mobile Device Management Solutions, in addition to the management evolution in relation to cost and security benefits (Ortbach et al., 2014). Another suggested using the fit and viability Model FVM in adopting mobile technology which combines the theory of task/technology fit with the general notion of organisational viability, identifying the criteria for measuring fit and viability, and applying this to multiple cases (Liang et al., 2007).

Based on Soh and Markus's Model for IT creation, a model was proposed for Mobile Enterprise value creation that suggests a life cycle of three stages. Every stage has two steps, and proposed a set of activities and methods for every individual step. The suggested process is the mobile IT conversion process which includes the analysis and design steps, and a Summary of Management Activities for The Mobile IT Use Process Task including adoption and operation steps, and the competitive process which includes the controlling and evaluation steps (Stieglitz & Brockmann, 2012). However, this was a standalone process. The focus was on the developmental proposed process; it did not offer guidance on how to utilise the mobile platform, and not link the initiative back to the business oversight.

Some frameworks are designed around outlining the areas that are impacted by the mobile in an enterprise such as the Cognizant framework, which is an ecosystem in which mobile solutions are developed. It is built to handle the four aspects of mobile adoption; Technology, Governance, Compliance and Security, and Support (Santhosh et al., 2012). This came with no sufficient guidance on mobile utilisation, or the implementation process.

In order to avoid having a high level of investment in IT without any productivity gains, or what is labelled as 'productive paradox' which is proven by empirical evidence showed that an organisation could   (Picoto et al., 2010). A holistic approach is needed to manage the transformation to a mobile enterprise, in addition to being measurable and supportive in defining a clear mobile strategy that is aligned with business strategy.

Gartner is expecting the number of applications on the app stores to drop by 20% by 2019, due to cost exceeding the benefits (Gartner, 2016a). Many mobile initiatives started under pressure from staff and customer to extend their existing applications, adopting with a focus only on the preceded benefits of mobile solutions (Hariharan, 2008), , (Garcia-Gonzalez et al., 2010), (Kolici et al., 2013). This emphasises the need for a holistic mobile framework approach that utilises the platform for various aspects of the business, and relates the planned initiative to a tight business-end evaluation, that is additionally aligned with the business's strategic objectives. Such a framework was not found during the literature review; therefore, the proposed framework should encompass the essential architectural elements of mobile transformation, regardless of the technologies used in terms of hardware and software.

4.3   The Mobile Holistic Enterprise Transformation Framework (MHETF)

The proposed framework is a generic and comprehensive Enterprise Architecture-based framework that supports enterprises transitioning to becoming a Mobile Enterprise in various ways. Although, it inspired by EA and works in a similar manner, it is only applied to the mobile gap within a given scope. It supports the depiction of the vision of how current services will be enhanced and extended with mobile capabilities by categorising and organising mobile capabilities. It facilitates new opportunities to be explored, for existing and planned services. It also facilitates to allow the value of the mobile platform to be measured regardless of the method

and techniques. The framework is strategic but not isolated from the implementation; it is interoperable with other frameworks. And finally, the framework is not a replacement to the existing frameworks or methodologies. Instead, it provides a holistic view of the transition to a mobile enterprise, presenting how mobile could be of value and facilitates the transformation to maximise the benefits. In this section, the elements of the frameworks are explained, the mobile values are presented, and the next chapter (chapter 5) will discuss how the framework should be used.

4.3.1 The Vision of the Proposed Framework

It has been suggested that the objective of the enterprises' increasing investments in extending their information systems to the mobile platform is to allow them to better use their human resources when they are outside the company's locations and to extend their information services to customers wherever they are (Garcia-Gonzalez et al., 2010). However, this notion of why an enterprise needs mobile seems narrow. Mobile Enterprise might provide more than just enabling employees to work outside. It comes down to the enterprise's mobility concept to give employees better possibilities to work on the move effectively by integrating mobile technologies into its existing IT infrastructure (Hasan et al., 2013).

Consumer mobile devices are at the core of this trend; the IT Departments focuses on bringing service to the consumers' devices since they are in many cases as good if not better than what IT provides. The users are more familiar with their devices and will tend to use existing social and productivity tools more at work if they are familiar with them outside of it as well. This seems to be readily comprehended by manufacturers and major mobile and web applications developers, and they are taking businesses into consideration when creating these consumer devices applications to satisfy the users' demand to be able to use these devices and services for business (Wood, 2012). Although mobile was initially aimed at businesses, a reason for the current consumer trend might be that it was used primarily for social activities first. A second reason is the wide variety of mobile applications that employees could still use during work hours, and thirdly, typical business applications are usually designed to handle multiple-step processes, and concentrated data (Rampoldi-hnilo et al., 2009).

The proposed framework focuses on utilising consumer mobile devices including smartphones and tablets, thus it is important to capture and classify the consumer's mobile devices characteristics, and move to capturing the mobile enterprise applications characteristics and categorising the mobile-added values. It is important to assess the mobile platform in relation to unique business features and to distinguish this innovation from the previous ones (Picoto et al., 2010).

The work was done by (Liang et al., 2007), (Picoto et al., 2010). Sørensen (2014) attempted to classify them differently. However, the classification could have been more practical. The following is the suggested classification of consumer mobile devices characteristics, identified for the purpose of this thesis. They are assumed in most smartphones in the market:

- *Instantly ON*; since it is always powered and connected.

- *Portability*; it is safer to assume they are close to the user than PCs or laptops.

- *Personal device*; mobile devices are usually used by one user, and most mobile operating systems are designed to be operated by one user.

- *Additional and continually improved capabilities*; advanced cameras, microphones & speakers, touch screen and smart Operating Systems.

- Additional and continually improved connectivity such as Bluetooth, cellular and GPS, and the addition of NFC and other means of communication.

However, when it comes to using the mobile platform in business, and designing the future state of an enterprise that is powered by the mobile platform capabilities, the added capabilities were categorised in a taxonomy model of mobile capabilities. They were organised in a way that provides a useful analytical framework for the development and discussion of mobile adoption. They differentiate the mobile services from remote workplaces and current conventional electronic capabilities. The model should not be affected by devices; it is based on the capabilities assumed in most smartphone devices.

Additionally, the literature indicates the need for measurable mobile initiatives aligned with the business goals and strategic objectives. The second element of the framework should support the measurement of the effectiveness of the planned mobile services; it should serve as a framework within which measurement factors are organised and linked to each proposed business capability. The framework will then base the performance targets on the improvements in Nichol's four factors that were discussed in Chapter 2. The third element of the framework is the implementation of solutions, which is a holistic way to investigate and discuss mobile solutions during the design and implementation of mobile services and to organise the mobile strategy since different policies and guide lines could be discussed under each part. It was important to see the mobile added value in light of the potential Return on Investment (RoI) (Stieglitz & Brockmann, 2012), and it can be additionally represented in this framework as implementation solutions and targets. As outlined in Figure 4.1 the proposed framework aims to achieve the following benefits:

- **Understanding the concept of mobility trend:** the ability to view mobile capabilities, business capabilities and the expected results in a single model makes it easier for technical and non-technical people to comprehend the latest trend of mobile services.

- **Unified language for mobile project:** the framework allows the developer to understand the business results of the transformation, and for the business to understand the implementation process and areas of concern to them. Both sides will agree on a clearly defined future state, and understand the capabilities targeted by the transformation.

- **Enhance perception of mobile services:** the ability to view the capabilities of mobile services and objectives enhancing the perception of the mobile services.

- **Keeps Focus on targets:** the ability to visualise the future state, making it clearer to decide on what matters to the end results throughout the implementation phase.

- **Clearer assessment of mobile investment:** Mapping current and new future state(s) and the gap between them to allow for a simple ROI calculation and decision to be made on whether the transformation is urgent or not.

- **Executives buy-in:** the ability to visualise the mobile services and to articulate the values quantifiably, make it easier to communicate the proposed transformation plan to

the decision makers. Additionally, the proposed solution components are quantifiably evaluated, which clearly justifies the investments in business terms.

- **Increase the satisfaction of projects owner:** involving the key stakeholders and documenting their concerns, and making recommendations at an early stage facilitates for better planning and more accurate pricing.

- **Interoperable with existing framework:** the framework was developed on the basic concepts of the enterprise architecture frameworks (EAFs) which is mapping current and future stages, and facilitating the transformation.

- **Reduce cost and time** of mobile transformation planning through one holistic and simple approach. The framework was presented and applied to each case in no more than three hours.

- **Successful implementations:** Understanding the mobile capabilities, any underlying concerns and issues of mobile transformation. A clearly defined future state could reduce risks and increase the chances of successful transformation.
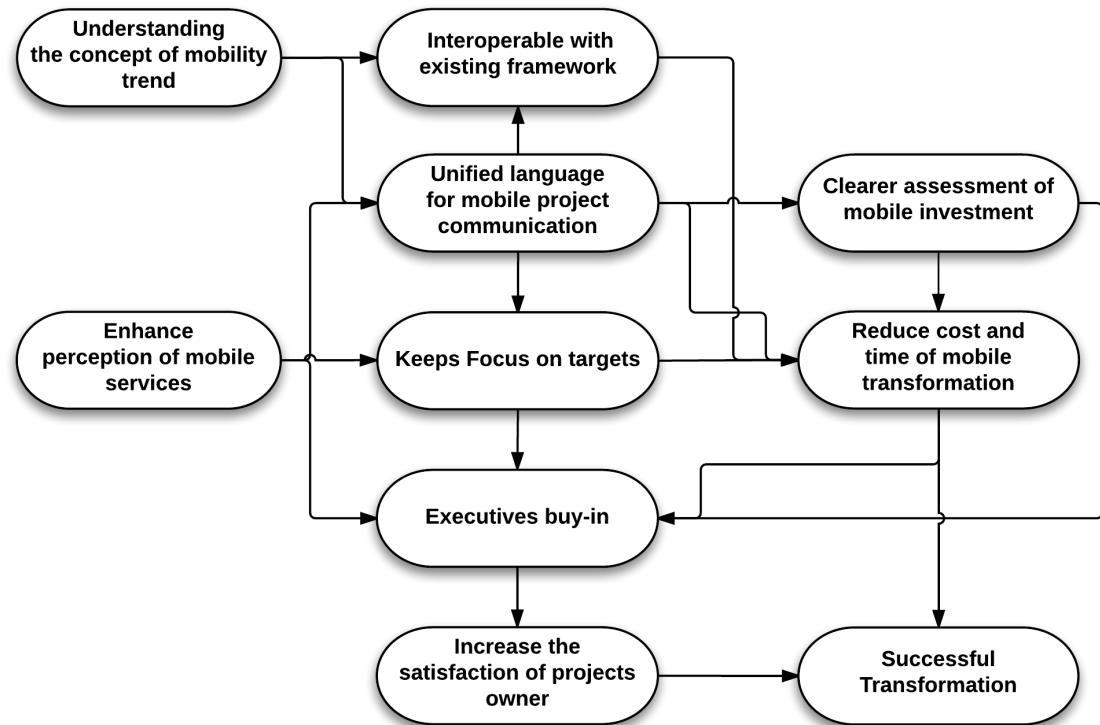
Figure 4.1. An Outline of the Proposed Benefits

4.3.2 Development of Proposed Framework

The proposed framework is derived from the literature through a business and a technical analysis. As shown in Figure 4.2, many examples of successful mobile solutions were reviewed. Eight were documented and analysed further, covering different business sectors. They were analysed in term of the objectives achieved, which have been outlined in (Chapter 2, Section 5.2) and in term of the smartphones capabilities, they utilised. The eight case studies reviewed in Chapter 2 were analysed and used to categorise the mobile capabilities which are Location-Based Services, Instant Communication and Collaboration, the User Experience, Personalised Services and Accountability as depicted in Figure 4.2(b).
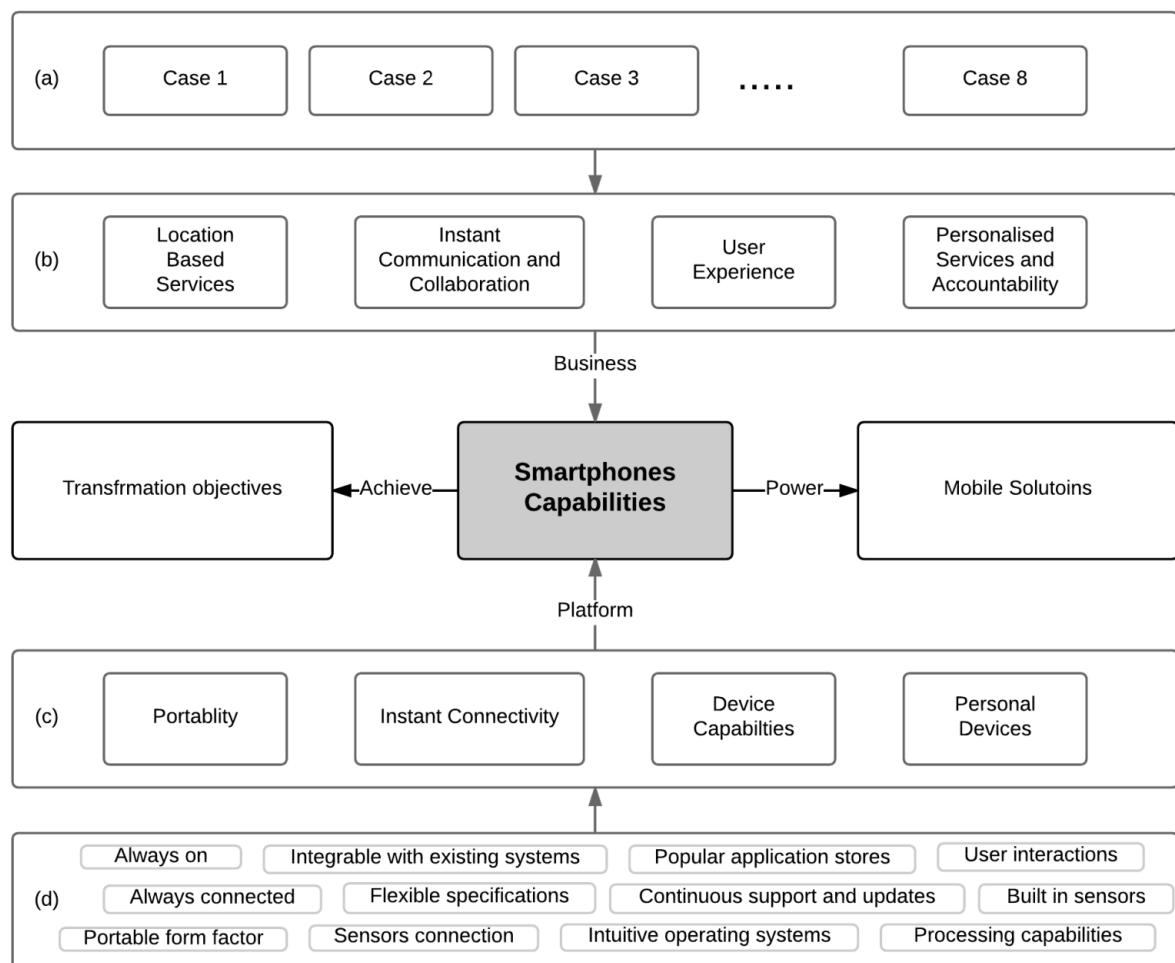
Figure 4.2. The Development of The Proposed Framework.

During the Literature review, the smartphone capabilities were categorised and then simplified into four divisions as depicted in Figure 4.2(c). The development of the framework evolved

through multiple iterations during a top-down, bottom-up approach to outline the mobile capabilities in relation to the transformation objectives and mobile solutions as depicted in Figure 4.2. These iterations as illustrated in Table 4.1 were:

4.3.2.1 Version '1': Metrics-Based Analysis

An attempt was made to develop the framework by analysing the reviewed case studies, outlining the ways in which smartphones capabilities were utilised, and then assessing the values. The aim was to categorise these capabilities and to ensure that the identified categories were inclusive of all smartphone capabilities. This version offered a list of 'Mobile services' derived and validated by the cases and derived from the smartphone capabilities as per the development process outlined in Figure 4.1. This version dealt with these capabilities as components that any involved Business Analysts could combine to satisfy the requirements.

4.3.2.2 Version '2': Platform Focused

In this phase, the mobile capabilities were categorised into four generic categories to streamline the planning process. The intention was to cascade down from those categories and to go in to detail on the available platform options. However, the literature indicated the need for a rather holistic approach to mobile transformation investments that encompasses both the business and technical sides. In this version, the mobile (capabilities) were still referred to as (services).

4.3.2.3 Version '3': Holistic

This version incorporated the transformative objectives of Mobile initiatives into the framework in order to be able to generate a future state. The aim was to ensure that only mobile solutions comments that are satisfactory to the business objectives are implemented in the current transition. Objectives achieved in the reviewed case studies were mapped to the identified goals of mobile adoption in a holistic view. However, in this version, the mobile solutions were too focused on the platform and not yet matured enough to represent the application types.

4.3.2.4 Version '4': generic

In this version, the framework was visually enhanced, and the solution components are categorised into the four categories of enterprise mobile solutions. These categories are used to

describe the end solutions and will be a better fit into the overall mobile Transformation strategy. The framework is explained in-depth in the next section. And the following section describes the framework components in more detail.

Table 4.1. The Evolution of the Proposed Framework.

Version 1	Trnasformative Objectvies (sheet 2) — Mobile Services - Smartphones Capabilities

Version 1 (table content):

	Health	Education	Banking	Tourism
	Case 1 / Case 2	Case 3 / Case 4	Case 5 / Case 6	Case 7 / Case 8
	Identification	mobile video conferencing	Mobile Paymnet	Notification
	Real time video monitoring	Notification	Notification	Remote data access
	Notification	Remote data access	mobile video conferencing	Sensors interaction (internal / external)
	Sensors interaction (internal / external)	.....	Identification	.....
	.....		Remote data access	
			Sensors interaction (internal / external)	
			.....	

Version 2

Location Based Services — Personalised Services — Instant communication & collaboration — User Experience

Version 3

INCREASE EFFICIENCY | INCREASE CUSTOMER SATISFACTION AND USER EXPERIENCE | IMPROVE PROCESSES | NEW OPPORTUNITIES

Location Based Services — Personalised Services — Instant communication & collaboration — User Experience

BASIC MOBILE PHONE SERVICES | MOBILE WEB | HYBRID MOBILE APP | NATIVE MOBILE APP | BUSINESS MOBILE PLATFORM

Version 4

INCREASE PRODUCTIVITY | INCREASE/ CUSTOMER SATISFACTION AND USER EXPERIENCE | IMPROVE PROCESSES | NEW OPPORTUNITIES

Goals — Location Based Services — Personalised Services — Targeted Capabilities — Instant access, communication & collaboration — User Experience — Components

OUTWARD FACING MOBILE APPLICATIONS | MOBILE APPLICATIONS MANAGEMENT "MAM" | MOBILE DEVICES MANAGEMENT "MDM" | INWARD FACING MOBILE APPLICATIONS

4.3.3　Targeted Capabilities

Despite the well-known consumerization benefits, few organisations have developed a strategy encouraging employees to embrace consumer tools at work (Castro-Leon, 2014). The key to maximising the benefit of IT is to understand the impact of IT on the

Figure 4.3. Mobile Targeted Capabilities

business (Silvius, 2006). A taxonomy of mobile capabilities from the enterprises perspective has been suggested [Figure 4.3] to enable enterprises exploring their options to maximise their utilisation of the mobile applications capabilities and values. After the categorisation of smartphones capabilities as illustrated in Figure 4.4, and the review of mobile applications, the following factors were considered in the categorisation outlined as follows:

- They should be generic for different applications and business lines.
- They should cover the inward-facing applications (aimed to internal services) and outward-facing applications (for customers).
- Each of them can drive or trigger the interest in the mobile platform, and they can be combined to maximise utilisation and benefits.

Instead of looking at existing mobile solutions and applications, or considering mobile web-friendly platforms for their current electronic services, enterprises can draw a future state of their existing operational and planned services and applications for internal systems and every business line in the light of the targeted capabilities. The capabilities are categorised to organise and streamline the analysis process, providing a unified language to enable the exploration of mobile benefits to be done extensively, and finally, to produce a clear set of requirements for the implementation and transformation process. The categories are:

- Location-Based Services.
- Personalised Services.
- Instant Access, Communication and Collaboration.
- User Experience.

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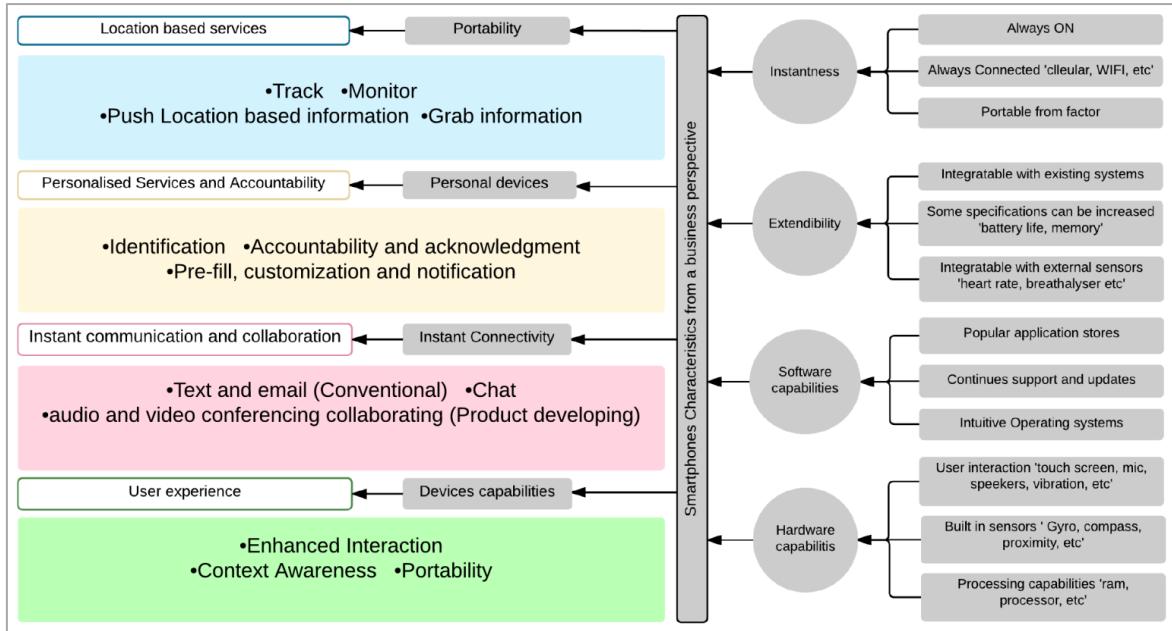
Figure 4.4. The Categorisation and Mapping of Smartphones Capabilities.

4.3.3.1 Location Based Services

The availability of information through mobile devices has led to an increase in employee independence from fixed workplaces. This has resulted in the traditional workplace (office) beginning to lose its importance and more work-related activities taking place outside the office, resulting in the 'mobile enterprise' (Stieglitz & Brockmann, 2012). An obvious addition of mobile is enabling the users' mobility, allowing the users to conduct business almost anywhere, with the ability to get the user's location or tracking the mobile devices. The value increased significantly.

Most smartphone devices nowadays are equipped with various means to grab the user's location including the cellular network, 'WIFI' networks, and most importantly, 'GPS'. The location could enable new services and enhance existing ones, whether the location is used by the mobile device's user, sent to an operator or an electronic service provider.

While reviewing some examples of current mobile applications in different domains, some users benefited from mobile-based services by geo-tagging their files which could be then utilised in various ways such as having additional information about the files, better insight, and enhanced filing and a documents management systems, where the storage can be categorised geographically for easier storing and recollection.

On the other hand, businesses and service providers' benefits include user tracking and monitoring, assigning or triggering tasks based on location, pushing relevant information based on a user's location, and gathering information whether it is provided by the user or is an automated process that gathers the information from the mobile device applications, built-in sensors, or external customised sensors.

4.3.3.2   Personalised Services

Mobile phones are personal devices, and they are used in many applications as a personal identifier such as mobile payments and mobile banking. Additionally, with the advancements in mobile operating systems, users can customise their phones as per their preferences, and service providers can provide even more customised services. In fact, companies are adopting mobile solutions under pressure of their employees, as they would prefer to choose the best fit for job processes and establish suitable policies that govern the integration of chosen consumer solution to the existing environments (Ortbach et al., 2013), (Harris et al., 2011).

Additionally, since mobile devices were designed to be used by a single user and the data collected from the user manually or continually through the various sensors, it is assumed to be the context of one user. This has made smartphones the preferable device for many applications, and the go-to technology for consumers according to a Forrester Research report (Husson, 2015). Examples include recording the user's movement and heart rate throughout the day for health applications, the user's movement and location in fleet management, mobile employee tracking, and many other applications.

4.3.3.3   Instant Access, Communication and Collaboration

Employees rely on their smartphones for crowd-sourced decision making, connections and networking, customer interactions, and business collaboration (Intel, 2013). In a mobile enterprise, employees can access and update enterprise databases from any location and at any time (Stieglitz & Brockmann, 2012). Since mobile is an instantly-on device, always connected, and most of the time close to the person, and capable of pushing notifications, all of this has facilitated instant communication and easier collaboration. Ubiquitous real-time access to critical business information is one of many advantages gained from Enterprise Mobility. It supports decisions made in a shorter time, increasing worker productivity and reducing business

operation costs (Hasan et al., 2013). This is one of the main benefits of adopting the mobile platform; it is argued that the frequently interrupted and fast-paced work style of business applications are the most successful (Rampoldi-hnilo et al., 2009).

Employees can use mobile devices to interact with colleagues or customers, and to access and share all of the needed information. Mobile access and activities might include managing documents, connecting to the customer relationship management system 'CRM', email and social business software, and steps in workflows via Internet-based data transmissions (Stieglitz & Brockmann, 2012).

The use of social media services for work activities is a trend. Many Enterprise Resource Planning (ERP) and Document Management System providers are adding these capabilities to their packages, such Microsoft Share point and Yammer. Besides, mobile is playing an important role in driving the real-time active usage of social platforms in all markets. The most popular consumer mobile devices operating systems are iOS and Android, and their users are significantly more likely to use social networks than the average internet user from any other platform around the world (GlobalWebIndex, 2013). Over the last three years, digital media has grown by 50%, and 90% of that is accredited to the smartphone (comScore, 2016).

4.3.3.4   User Experience

Every year, hardware manufacturers are pushing smaller, thinner, lighter and more beautifully designed smartphones with a longer battery life. The bright, responsive multi-touch screen, handy camera and microphone, and other device capabilities such as the compass, GPS, flashlight and the fact that the mobile devices are usually handy and instantly on has made the mobile smartphone an acceptable platform for electronic services, and further created a demand for mobile services. Individuals are so keen to use their devices as they seem to have stronger bindings to their tools which have increased the importance of information technology in their life (Ortbach et al., 2013), (Harris et al., 2011).

Mobile applications have been well received since Apple's iPhone that was launched in 2007. The Software Development Kit (SDK) and the guidance documentation that supported

developers to get their apps to be well designed, consistent with the operating system and pushed them into considering usability and customer satisfaction as much as function. In addition to the quality native apps, the application stores' experience, the ability to search for apps in one place, evaluating the apps through users' reviews and then choose to install with a click are all important. The desire to choose freely is always associated with the trend of IT consumerization (Ortbach et al., 2013).

This was reflected in the 2014 statistics from YouTube showed that 40% of YouTube's global watch time is on mobile devices, and in only one year, it has grown to more than 50% in 2015 (Youtube.com, 2016). Mobile is the main driver for the growth of social networks, and since Q1 2011, the number of users accessing the internet via a mobile phone has increased by 60.3% to 818.4 million across the 31 GWI markets. (GlobalWebIndex, 2013). And according to Forrester, Mobile is the '*new face of engagement*' (Schadler & Mccarthy, 2012).

In addition to that, mobile could use the device preferences and data gathered from the available sensors, to be aware of user context and to enhance the experience accordingly, which could decrease the amount of manual work required from the user, and increase the volume of data gathered by the business in an automated and more accurate manner.

4.3.4   Mobile Transformation Targets

In Chapter 2, the transformative effect of mobile applications was discussed along with the goals that make the transformation to a mobile enterprise a competitive advantage. Companies recognise the need for a mobile strategy to effectively compete in the future (Buckellew et al., 2013). The following are the strategic goals for embracing mobile, and can be used to measure and monitor performance appropriately. It is suggested that the processes should be the unit of measurement since it is difficult to quantify the benefits in relation to mobile in isolation (Picoto et al., 2010). Since some other factors may not be reflected in the process enhancement, and companies could use their own set of Key Performance Indicators (KPIs) for measurements. The following are the goals based on Nicol's (2013) transformative mobile solutions, attributes and the benefits of mobile transformation solutions listed by Seidel's (2013). The goals are to be considered in the planning phase, and can be used for control, continued improvement and operations auditing.

- Increase Productivity.
- Increase Customer Satisfaction and enhance user experience.
- Improve process.
- New opportunities.

4.3.4.1   Increase Productivity

In a recent survey, companies from 13 countries stated that the most important reason for mobile initiatives is to increase the efficiency and effectiveness of their employees (Callewaert et al., 2013). This is knowing how 'business value' can maximise IT investments, addresses efficiency and the effectiveness of IT, where IT contributes to the business strategy and objectives (Silvius, 2006). In relation to enhanced communication and more efficient and information timeliness, mobile technology can increase organisational productivity and profitability (Liang et al., 2007). When employees extend their workday beyond normal work hours and are able to access and get information and make informed decisions remotely, productivity increases (Koch et al., 2014), (Dernbecher et al., 2013).

Productivity is the ratio between output and input. It is the product of efficiency and effectiveness where efficiency expresses the utilisation of resources (Rolstadås, 1998). Simply put, effectiveness requires good decisions, and it is concerned with doing the right thing. Efficiency is the way that these things are done, and they both represent productivity. With the values added to enterprises, the expected output is going to change, as do the inputs (Pitichat, 2013). For this goal, enterprises should compare their current input/output ratio to the planned input and expected output.

4.3.4.2   Increase Customer Satisfaction and User Experience

Consumer grade solutions are often flexible, autonomous, and can create significant value for an organisation due to increased employee productivity and satisfaction (Ortbach et al., 2013), (Koch et al., 2014). There is a huge demand for mobile services, and fulfilling that demand can help to increase the customers and employee satisfaction. Mobile offers more capabilities, such as notifications and reminders, and context awareness where there is less work for the user to do manually, and the convenience of being close to person, so then the user can conduct the

transaction whenever they need to, saving time and reducing the chance for delays if the user is mobile, or being forgotten.

IT consumerization is driven by the employees themselves and influenced by their personal experiences with IT (Harris et al., 2011), (Dernbecher et al., 2013). The enterprise should consider all of these capabilities, and quantify the impact of customer satisfaction which is one of the many drivers, and in many cases, the only perceived value justifying the cost of the mobile services. In a survey that took place in 13 countries, enhancing customer experience and increasing satisfaction was listed as the third driver for adopting mobile (Callewaert, et al., 2013).

4.3.4.3 Improve Processes

Mobile can speed up processes, particularly when making and communicating decisions is required (Stieglitz & Brockmann, 2012). Mobile capabilities should have an impact on the existing processes. Removing space and time constraints to some extent, enabling personalised service through powerful devices equipped with advanced technologies, benefiting from instant communication and on the move access to the back-end systems and collaboration could change the processes involved. When new capabilities are added, businesses should consider re-engineering their process in the light of these capabilities.

A process improvement is a tangible value, and if the processes improved, then businesses could see improvement in other goals such as productivity and decision-making, operational costs and customer satisfaction (Picoto et al., 2010).

4.3.4.4 New Opportunities

Mobile capabilities mean new opportunities; and being able to almost reach staff and customers regardless of space and time in a way can allow for new kind of services to be offered. New sources of revenues can be introduced since businesses are closer to the customers and are able to collect more information. Additionally, benefits occur when consumer level tools provide employees with a better and more innovative way to do their job, such as their smartphones (Koch et al., 2014).

The emergence of mobile apps creates new opportunities for using highly matured mobile devices and networks (Stieglitz & Brockmann, 2012). The integration of this new type of data could enhance the back-end system, creating new applications and reports (Kirkham et al., 2006).

The trending technology in the world today is better utilised with mobile if a mobile strategy is in place, that will support Cloud strategy and vice versa, will facilitate more engaging Social networks, and enrich the data gathered from customers which assists with big data. '*The continuing evolution and development of cloud-based solutions and social, enterprise and mobile technologies are increasingly leading to so-called IT consumerization with individuals demanding more from their devices, applications and technologies*' (BCS The Chartered Institute for IT, 2013).

In addition, since most smartphones have multiple means to connect to other devices, the development of smart objects that can perform various tasks, and communicate results to the/a smartphone is a trending industry. For example, many cameras now are designed without connection to the internet, screen, or zooming buttons on the assumption that the users will connect them to their smartphone which already has all of these capabilities, and that enables them to have more space for lenses, memory and battery. These objects are beneficial to many organisational operations, in every industry and utilising mobile could allow for more affordable objects that are able to be integrated with back-end systems to be created.

4.3.5   Mobile Solutions Categories 'Implementation Solutions'

The current solutions and practices of mobile enterprises require attention to each of the following areas; the Outward-facing Mobile applications, Mobile Device Management, Mobile Application Management, and Inward-facing Mobile applications as depicted in Figure 4.5. These following areas can streamline discussions around mobile adoption since they can be discussed separately, and each may require a different set of skills. Also, based on the cost analysis in these areas, this facilitates a full picture view, which reduces the probability of overlooking essential elements, missing some aspects from the cost analysis, or having the disadvantage of not considering them in the implemented solution.

4.3.5.1 Outward Facing Mobile Services and Applications

Besides the customer application, mobile enterprise applications are becoming one of the most discussed topics in the enterprise (Wu et al., 2010). It means building client applications on current advanced smartphones for existing enterprise systems, such as Enterprise Resource Planning 'ERP', Customer Relationship Management 'CRM', and Supply Chain Management 'SCM'. This section is focused on the development of those applications.

The mind-set should change from provisioning standardised technology to IT departments that are a user-centric, ensuring access to the right application at the right time in the workforce (BCS The Chartered Institute for IT, 2013). '*A service provider is advised to cultivate positive consumer experiences and avoid negative experiences at all costs. While this is probably true of consumers of all products and services, users of mobile value-added services are likely more tech savvy than the general population*' (Yang et al., 2011).

4.3.5.2 Mobile Application Management 'MAM'

MAM focuses more on the application and less on the device. It is used to develop custom applications that enable IT to deploy, provision, update, and manage the applications (Intel, 2014). 'MAM' also offer functions including policy enforcement and security settings, the distribution of software, secure areas for applications such as documents, e-mail, calendar, contacts, version management and other security service including establishment (VPN) connections for specific applications, authorization, encryption and authorization, and remote control (Stieglitz & Brockmann, 2012).

4.3.5.3 Mobile Device Management 'MDM'

Although enterprises demand mobility and flexibility of their workers since it is proven to be an advantage, the involvement of mobile technologies and applications has also brought new security challenges and risks, particularly on mobile devices themselves (Hasan et al., 2013). Mobile Device Management is concerned with managing the users' mobile devices that are used to conduct the business.

In detail, mobile device management systems offer functions such as remote device administration and configuration, inventory and asset management, remote wiping or device lockout, the installation of updates on operating system or application level, geolocation of devices, or cost management (Ortbach et al., 2014). Another classification is "*software distribution, policy management, inventory management, security management, and service management*" (Harvard Business Review, 2015).

MDM is not a desirable add-on; it is a prerequisite, it should go hand in hand with the trend of Bring Your Own Device (BYOD) (BCS The Chartered Institute for IT, 2013).

4.3.5.4   Inward Facing Mobile Services and Applications

Employees expect to be able to pick and choose the tools that they want to use and to not be forced to adopt a certain solution (Ortbach et al., 2013). This category is concerned with the applications aimed for internal use. The mobile trend of Bring your Own Device is gaining a lot of momentum, where employees are allowed to use their personal devices to access the enterprises' systems. Although many employees are using their own tablet or smartphone for work purposes, few are willing to use their own PC as the primary device for work (BCS The Chartered Institute for IT, 2013). This type of mobile application which offers access to the enterprise's applications is regarded to be very beneficial to mobile enterprises', in fact it is was regarded as "*the biggest benefit to using mobile, followed by increased productivity*" which are undoubtedly linked (Harvard Business Review, 2015).

Companies should encourage investment in innovation, which in turn will reflect on their business's efficiency, effectiveness and flexibility (Silvius, 2006). Although some may suggest that employees should work with what they are supplied with in order to reduce cost, it is the IT department's responsibility to ensure that that employees have the workspace that helps them to fulfil their potential and gets the most out of their time for the benefit of the business (BCS The Chartered Institute for IT, 2013), (Zimmermann et al., 2014). 'BYOD' introduces security issues, and implementing an effective MDM and MAM solutions should mitigate those (BCS The Chartered Institute for IT, 2013). Figure 4.4 shows the elements of the proposed framework.
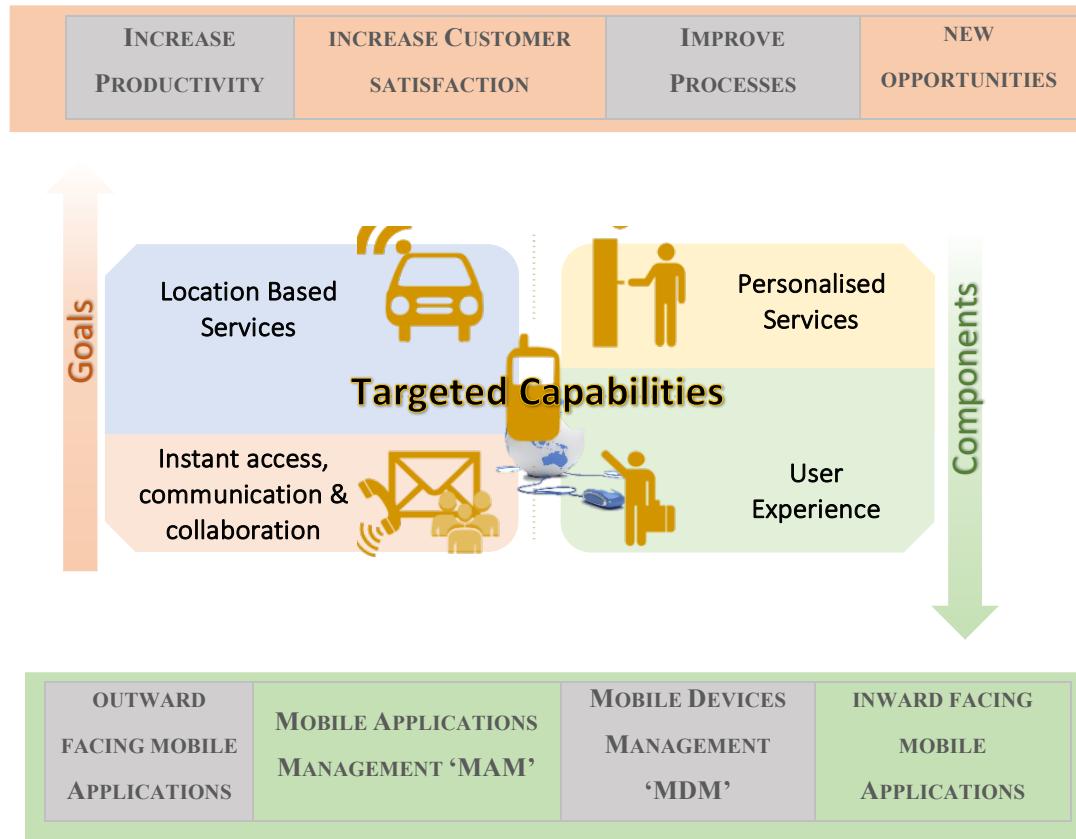
Figure 4.5. The Elements of the Mobile Holistic Enterprises Transformation Framework (MHETF)

4.3.6 Limitations:

Mobile platforms, just like any other, have limitation. Often mentioned limitations are privacy and security (Zimmermann et al., 2014), (Briefings, 2012), (Sarddar & Bose, 2014),(Pitichat, 2013), (Suo et al., 2013), (Venkatesh & Sridhar, 2014),(Wu et al., 2007), (Amoroso, 2013), (Mastrianni, 2013), (Buckellew et al., 2013), (Cisco, 2016), connectivity (Venkatesh & Sridhar, 2014), (Wu et al., 2010), (Khan et al., 2013), and regulations (IBMMobileFirst, 2013),(Marston et al., 2011), (Ortbach et al., 2014). Table 4.2 outlines the limitation in relation to the categories of mobile capabilities. These limitations should be considered in the transformation plan, with specifics that are collected using the proposed process outlined in section 1.4 of this Chapter. Other limitations include the design factors of consumer devices, such as the battery life, screen sizes and others that are related to the social factors surrounding the adoption of mobile working lifestyle. Issues such as Technostress, which is the established term for the stress resulted from

being not able to cope with constant, ubiquitous technologies is one example (Hsiao et al., 2016), (Niehaves et al., 2013).

Table 4.2. An overview of some limitation of mobile services in relation to the mobile capabilities.

Limitations	Location Based Services	Personalised Services	Instant Communication and Collaboration	User Experience
Privacy and security	Location can be used to track with no permission, and location related information could be accessed by non-authorised individuals and services.	Personal Information and user preferences can be used for unauthorised profiling.	Anywhere communications can expose the devices to harmful attacks, and they may not always use secure networks.	To offer enhanced experience, smartphones store a lot of information about the user, and some would continually listen to surrounding through the smartphones microphones, this exposes the user to more security threat.
connectivity	Location information are sent over the internet, loss of connection means a delay, and possible loss of location information	Personal verification often takes place when a service is initiated, services might be stopped in case of connection loss.	Being instant requires continues connection, the loss of connection create situation where mobile services lack instantaneousity.	In many cases, mobile applications really on a backend servers, on the assumption that the computing power of smartphones is less than those of the PC which could cause services to stop on the mobile platform. Besides, battery limitations could render the user unconnected in critical situations.
Regulations	Some countries have stronger regulations of geo-tracking than others. those regulations should be taken into considerations	There are many regulations around Personal Information, including those concerning the collection of finger prints, retina scanning, and face recognition.	There are regulations around the forms of communication of governmental transactions, and mobile payments.	Many countries have regulations limiting some of the capability of smartphones, such as VoIP and video conferencing and other disrupting technologies, which often face some resistance.

4.4 The Application of the Proposed Framework

The framework is a shortcut into the effective adoption of mobility, and therefore, the suggested process for applying the framework should be both intuitive and straightforward [Figure 4.6]. The proposed framework offers a holistic view of mobile adoption, by classifying the objectives and mobile services capability and solutions, to allow equal consideration of the relevant three aspects of the transformation.

The mobile initiative can be established to satisfy the business strategy in a top-down approach, and can be implemented in a bottom-up approach powered by the consumerization of IT. Evaluation should take place in order to justify the investment, and to make sure that it is aligned with the business goals and objectives. The following six phases are suggested to implement the framework as illustrated in Figure 4.6.
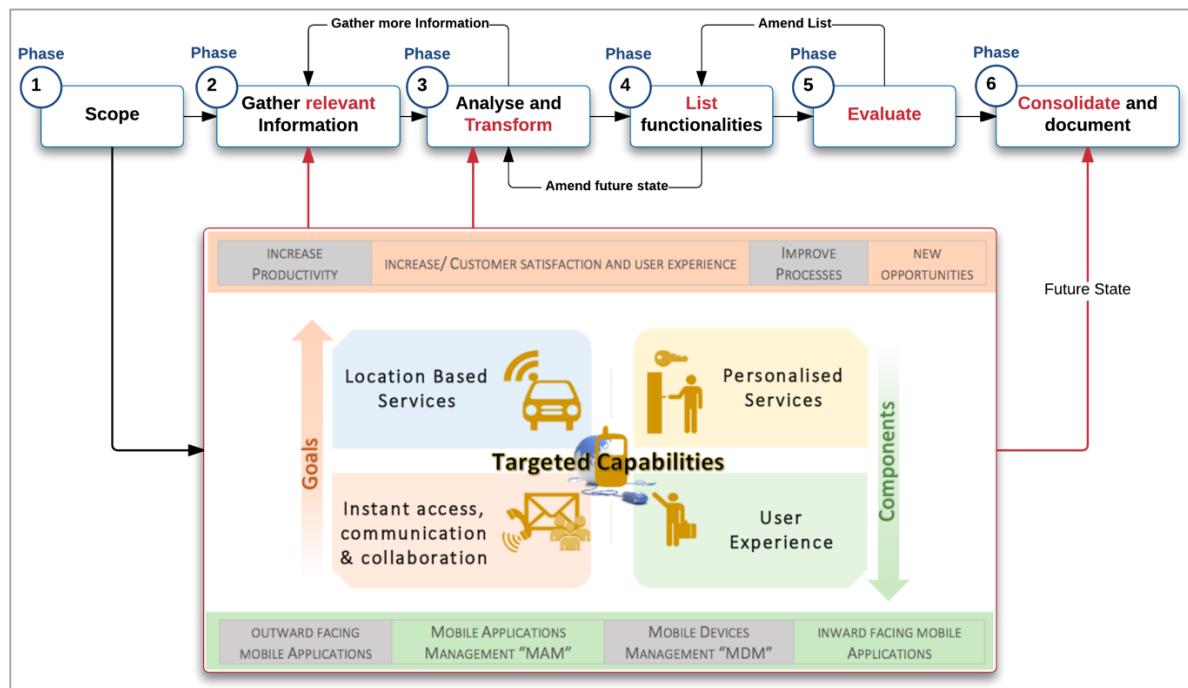
Figure 4.6. The Outline of Proposed Process.

4.4.1 First Phase: Scope

Start by identifying the scope of the transformation, where the change will take place. This might be a single project or service, a programme or the entire enterprise. The scope of the suggested framework does not address the issues related to governance or Project Management and rather, focuses on the future state of the mobile transformation and the outcome. However, as in any

effective change, approvals and executive buy-in and involvement are necessary (Birkinshaw, 2016), and business strategy, policies, standards and guidelines of the organisation should be adhered to. In case the enterprise has an enterprise architecture program in place, it should be informed of the mobile transformation if it was not already involved or triggered by it, and it should also be communicated with throughout through an inter-operability model that is presented in the next chapter.

4.4.2 Second Phase: Gather Relevant Information

A breakdown should follow the scope to the level of a single service or a task. Services should include electronic and non-electronic, extending to customers and internal staff. One of the main benefits of the framework is to focus the effort in information collection, and on only collecting information that is relevant to the mobile initiatives, saving time and expediting the plan for the mobile transformation. This information is derived from the framework and coloured in Table 4.3 to match the capabilities in Figure 4.6.

Table 4.3. Service Transformation with Mobile Capabilities

Detail	Description		Mobile Capability
Location	The expected location from which a user could interact with the service.	Goal	To extend services to a new platform and new users, or restrict them. And to utilise user's locations for service enhancement
Location sensitive	Document the locations' information that is relevant to the service.	capabilities	• Tracking and monitoring. • Push-Location based information. • Grab information.
Relevant Information	The information needed for the service provider to perform the service.	Goal	To enhance velocity and frequency of data delivery, enhance the integrity and privacy of information, and evaluate new ways to utilise collected information.
Time sensitive	The frequency and speed of information delivery.	capabilities	• Instant Text and email (Conventional) • Chat • audio and video conferencing • collaborating (Product developing)
Info Destination	The beneficiary party of transferred information, often the service provider.		
Source of Information	The source of information needed for the service provider to perform the service.	Goal	To automated or Partially automate services (ex: automate identification), and improve them with an enhanced accountability and acknowledgements, customization for users and user types.

ID sensitive	The ID of individuals interacting with the service.	capabilities	• Identification. • Accountability and acknowledgement. • Pre-fill and automation. • Customization and notification.
Communication Type	The type of communicated information Text based, Picture, Audio and Video.	Goal	To utilise mobile capabilities to read context information of relevance to the service, through applications, various sensors of built in smartphones or connect to external ones. In addition to using the capabilities to enhance the user experience (ex: notifications and reminders for example)
Experience	The measures which are taken to enhance the user interaction or a use of a service	capabilities	•Enhanced Interaction •Context Awareness •Portability

After scoping the mobile initiatives and documenting the breakdown of service and tasks, and for the planner to analyse and transform the following, the information has been suggested to be collected for each service

4.4.3   Third Phase: Analyse and Transform

This stage is about applying the framework to every service individually if the objectives are already set, then the mobile services capabilities should be explored to identify initiatives that could help satisfying those objectives in Table 4.3, and visa-versa, the mobile services capabilities should be explored, and the resulted initiatives should be evaluated.

The framework works as a template as well, and the objectives and initiatives should be documented. In addition to this, an important part of this phase is to use the solution section to document any concerns, specific requirements, requirement not requiring mobile capabilities, or strategic considerations related to the identified four categories in each section respectively. The outcome of this phase should be a card for every service, filled in with the objectives that they serve, the functionalities required to meet those objectives and the concerns and strategic considerations related to the initiative.

4.4.4 Fourth Phase: List Functionalities

These are functionalities that the mobile solutions should provide; a comprehensive list of mobile functionalities organised in the proposed four categories of the framework also enables the planner to view the first product of the framework.

The Mobile capabilities are derived from the smartphone's capabilities as detailed in Figure 4.5, and how the capabilities are linked to solutions in turns and eventually, how they are linked to the objectives.

As the functionalities are listed, new functionalities may emerge to satisfy other functionalities, or to help improve or constrain them. Additionally, a second iteration of mobile enhancement can be carried out as the future state becomes clearer. These functionalities are constrained by the customer's requirements and the strategic considerations are communicated to developers to improve upon and for the next phase to be done.

4.4.5 Fifth Phase: Evaluate

In this phase, the Balanced Scorecard (BSC) has been chosen to be applied as shown in Figure 4.7 to assess the quantifiable and unquantifiable benefits of mobile initiatives, and to align the objectives with the business strategy. A detailed guidance on the application of the 'BSC' is in the following chapter (Chapter 5).

Zooming in the objectives at this phase may trigger the need for more functionalities to be added, amended or constrained. For instance, if measuring one of the objectives required counting the time a user has spent at a certain location, then this functionality is supposed to be added unless it conflicts with a policy or other interests of the customer.

Evaluation is not only restricted to the value, but could also be carried out using the 'Multi-criteria Decision making' techniques to decide to evaluate and decide on a decision such as the phases of rolling out mobile solutions, smartphone devices, application types etc., by comparing costs to estimate the value if any of these options were to be followed.

In this phase, if an Enterprise Architecture Program existed, then it should be utilised for an increased visibility of the effects of the proposed changes, and this helps to utilise the mobile transformation effort for other uses enterprise-wide.
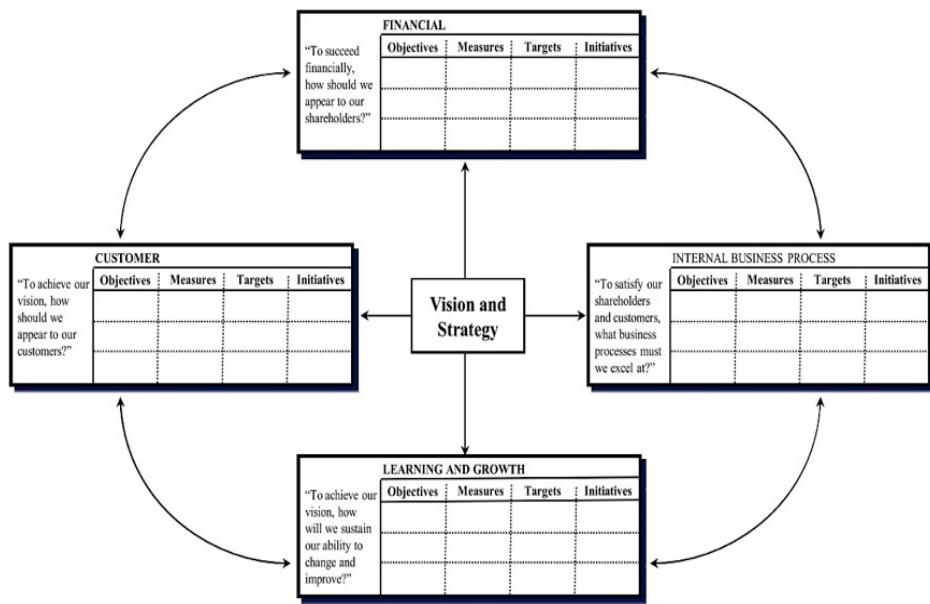
Figure 4.7. The Balanced Scorecard (Kaplan, 2010)

4.4.6   Sixth Phase: Consolidate the Transformation Plan

The output of the previous stages should carry out a proposed roadmap. However, they might be scattered over several templates that outline a future state, lists of functionalities, and other documentation relating to the evaluation and decisions made throughout the process.

This phase is concerned with consolidating policies, requirements, functionalities, describing the end products and the objectives that they serve, their estimated value, and a plan for future phases. The contents of future state descriptions and strategic concerns could be mapped directly to the template or documented according to the organisation's standards and indexed in the template as shown in Figure 4.8. Other supporting documents from the transformation project may translate to lessons learned and kept for future reference.
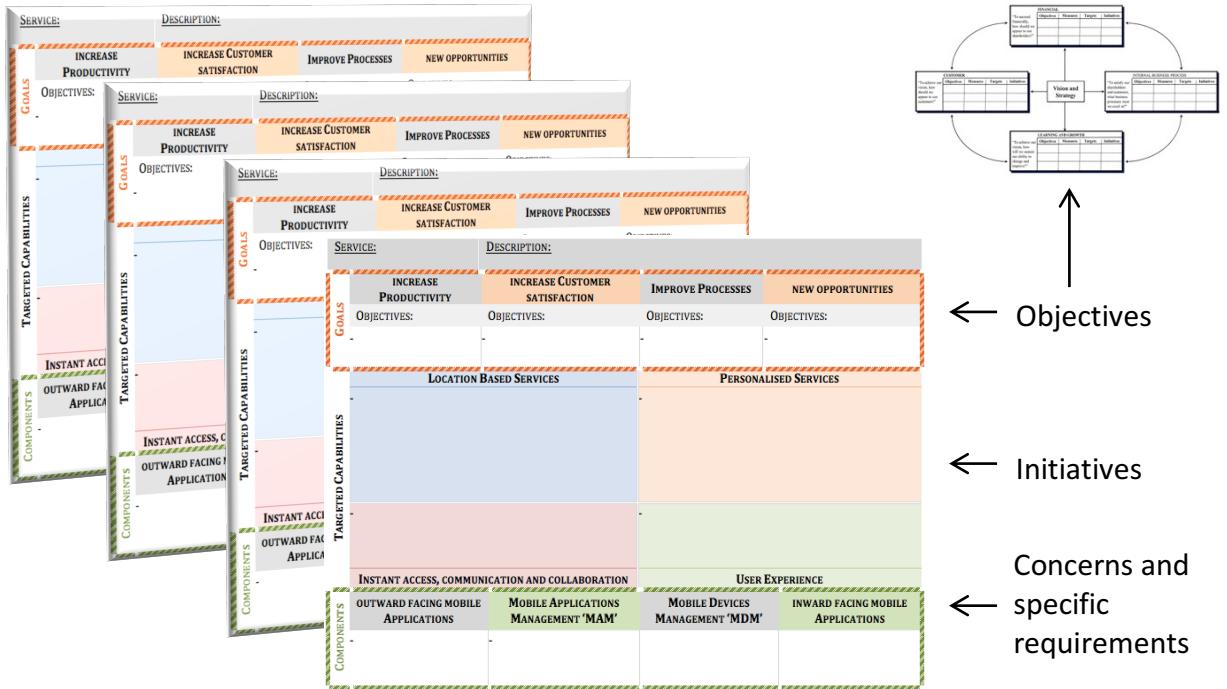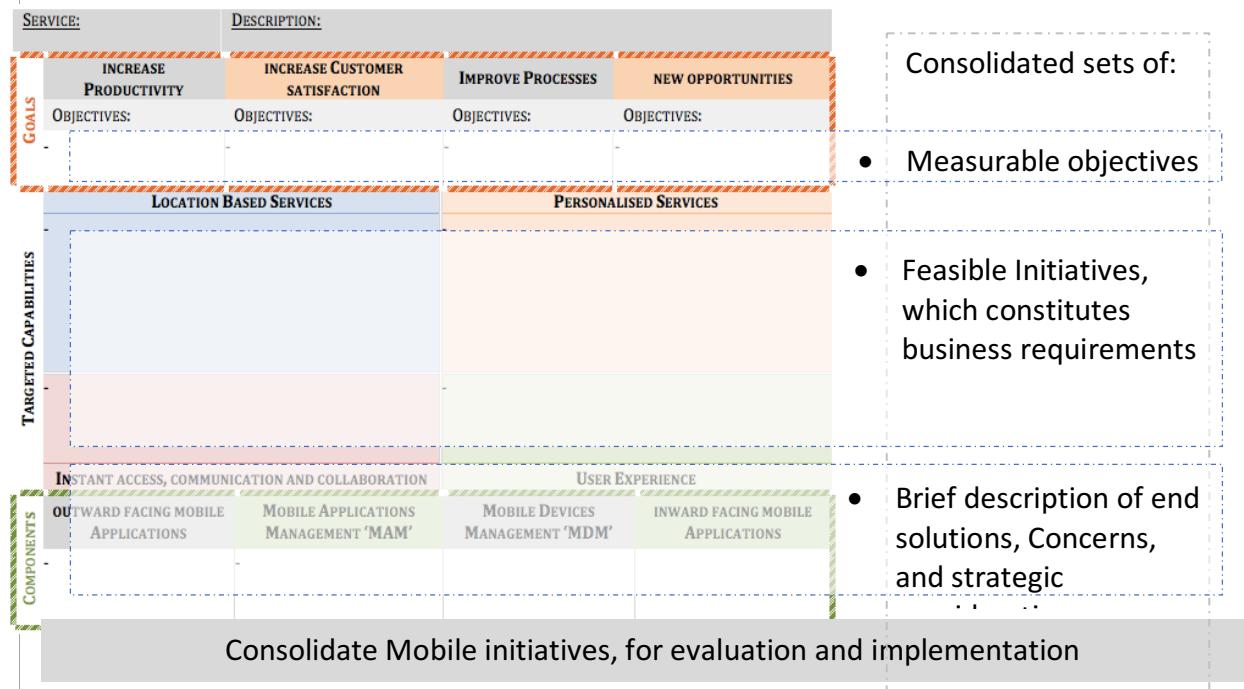
Figure 4.8. The Phases of Framework Application.

Summary

Smartphones are the new face of engagement. The demand for mobile services is higher than ever, and organisations need to consider adopting mobile for internal operations 'Mobile Enterprise' and in the services extended to customers. Many existing frameworks are addressing technical changes or different aspects of the mobile business strategy. There is a need to have a comprehensive mobile enterprise framework that guides the transformation process and supports the creation of a clear mobile strategy. In this chapter, we attempted to design taxonomy of mobile added values, categorising the values in catogries (4) for easier evaluation and consideration of benefit and cost, and setting the development requirements. The taxonomy should help in creating the vision for mobile transformation since a future state is clearer and the values of mobile are known. Also, the framework should help in defining the mobile strategy by, first, facilitating for the benefits gained if the mobile values are added to be measured by suggesting the targets. Secondly, by basing the strategy on the solution components of the framework, including internal services, Business Applications for the customers, MDM to manage the devices, and MAM to manage the application.

A simple process is suggested in the chapter to guide the implementation of the framework, although the framework is not a supposed to manage the transformation project of implementing the future state. It specifies the business requirements for the development of mobile solutions and capabilities within the enterprise, and support the development of the mobile strategy.

In the next Chapter (Chapter 5) the proposed framework is applied to two additional case studies to illustrate how it can be applied and further validate the framework. It presents the supporting models that are developed to ensure the framework is better equipped to handle versatile real life scenarios.

Chapter 5. Framework Application

5.1 Introduction

In the previous chapter, a framework for mobile adoption was suggested to have the following three sections: categorising mobile services capabilities, and objectives and solutions as shown in Figure 4.5. These sections should be able to generate a holistic future state view of mobile adoption, and for that to effectively work, a process to implement and evaluate the outcomes of the framework has to therefore be developed. The method should ensure that the framework continues to be intuitive and easy to use, and facilitates for the maximum utilisation of mobile services capabilities.

Evaluation is an essential part of the transformation process, although evaluation of IT investments, in general, is difficult. The most commonly cited reasons to evaluate investments in IT beside the intangible nature of the benefits include the difficulty to quantify strategic and competitive advantages, and that the benefits of IT are indirect and usually realised in the long run. 'The theories and techniques available are inappropriate for understanding and capturing the value of information systems.' (Giaglis et al., 1999).

The justification for IT investment has evolved over the last four decades from the need to automate business processes and controlling costs to the era of ubiquitous computing where IT is driving the business structure (Silvius, 2006). As a result of this, evaluating IT investment in

quantitative measures is becoming more complex, particularly in mobile solutions which has been described as the most disruptive technology since the Internet. (Manyika et al., 2013).

The business mobility market will be transformed by offering '*mature, standardized applications and pervasive high-speed connectivity to employees, vendors, customers and other enterprises'*. A wider array of business processes will be impacted than ever before and new mobile business models will be generated (McDowell, 2008). This chapter illustrates how the framework can be applied and evaluated using two additional case studies, presenting the supporting models including the Mobile Maturity Model and the Enterprise Architecture Interoperability Model. This is followed by an explanation about how Multi-Criteria Decision Making techniques can be used to evaluate the candidate components of mobile transitions.

5.2   Evaluation of the Proposed Transformations

Beside the need quantifiable and unquantifiable benefits of mobile adoption, another distinction has been made between the so-called '*hard benefits'* and '*soft benefits'*. *'Hard benefits are those over which a unit has substantial control'* (Danko & Downs, 2012) including traditional measure such as '*reduced real estate costs'*, '*faster sales cycles'*, '*lower costs'* (McDowell et al., 2008), whereas the soft benefits are '*those over which a unit has some influence'* (Danko & Downs, 2012) such as the human factors including attracting the best talent, improving customer service and building brand reputations as reasons for deploying mobility (McDowell et al., 2008).

Appraising mobile initiatives is necessary even at the project's early stage in order to obtain stakeholder support, since executives are more likely to agree to hard benefits, although soft benefits can sometimes match or even exceed the hard benefits (Danko & Downs, 2012). In terms of mobility, executives are more concerned with soft benefits for pushing their organizations toward greater mobility (McDowell, 2008), (Ackerman, 2013).

The Balanced Scorecard (BSC) has been used as a performance management system and emerged as a proven strategic management system. It works by identifying and measuring the critical factors pertaining to the organization's flexibility and responsiveness to customer needs. It is an alternative measurement to arbitrary goals and targets (Askar, M., Imam, S., & Prabhaker, 2009). After an extensive comparison to other methods, Milis and Mercken (2004)

and Silvius (2006) strongly suggested the use of the Balanced Scorecard to evaluate ICT investments. It is suggested for knowledge-based projects (Lyu et al., 2016) and performance measurements for multi-faceted impact ICT Investments (Loeser & Grimm, 2012).

5.2.1 Balanced Scorecard (BSC)

In order to justify the proposal of a system, a set of specific business goals have to be identified with a set of primary objectives to be sought by the introduction of this system and to constitute the expected benefits that have to be comparatively evaluated against any cost (Giaglis et al., 1999).

Developed by Kaplan and Norton (1992), the Balanced Scorecard can be used to quantify and measure the goals and objectives of mobile initiatives. The Balanced Scorecard is used extensively in both business and government, to align the business activities to the vision and strategy, to improve internal and external communications, and to monitor organization performance against strategic goals. A survey showed that organizations are increasingly focusing on new and sometimes non-financial measures in relation to Return of Investment (McDowell et al., 2008).

Measurement motivates, and that is why the BSC can acts as a catalyst for bringing in the 'change' element within the organization. So for the first time, it enables organizations to look ahead using leading indicators instead of using lagging indicators (Sharma, 2009).

The ultimate outcome measure is the financial perspective, and the BSC supplements it with metrics from three additional perspectives as the drivers for creating long-term shareholder value. The Balanced Scorecard supporters claims that it aligns with the strategy leading to better communication and motivation, which translates to an enhanced performance, considering that these measures are might be evaluated and changed to better support the business goals (Sharma, 2009).

The development of an effective Balanced Scorecard requires close attention paid to the links between objectives, particularly with financial objectives. The BSC Strategy Map suggests that learning and growth metrics support the internal business processes and customer process

objectives, which eventually will enable the enterprise to achieve it its financial objectives. Objectives can be set for each initiative based on the norms of the industry, and the mobile goals in order to measure and evaluate the outcomes. The impact of adopting mobile technology will be measured by all of the metrics in Figure 5.1.

5.2.2 BSC Metrics

The Balanced Scorecard links strategy and actions, and considers the financial and non-financial objectives. It can be implemented as a performance management system as well as a performance measurement tool, which explains the increasing importance amongst different businesses.
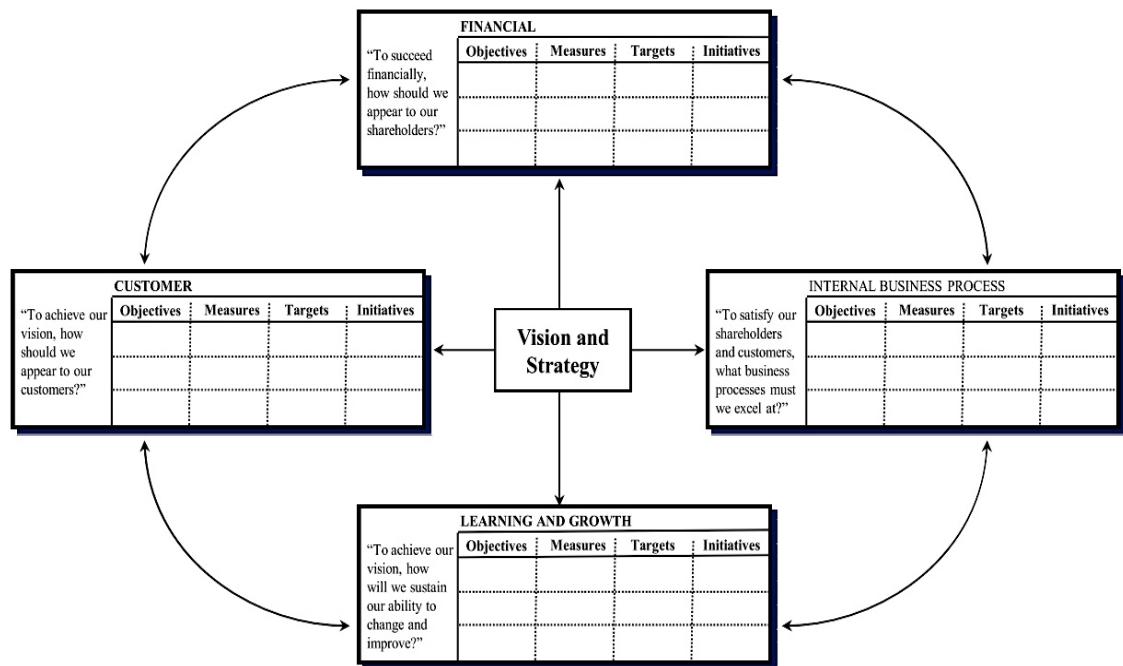
Figure 5.1. The Balanced Scorecard (Kaplan, 2010).

Intangible assets such as knowledge and technology affect the financial outcomes indirectly through chains of cause-and-effect which can be measured in multiple steps 'matrices'. For example, 'employees training' leads to 'improvements in service quality', 'service quality' leads to 'higher customer satisfaction', and 'customer satisfaction' leads to 'increased customer loyalty' which increases revenues and margins (Kaplan & Norton, 2001). In addition, intangible assets usually have to be bundled with other intangible and tangible assets to create value. They

may not create value on their own. For example a new growth-oriented factor could require knowledge about customers, training for sales employees, new databases, new information systems, a new organization structure, and a new incentive compensation program (Kaplan, 2010).

The metrics used in the Balanced Scorecard (Karathanos & Karathanos, 2005), (Kaplan & Norton, 2001) are outlined as follows:

5.2.2.1 The financial perspective

This perspective contains the financial measures concerned with revenue growth and profitability, and the stakeholders' perspective. It should answer the question, 'How should we appear to our shareholders?'

5.2.2.2 The customer perspective

This perspective is concerned with value creation, and the perspective of customers. The measures should answer the question, 'How should we appear to our customers?'

5.2.2.3 Internal business processes perspective

This perspective measure the efficiency of internal operations, and the business processes that satisfy the previous two perspectives. Measures in this perspective should answer the question, 'What processes must we excel at?'

5.2.2.4 Learning and growth perspective

This perspectives measure is concerned with the creation of an organisational environment that allows the organisation to meet targets for innovation, learning and growth, measures should answer the question, 'How can we sustain our ability to change and improve?'

Each of the four metrics should document the objectives, the measures of each objective, the target of each measure, and what initiative should be carried out to achieve the associated targets.

The Balanced Scorecard metrics are linked through a chain of cause and effect. The objectives of the financial perspective are supported by the other three perspectives. The objectives of the customer perspectives are achieved through meeting the objectives in internal business processes, learning and growth, and eventually, the learning and growth perspective supports all of the other three perspectives (Ahn, 2001).

5.2.3 'BSC' Application

In this section, two case studies were selected from the literature to illustrate the application of the Balanced Scorecard to the audience of the primary case study that took place in Saudi Arabia, some objectives are documented in these cases, however, in those cases the focus was on demonstrating the actual mobile solutions more than relating them to a set of tenable or intangible objectives. Therefore, we referred to other source to complement these cases with common objectives used in their fields, and identifying, what could be impacted by the mobile, and to showing the cause and effect chain where possible.

A primary research study was carried out at a major electronic services provider, and actual figures and objectives were used for evaluation. The objectives and measures categorised in the framework fall into four categories, which are:

- Productivity.
- Customer/user satisfaction.
- Process improvement.
- New opportunities, which include offering new services and products.

These categorise will simplify the process in term of underpinning the benefits and objectives of the relevance of the mobile initiatives.

'The Balanced Scorecard puts strategy-the key driver of results today at the centre of the management process' (Sharma, 2009). Overall, the proposed framework in Chapter 4 drives mobile adoption, working as a strategic view of the future state of the transformation in term of objectives, targeted capabilities and actual solutions as shown in Figure 5.2.

The framework supports the evaluation by:
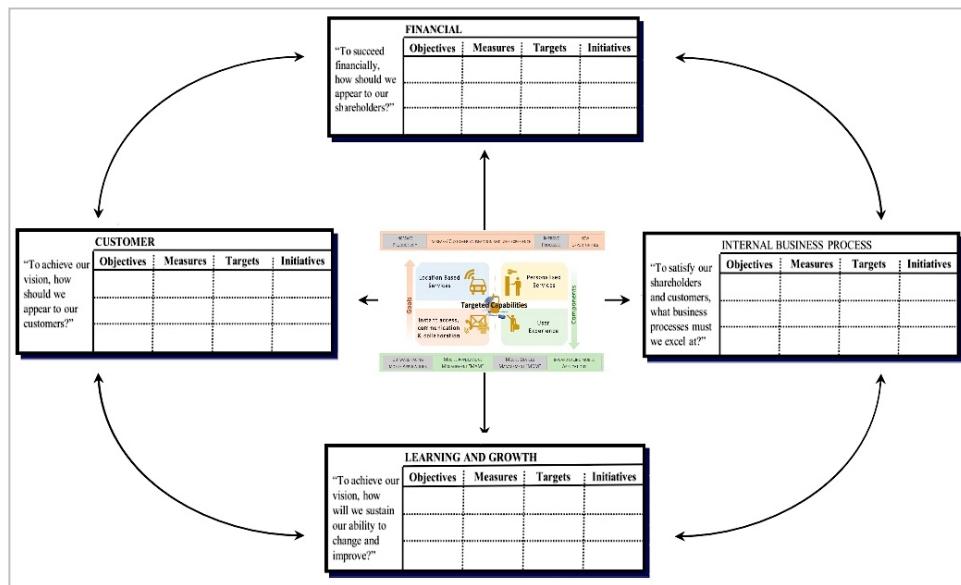
Figure 5.2. 'BSC' For The Measurement of The Mobile Initiatives Adapted from Kaplan (Kaplan, 2010).

- Describing the mobile initiative, affecting the measures more accurately.
- Keeping the mobile initiative objective-oriented, through relating them to the specified goals.
- It facilitates for an effective way to identify and document strategic considerations, through the categorisation of concerns and recommendations related to the implementation.

The metrics above can be used to evaluate the desired benefits of the mobile initiatives and manage the performance of the outcomes. However, in our case studies, the focus is on the evaluation of mobile adoption and the metrics need to be adapted to be more specific to that purpose. Table 5.1 shows how the BSC can be adapted to evaluate only the aspects relevant to the mobile initiatives.

Table 5.1. The Questions Explaining The Perspectives of BSC, And The Suggested More Specific Questions For Mobile Initiative Evaluation.

Perspective 'metrics'	BSC	BSC for mobile initiative
Financial perspective	How should we appear to our shareholders?	- What financial measures are to be improved by mobility?
The customer perspective	How should we appear to our customers?	- What user satisfaction measure can be improved by mobile? - How could mobile enhance the corporate image?
Internal business processes perspective	What processes must we excel at?	- What processes improvements measures can be improved by mobile?
Learning and growth perspective and innovation	How can we sustain our ability to change and improve?	- What measures can be used to assess the mobile capability maturity and sustainability? -How could mobile help in sustaining the business?

The value of the mobile initiatives is compared to the cost of developing and deploying the initiatives, which requires the involvement of professionals. This will enable the executives to make an educated decision on what mobile initiatives to implement, to postpone to a later phase or to discard entirely.

5.3   The Selected Case studies for BSC Application:

The framework was derived from the literature including from eight case studies across the fields of education, health, tourism and banking for use in relation to validation. It underwent several iterations and refinements until it arrived at the right combination of elements. Two additional case studies were selected for the purpose of the discussion of framework application and evaluation using the Balanced Scorecard. The case studies vary in nature between profit and non-profit, simple and complicated, and novice and professional levels of implementation.

Information on the actual figures is not available, in addition to any discussion on concerns and recommendations prior and during implementation. Therefore, for the purpose of the discussion, benchmarking figures were obtained from variable sources and assumptions were made showing examples of some of the relevant issues for each category in the solutions section.

5.3.1 Validation Case Study 1: A Computer Systems Company

The first case study is for a computer systems company with many field agents (Antenna, n.d.). The company is one of the largest providers of business outsourcing solutions to about 25.000 automobile, truck, motorcycle, marine and recreational vehicle dealers in Asia, America, Europe and the Middle East. The front-line engineers are accustomed to hard-wired solutions, which has prevented them from responding quickly to fluctuating service demands.

The new solution suggested would allow them to take real time actions resulting in improvements in several measures including accurate arrival times (ETAs) to customers, which increased from 10% to 90%. The objectives achieved and capabilities adopted are outlined in [Figure 5.3].

5.3.1.1 Application

The case study was mapped to the proposed framework using the template for a holistic view of the mobile initiative as shown in Figure 5.3. The mobile initiatives can be trigged by the need to enhance the performance of the organisation in several measures, the need for mobile capabilities, or simply as response to user demands.

The scope of the mobile initiative was to improve the service that handles the needs of the mobile engineers. The characteristics of that initiative were mapped to each mobile service capability respectively, to help communications to other involved members and more importantly, to the development team. Additionally, in cases where the framework was used, it should allow for a more comprehensive consideration of mobile services capabilities. No concerns related to strategic consideration were documented, however, the considerations of security or privacy are still important for such a solution, in addition to other policies for devices and application management.

CASE STUDY: ADP Dealer Services	DESCRIPTION: For field engineers to take real-time action from the frontlines with mobile solution.		

	INCREASE PRODUCTIVITY	INCREASE CUSTOMER SATISFACTION	IMPROVE PROCESSES	NEW OPPORTUNITIES
GOALS	OBJECTIVES: - Reduced call centre costs - Lowered customer service costs.	OBJECTIVES: - Improved customer service quality with accurate arrival times (ETAs) to customers. - Improved customer responsiveness.	OBJECTIVES: - Improved inventory and parts management	OBJECTIVES: - Easily and economically to adapt to future requirements, such as time and expense management, preventative maintenance processing and Signature Capturing.

	LOCATION BASED SERVICES	PERSONALISED SERVICES
TARGETED CAPABILITIES	- Communication and files can be geo tagged.	-
	- Engineer's to be able to access the back-end system and update them on the move. - Receive work orders via real-time notification with customers' information. - Using mobile to track bar-coded parts to manage and report on service inventory in real time.	- Information to be stored on mobile devices if for any reason the device cannot connect to the back-end system, and update all at once when it connects. - Mobile Phones can be triggered to notify engineers in real time notification.
	INSTANT ACCESS, COMMUNICATION AND COLLABORATION	USER EXPERIENCE

	OUTWARD FACING MOBILE APPLICATIONS	MOBILE APPLICATIONS MANAGEMENT 'MAM'	MOBILE DEVICES MANAGEMENT 'MDM'	INWARD FACING MOBILE APPLICATIONS
COMPONENTS		Concerns and recommendations about future updates.	Concerns and recommendations about engineers' mobile devices.	Concerns and recommendation about usability.

Figure 5.3. First Case Study: Computer Systems' Company (Antenna, n.d.).

5.3.1.2   Evaluation

The achieved objectives in this case were:

- Lowering customer service costs.

- Reduced call centre costs.

- Improved customer responsiveness.

- Improved customer service quality measured by accurate arrival times (ETAs) to customers.

- Improved inventory and parts management.

- Easily and economically adapting to future requirements such as time and expense management, preventative maintenance processing and Signature Capturing.

These objectives were met through the application for mobile, and can be presented in the balanced Scorecard as shown in Table 5.2. However, to illustrate the way in which 'BSC' is used in real-life, more relevant objectives and measures were added from the KPI Library online (KPI Library, n.d.).

Table 5.2. The Balanced Scorecard for Computer Systems Company Case Study.

Financial perspective	Internal business perspective
Lower customer service costs: * - Average lifetime value of customers. - Monthly Recurring Revenue (MRR). - Lower call centre costs: * - Number of incidents per developed application. - Number of calls per engineers.	Improve inventory and parts management: * - Percentage of Inventory Accuracy Improved engineers fleet Management: - Accurate arrival times (ETAs) to customers. * - Transit time. - Mobile engineers time utilization.
Customer perspective	**Innovation and learning perspective**
Improve customer service quality: * - Accurate arrival times (ETAs) to customers. * - Number of complaints. - Customer Retention Rate. - Customer satisfaction survey. Improve customer responsiveness. * - Average engineer response time. - Number of complaints.	Easily and economically to adapt to future requirements: * - Time-to-market of new products/services
* Objectives and measures documented in the case study.	

Achieving these objectives should help the organisation to realise the financial benefits of the chain of cause and effect. For example, enhancing the arrival time and enhancing customer satisfaction, which should in turn increase and enhance financial measures.

The example will illustrate how measures can be set to match the objectives related to the scorecard of customer perspective [Table 5.3], since the reported value in the case study is

related to it. However, some assumptions have been made to present a more comprehensive example:

Table 5.3. Example Customer Perspective for Case Study 1.

Customer perspective:			
Objectives	Measures	Targets	Initiative
Improve customer service quality *	Accurate arrival times (ETAs) to customers. *	90% *	Mobile initiative in Figure 5.3
	Number of complaints.	TBD: This is can be enhanced with regards to complaints regarding engineers' delays.	
	Customer Retention Rate.	TBD: meeting the 'SLA' standards could increase this factor as discussed below.	
	Customer satisfaction survey.	TBD: Based on current satisfaction rate, and expected increase.	
Improve customer responsiveness. *	Average engineer response time.	TBD: could be enhanced significantly with the ability to handle tickets on the move.	
* Documented in the case study. TBD: To Be decided by the company's team.			

5.3.1.3 Discussion

- The IT service provider company is well established, and they are expected to have performance measurement systems in place that measures many validated and fine-tuned KPIs. However, in this attempt, the goal was to list several objectives and measures that are expected to be enhanced by the implementation of their mobile initiative.
- Improvements by mobile initiative were focused on:
  - o Enhanced inventory management.

- o Better mobilisation of engineers.
  - o Engineers to have an instant access on the move to the system.
- The solution helped engineers deal with assets in their inventory faster, and allows the engineers to get notifications on the go that is reported in the case study to have enabled the company to in turn improve the customer service and standards of the agreed SLAs. This means that the company should expect less complaints pertaining to adhering to the agreed response time in the SLA, and the arrival time of the engineers. This in turn should reflect on the customer satisfaction rate, and customer retention overall.
- With on-the-go notifications and data access, the company manages the engineers more efficiently, and engineers can get the information they need instantly, saving the engineers time. The company's own call centre would also save time since the engineers do not need to call for information as reported, as well as customers'' time, which should increase satisfaction.

Table 5.4 and Figure 5.4 shows a detailed scorecard as an example, and an overall map of the cause and effects of the BSC for case study 1.

Table 5.4. An Example of a Customer Perspective Scorecard.

Customer perspective:				
Objectives	Measures	Current	Targets	Initiative
Improve customer service quality.	Accurate arrival times (ETAs) to customers.	10%	90%	Mobile initiative in Figure 5.3
	Number of complaints.	50	40	
	Customer satisfaction survey.	95%	97%	
Improve customer responsiveness.	Average engineer response time.	1 working day	3 working hours	
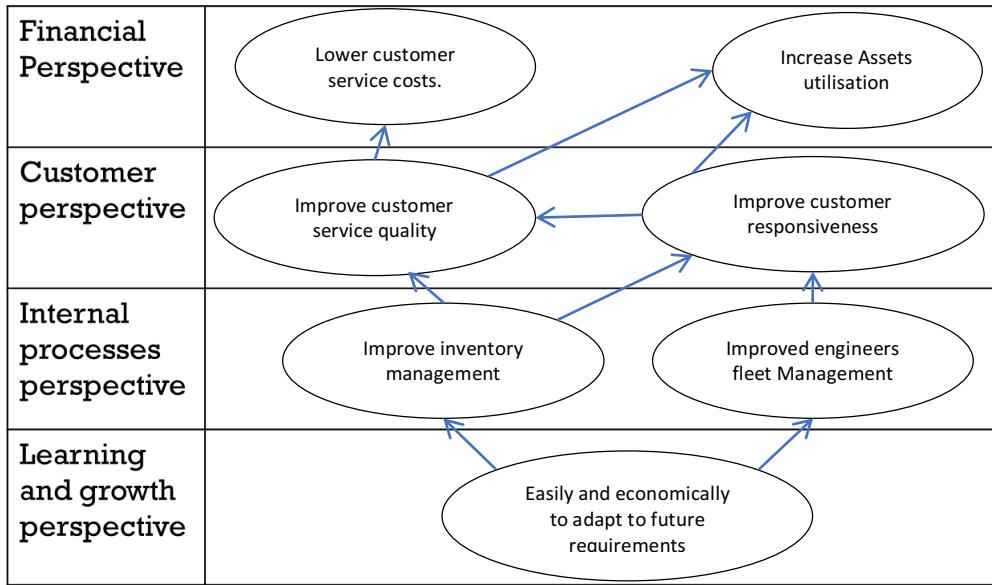
Figure 5.4. The BSC Map for Case Study 9.

5.3.2 Validation Case study 2: A Primary School

The second case study is for a primary school in India, which uses mobile video games to support students in rural areas in learning English (Kam et al., 2009). 31 children participated in the pilot study, and 4 left during the programme. The study was conducted in a private school. However, the students enrolled in the study were selected from other public schools, and the pilot was run as an after-school programme.

Despite poverty, the fact that most households had only one mobile phone and some did not entrust their children with these costly devices, the results were encouraging. Students were loaned mobile phones for the period of the programme. The curriculum was broken into six levels for the video games, and the children could move from one level to another at their own pace.

For the pilot study, the material was preloaded on the mobile phones because of the cost of cellular networks for the families, which was also the reason why the other capabilities of mobile devices were not utilised at that stage. Significant post-test gains which could be reasonably attributed to the mobile phone-based English learning games were achieved [Figure 5.5].

5.3.2.1 Application

The case study was mapped to the proposed framework, which served as a template for the holistic view for the mobile initiative. Usually, the mobile initiatives could be trigged by the need to enhance the performance of the schools in several measures, including the need for mobile capabilities, or simply as response to the users' demands, or those of the staff or customers. However, in this case, it was triggered for research purposes.

The scope of the mobile initiative was to improve the way that English is being taught to students in rural area. The characteristics of that initiative were mapped to each mobile service capability respectively. In this case, it clearly shows the potential of how the developed solution can be improved if more comprehensive considerations of the mobile services capabilities were taken into account.

No concerns of strategic consideration were documented. However, presumably, considerations relating to mobile device management could be recorded regarding how the loaned devices should be managed.

CASE STUDY: *Mobile Education in India*	DESCRIPTION: *A primary school uses mobile video game for teaching English*		

	INCREASE PRODUCTIVITY	**INCREASE CUSTOMER SATISFACTION**	**IMPROVE PROCESSES**	**NEW OPPORTUNITIES**
GOALS	OBJECTIVES: -	OBJECTIVES: - *Increased students' score in English*	OBJECTIVES: - *Teachers to spend less time in class.*	OBJECTIVES: - *Provide more support to students from rural areas.*

	LOCATION BASED SERVICES	**PERSONALISED SERVICES**
TARGETED CAPABILITIES	- *The game was designed to work outside the school.*	- *Since the phone is a personal device, the game is played by one student and it records their progress over time.* - *Mobile Phones are close to the student, which allows them to study whenever they have the time to do so.*
	-	- *The game utilizes the mobile devices capabilities, beside the interactive screen, processing power and memory.*
	INSTANT ACCESS, COMMUNICATION AND COLLABORATION	**USER EXPERIENCE**

	OUTWARD FACING MOBILE APPLICATIONS	**MOBILE APPLICATIONS MANAGEMENT 'MAM'**	**MOBILE DEVICES MANAGEMENT 'MDM'**	**INWARD FACING MOBILE APPLICATIONS**
COMPONENTS	- *Concerns and recommendations about applications and learning*	- *Concerns and recommendations about the materials deployments*	- *Concerns and recommendations about the devices*	

Figure 5.5. Second case study: A Primary School in India (Kam et al., 2009).

5.3.2.2 Evaluation

The achieved objectives in this case were:

- To increase the students' performance in English. Measured by the English exam scores.

- Increase teacher's productivity, measured by the teachers to spending less time in class.

- And for the future, the intent is to provide more support to students from rural areas.

These objectives were met through the application for a mobile device, and can be presented in the Balanced Scorecard, as shown in Table 5.5. However, to illustrate the way in which 'BSC' is used in real-life, more relevant objectives and measures were added from various sources (Karathanos & Karathanos, 2005), (KPI LIbrary, n.d.).

Table 5.5. The Balanced Scorecard Primary School Case Study.

Financial perspective	Internal business perspective

School revenue:
   - Grants.
   - Private fund.
   - Number of Students enrolment
Cost Management:
   - Teaching hours per week *
   - Expenditures per equivalent full-time student.
	Teachers productivity:
	   - Teaching hours for English teachers per week *
	   - Student / teacher ratio
	   - Average class size
	Quality of teaching:
	   - Graduation rate
	   - Class attendance rate
	   - Number of Students enrolment.
	   - Dropout rate.
	   - English exam scores *

Customer perspective	**Innovation and learning perspective**

Student learning results:
   - Time spent on mobile learning materials.
   - Class attendance rate
Parent overall satisfaction:
   - Satisfaction rate *
   - The percentage of private funding to the total amount of funding.
   - Percentage of students leave the school to other local schools
	Continues development in Mobile education:
	   - Time to lunch the next version of mobile application.
	   - Number of additional features

*Objectives and measures documented in the case study.	

The example will illustrate how measures can be set on the objectives related to the scorecard of the internal business perspective [Table 5.6], since the discussed value in the case study was related to it. However, some assumptions have been made in order to present a more comprehensive example:

Table 5.6. Example Internal Business Perspective for The Primary School Case Study.

Internal business perspective:			
Objectives	Measures	Targets	Initiative
Increase teachers' productivity	Teaching hours for English teachers per week *	40 hpw: Less time spent on English Exercises in class, and more time spent on preparing and monitoring the remote learning process.	Figure 5. 5
	Student / teacher ratio	TBD: current nation average is 29/1, a decision can be made to benefit from the mobile experience in increasing English lessons and lowering student / teacher ratio.	
Improve the Quality of teaching:	English scores *	47% (was 29%)*	
	Graduation rate	TBD: Based on the school's current Graduation rate, and the number of student failing in English.	
	Class attendance rate	TBD: being able to learn at the at their own speed at home, and catch up with others in class, might enhance this measure.	
	Number of Students enrolment.	TBD: Based on current enrolment figures, the solution could enhance this measure as discussed below.	
	Dropout rate.	TBD: 19.8% is the Current dropout rate average in India, the solution could enhance this measures as discussed below.	
* Documented in the case study. TBD: To Be decided by the school.			

5.3.2.3   Discussion

- With teaching hours in India reported to be 45 (The Times of India, 2014), and with less hours able to be spent on the curriculum, an estimated 5 hours can be then used for doing other tasks (The Times of India, 2014).

- The average teacher / pupil ratio for primary school is 29/1 (Sanjay et al., 2014). A low ratio is usually helpful. However, in this case, with the main learning source being the mobile application, and with less load work load for the teacher, the ratio could increase with a negative impact on the teaching quality. Additionally, additional tasks presumably added to the workload, including refining the materials on the mobile app, and monitoring the student's progress.

- The tests scores were reported to be higher in the case study.

- With better results in the English exams, the number of students who fail in English should decrease; therefore, the graduation rate is expected to increase.

- Class attendance could decrease for various reasons. Some of each might be to do with the difficulty some students face in learning at the speed of other students in the class, for which being able to go at their own speed via the mobile application would be helpful. Additionally, attendance may increase due to less sessions being offered.

- The increase of student enrolment is an indicator of a good quality of teaching, so with an improved quality of teaching and graduation rate, the number of enrolment can be increased. Additionally, adopting a new solution to help students in rural areas could attract more students from those areas overall. Lastly, enhancing the school's image with new solutions could give them a competitive advantage that attracts more students as well.

- By 2017, 48% of India's student are expected to finish high school (Sheehy, 2012), whereas for primary schools, the official report quotes an average dropout of about 19.8% (Sanjay et al., 2014). However, others have reported different numbers going up to 40% (Bajoria & Braunschweiger, 2014). These figures are reported despite an act being passed by the Indian government making elementary school compulsory. Some of the reasons reported are child labour and early marriages for girls, in which case the solution may not be of help (Bajoria & Braunschweiger, 2014). However, dropouts for commuting reasons, or for discrimination in class, could benefit slightly from this initiative.

- With the involvement of professionals of the field, the enhancement on these measures could be estimated in financial or overall mission value 'for non-profit organisations'.

In addition, these objectives can be refined with more realistic measures, additional ones can be added, and a more comprehensive evaluation can be carried out.

- Other considerations must be considered in order to marginalise negative impacts, including:
    - Student who have less access time to smartphones might be less familiar with using smartphones, or do not have sufficient time with the smartphone.
    - If smartphones are provided, policies must be in place for maintenance and other concerns regarding mobile device management.
    - Some of the student's enthusiasm is due to the new and unusual experience, however with time that might decrease.

Table 5.7 and Figure 5.6 show a detailed scorecard as an example, and an overall map of cause and effects of the BSC for case study 10.

Table 5.7. An Example of an Internal Business Perspective Scorecard.

Internal business perspective:				
Objectives	Measures	Current	Targets	Initiative
Increase teachers' productivity	Teaching hours / week	45	40	Mobile initiative in Figure 5.5
	Student / teacher ratio	29/1	25/1	
Improve the Quality of teaching:	English scores	29%	47%	
	Dropout rate.	19.8%	18%	
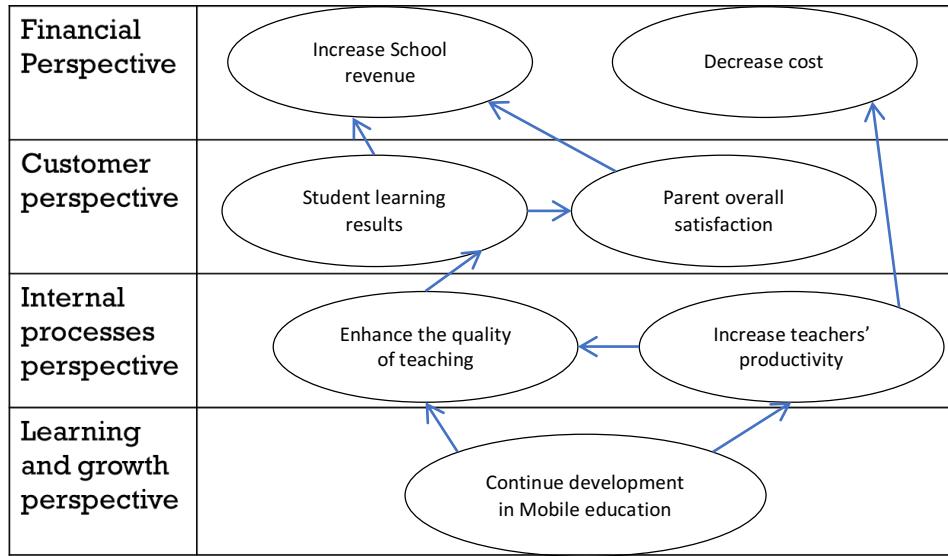
Figure 5.6. The BSC Map for Case Study 2.

5.4   Framework Additional Components

The proposed framework aims to produce a blueprint of a future state to facilitate for the mobile transformation of a given scope. However, considering the variety of business needs, it offers additional components to offer guidance on integration and the creation of IT and mobile strategies.

5.4.1   Mobile Maturity Models

Enterprise Capabilities Maturity models are used as a specific class of 'objects' and applications to assess an enterprise in an 'as is' situation to guide improvement initiatives in the future phases (Röglinger et al., 2012). Maturity Models reduce complexity and allows for benchmarking, better decision-making and direction setting toward a clear end goal. This paper adapts the MHETF framework to draw the end goal, and has reviewed an exit mobile maturity models, and proposed a holistic mobile maturity model (Alqahtani et al., 2015).

Mobile maturity models show different levels of maturity of mobile adoption. Bench marking suggests the optimal phase and future state transformation. These maturity models are being

suggested to help enterprises realise where they are and to help them transition into a mobile enterprise.

However, they have considered mobile services from different perspectives and some are more inclusive than others. A common description of the mobile enterprise is '*anytime, anywhere-enabled services providing new channels*' (Isaac & Kennedy, 2007). The reviewed Mobile Maturity Models can be classified into three categories:

5.4.1.1　MMM From a Strategic Perspective

Considering the development environment of mobile software and solutions, Song & Anderson (2013) suggested a clear description of the development environment and the expected outcomes of the different maturity stages. Mobile enterprises should be designed to enable mobility solutions to drive and sustain competitive advantages. By enabling employees, suppliers and distributors with an agile end-to-end mobile application lifecycle strategy to be deployed and mobile development to be integrated into application development. A similar strategic maturity model developed by Oosten suggested for the end goal is to have an organisation-wide strategy focuses on mobile, integrated platform capabilities, and ubiquitous connectivity. They will have a policy-driven and 'factory' approach to mobile innovation (Oosten, 2014). IBM's popular Mobile Infrastructure Maturity Model (MIMM) complements both maturity models with a mobile strategy maturity perspective. This is where the end goal of mobile strategy is to provide an enterprise-wide strategic approach to IT infrastructure, in addition to a large number of cross-organisational integrated mobility technology initiatives underway (IBMMobileFirst, 2013).

5.4.1.2　MMM from Mobile Capabilities Perspectives

Other maturity models focus on the capabilities offered to an enterprise and considers an enterprise more mature as they utilise more capabilities. An example of that is the 'BPTrends' maturity models which describes the end goal as having fully managed devices with an enterprise workflow, enforced mobile policies, strategy drives roadmap; and mobility-enabled process innovation (Paradkar et al., 2012).

The Ektron's Model is where the end goal is leveraging the devices' capabilities, such as touch centric and extensively uses HTML5 (Ektron, 2013).

Table 5.8. Transitions of Current Mobile Maturity Models

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
(Song & Anderson, 2013)	Ad Hoc	Opportunistic	Repeatable	Managed	Optimised
IBMMobileFirst (2013)	Evaluators	Piloters	Experimenters	Mobile Technology Leaders	
Oosten (2014)	Opportunistic		Strategic		Mobile-First
Paradkar et al., (2012)	Mobile Zero	Mobile Aware	Mobile Enabled	Mobile Enterprise	
Ektron (2013)	Forget it	Focus	Friendly	Mobile First	
PwC Advisory (2007)	Discovery	Silos	Integration	Transformation	Enterprise mobility
Basole (2005)	Mobilization	Enhancement	Reshipment	Redefinition	
Unhelkar, (2009)	Ad-Hoc State	Preliminary State	Advanced State		Managed State

5.4.1.3 MMM Based on Generic Information Systems (IS) Maturity Models

Technology-enabled enterprise change is a concern for many when adopting new technology, although mobile has been labelled as the most disruptive technology (Manyika et al., 2013). Consequently, some generic frameworks can be used in the case of mobile technology and vice versa. An example is the description of the optimal maturity phase by (Unhelkar, 2009) as '*completely transformed and matured business with mobile technologies and applications playing a major part in all aspects of the business'* in addition to having an organizational structure change, flexibility, the economic dimension in focus, and for the adoption as a whole to be environmentally responsible. The description is generic, and can describe other technologies and capabilities in relation to adoption as well. Another example is the Mobile Transformation Stages Model by Basole, (2005). The model suggest that the optimal phase is when mobile has to redefine the industries and markets. Table 5.8 shows the phases for each of the maturity models discussed, with an attempt to align the phases (Song & Anderson, 2013) in order to give a perspective on the way that each model envisions the transition to the final Mobile Enterprise.

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Although the maturity models outlined in Table 5.8 are different, they are not contradictory. They differ in their perspective of the optimal phase of mobile adoption, and the way that each enterprise is transitioning to that phase. However, if combined, they offer a rich maturity model that covers most aspects required to establish a clear road map to mobility.

Transitioning to a mobile enterprise differs based on the perspective of the maturity model, which translates to different levels and the label of maturity. Although most of the reviewed models have similar levels, the proposed maturity model follows the four phases of: Mobile Void, Mobile Aware, Mobile Enabled, and Mobile Enterprise (Unisys, 2013). Based on the reviewed maturity models and the review of mobile initiatives from ten case studies across the fields of education, health, tourism and banking, Figure 5.7 presents the future optimal phase of a mobile enterprise as envisioned by the MHETF framework. The objectives section - 'top section' - of the framework include Increase Productivity, Increase customer Satisfaction, Improve Processes, New Opportunities to assess the expected value of the mobile transition. The solutions section - 'bottom section' - presents the requirements for those solutions to be implemented and executed successfully. Figure 5.7 highlights the transition throughout the maturity phases into achieving the targeted mobile capabilities successfully, which are outlined as follows:

- *Mobile Void*; No mobile implementations. Mobile might have been considered without actual steps been taken.
- *Mobile Aware*; Targeted capabilities implemented, in the form of mobile applications as an extension of existing electronic services. This is without the establishing business's capabilities and targeted objectives, or any separate, strategic effort for mobile services.
- *Mobile Enabled*; High-level mobile strategy, policies and guidelines. A limited number of mobile initiatives, to respond to business needs. e.g. 'the utilization of MHETF framework to transform several initiatives'.
- *Mobile Enterprise*; An effort towards an enterprise-wide transformation to mobile enterprise where the objectives are aligned with enterprise-wide goals and objectives, standardized approach to mobility, enforced policies and an integrated services platform. e.g. 'The use of MHETF in conjunction with an Enterprise Architecture framework.

MOBILE MATURITY MODEL			
INCREASE PRODUCTIVITY	**INCREASE CUSTOMER SATISFACTION**	**IMPROVE PROCESSES**	**NEW OPPORTUNITIES**
- Business aligned Productivity objectives and policies. - Reuses services.	- Satisfaction objectives and policies alignment - User centric developed applications	- Mobile enabled processes	- Enterprise wide use of lessons learned. - regular mobile solution evaluation against desired value, and challenges

GOALS (vertical label)

MATURITY PHASES (vertical label)

LOCATION BASED SERVICES		PERSONALISED SERVICES	

Mobile Void   Mobile Aware   Mobile Enabled   Mobile Enterprise

INSTANT ACCESS, COMMUNICATION AND COLLABORATION		USER EXPERIENCE	
OUTWARD FACING MOBILE APPLICATIONS	**MOBILE APPLICATIONS MANAGEMENT 'MAM'**	**MOBILE DEVICES MANAGEMENT 'MDM'**	**INWARD FACING MOBILE APPLICATIONS**
- User experience standards. - Back End Integration	- Integrated Applications Management platform - Performance and security - Policies alignment	- Integrated Devices Management platform - Infrastructure and security - Policies alignment	- User experience standards. - Back End Integration

COMPONENTS (vertical label)

Figure 5.7. Mobile Enterprise Maturity Model

Table 5.9 illustrates how the main components of mobile transition develop over time, for easier bench marking and goal setting. Beside the benefit of bench marking and realising the current state of an enterprise, MHETF can be used to design the end state of each transition for every planned and operational electronic service. This is in addition to producing the implementation road map for the mobile transformation. The transformation can be done through several transitions with the optimal goal of mobilising the enterprise, where mobile is considered first and foremost in future investments.

Table 5.9. Detailed Maturity Levels For Main Components of The Proposed Model Outlined In Figure 5.7.

	Mobile Void	Mobile Aware	Mobile Enabled	Mobile Enterprise
Vison	None	None	Partially for some initiative	Enterprise wide vision for mobile services.
Road map	None	None	Partially for some initiative	Enterprise wide roadmap for mobile services.
Polices and standards	None	Some	Developed policies and standards	Enforced polices and standards.
Business Mobile alignment	None	None	Initiatives are mainly in response to business needs, or direct demand for mobile	Mobile Initiatives are creating values for business goals. And anywhere any time principle is enforced enterprise wide
Mobile Enabled processes	None	Ad-hoc	Some processes are mobile enabled	Enterprise wide principle for mobile enabled services
Use of lessons learned	None	None	Separate silos of lessons learned	Enterprise wide principle and approach lesson learned recording and consumptions.
Continues assessments for future improvements	None	None	None	Continues exploratory effort improvement and innovation.
Integrated platforms and reusability	None	None	Some reusable products and functions. Simple API integration.	Enterprise wide reusability principle for integrated development and deployment platforms. Might include the use of Backend-as-a-Service solutions.

5.4.2 Enterprise Architecture Interoperability

'*Architectures are fundamentally shaped by concerns outside the practice of architecture and it is therefore of paramount importance that any architecture must accurately reflect external context.*' (Josey, 2010). The inter-operability model shows how the 'MHETF' framework can be used in conjunction with TOGAF to simplify the complexity of mobile services and mobile business capabilities, and to align the objectives of the mobile initiative with the overall enterprise-wide goals and objectives. There are many differences between Enterprise Architecture Frameworks, as there are no clear definitions for 'EA' and Enterprise Architecture frameworks (EAFs) as discussed in Chapter 3. However, if there is any clear commonality between them, it is that they facilitate both the current state and future state of an enterprise to be clearly mapped and respond to the gap with a transformation plan. They also have this in common with 'MHETF' with the focus on mobile capabilities.

The Architecture Development Methodology (ADM) is the core of TOGAF, a well-documented methodology with clear requirements, input and outputs for each phase as detailed in Chapter 3, Section 3.1.1. In the first phase of the TOGAF methodology, the 'ADM' requirements, include where the policies and standards are gathered. In later phases of the methodology, the Application Building Blocks (ABB) and Solution Building Blocks (SBB) are drawn up for the current state of the enterprise and the future state. The interoperability model is based on the four pillars, which are Vison, Applications, Reference models and Capabilities [Figure 5.8].
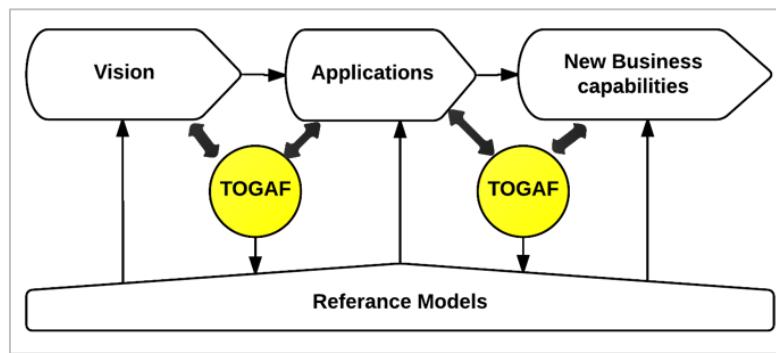

Figure 5.8. The Four Pillars of Interoperability with TOGAF

5.4.2.1 Vision

In the preliminary phase, the principles are collected which govern the implementation of 'MHETF'. Additionally, the use of 'MHETF' can be recommended as an outcome of this phase. The architecture effort starts with a request for architecture work, which could state a problem that requires a mobile solution or can be triggered to introduce the change to take effect by way of the implementation of the outcomes of 'MHETF'. In the latter case, the scoping of the architecture work should be done by 'MHETF' and the applications and services that are impacted by the change should have been identified as a part of that effort.

Mobile Holistic Enterprise Transformation Framework (MHETF) facilitates the vison of a mobile future state by categorising mobile service capabilities and the objectives that they bring about, besides allowing the concerned parties to document their concerns and recommendations for the four mobile capabilities. This is very similar to TOGAF's view of what vison should be - '*architecture vision describes how the new capability will meet the business goals and strategic objectives and address the stakeholder concerns when implemented*' (Josey, 2010). Furthermore, the provision of a first-cut, high-level description of the Baseline and Target Architectures for mobile services is facilitated by 'MHETF', which can be related to the business, data, application, and technology domains.

5.4.2.2 Applications

As new organisational needs emerge, a vision of the future architecture starts to take shape. 'MHETF' allows for mobile services to be designed either in response to business drivers or to employ a set of mobile capabilities. As the new applications are envisioned, separate capability categories - 'location-based services, user experience ... etc.' are considered A detailed functional requirement can be drawn, which constrains the Architecture Building Bocks (ABBs) and consequently, governs the development of the Solution Building Blocks (SBBs). '*ABBs are defined in relation to a set of contextual factors and then realized through SBBs*' (Josey, 2010).

5.4.2.3 Reference Models

'TOGAF' suggests two reference Models; the Integrated Information Infrastructure Reference Model 'III-RM' and the Technical Reference Model 'TRM. These reference model architectures

can be used during the development of the architecture and thus can move from the generic architecture to the organisation-specific architecture, as classified by TOGAF's architecture continuum [Figure 5.9].
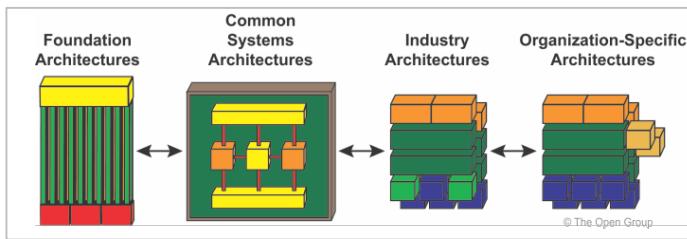

Figure 5.9. The Architecture Continuum.

The outcomes of the framework are mobile business applications that, if developed using the framework as a part of the implementation of an enterprise-wide architecture programme, have the potential to be ubiquitous, interoperable, and general-purpose and therefore regarded as infrastructure applications. The Technical Reference Model (TRM) is a major linking point between the MHETF framework and TOGAF. Considering the development of the outcome applications and services of 'MHETF' in the vision of boundless information flow, results come during the early considerations in relation to conforming to the Application Platform Interface, and then if any concerns arises, the Communication Infrastructure Interface can be referenced.

5.4.2.4   Capabilities

Mobile business capabilities are categorized by 'MHETF' into four categories; Inward Mobile Application, Outwards Mobile Applications, Mobile Devices Management, and Mobile Application Management. For every mobile service, concerned members are required by 'MHETF' to document their concerns and recommendations for each capability. TOGAF should respond to the concerns by identifying relevant policies and mitigation measures, or develop new ones.
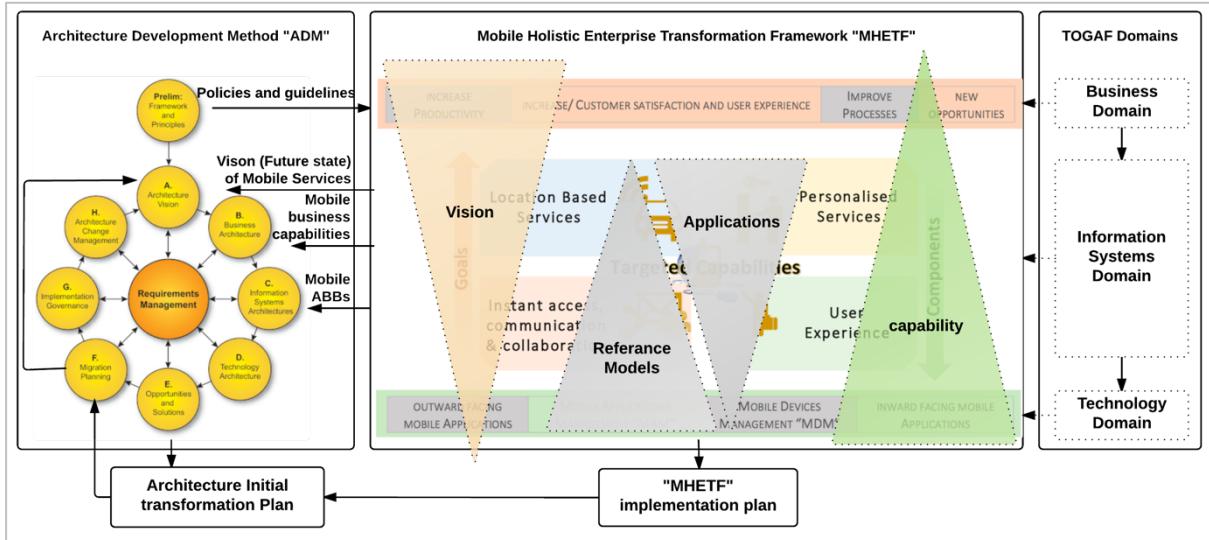
Figure 5.10. Interoperability Model.

Consequently, mobile applications changes TOGAF's Application and User Location Diagram, as well as the Environments and Location Diagram. In addition, mobile applications influence others TOGAF diagrams such as Data Dissemination, Functional Decomposition, and the System/Function Matrix. Figure 5.10 presents the interoperability model between 'MHETF' and 'TOGAF' by relating the four pillars to 'MHETF', and the significance of the four pillars of interoperability to the three components of 'MHETF' which are the objectives, mobile services capabilities and solutions. By using triangles to represent the significance, the diagram proportionally relates each pillar to a component of 'MHETF'. The significance of the size of the model diagram [Figure 5.10] highlights the relevant architecture domain for each component of 'MHETF' and how the output of 'MHETF' is used throughout the 'ADM' cycle.

The detailed interoperability model explains where the 'MHETF' is employed throughout the architecture development life cycle. Table 5.10 shows only the used and major 'ADM' outputs of relevance to the interoperability model throughout the phases of the 'ADM' cycle.

Table 5.10. The Relevant ADM Outputs and the 'MHETF' Role.

	ADM Outputs	The role of the proposed framework
1	Statement of Architecture work	Defining the project description and an overview of mobile services architecture vision. 'MHETF' allows for the concerns and recommendations to be documented in the solutions section and organized into the four categories. TOGAF is used to ensure the documented objectives are aligned with the enterprise goals and business drivers.
2	Business Scenario/ Architecture Vision	As business needs are identified using business scenarios, usually in the Architecture Vision or the Business Architecture phases of the 'ADM'. 'MHETF' provides the mobile service capabilities responding to those needs. Additionally, the outcome of 'MHETF' can be evaluated, which the business scenarios lack, as the objectives section represent the return on capital and the mobile solutions section represent the cost.
3	Business Architecture	'MHETF' facilitates for drawing a base line of existing mobile services by a simple mapping technique, and the calculation of business return of the mobile transformation change considering mobile solutions as business capabilities for the applications building blocks ABBs.
4	Technology Architecture	For mobile services, 'MHETF' provides detailed technical functionalities, and a high-level description of building blocks. Concerns collected in the business solution section of 'MHETF' can constitute criteria for solution selection.
5	Impact Analysis	Benefits of migration and cost estimation can be calculated for mobile service by assessing the gap between mapping the current state using 'MHETF' and planning the future state enjoying the identified capabilities and objectives categories.

5.4.3   Multi Criteria Decision Making 'MCDM'

The decision making process for screen size, device and application types and others can be support by Multi-Criteria Decision-Making (Xu & Yang, 2001), (Velasquez & Hester, 2013). The MHET framework is designed to work with Enterprise Architecture frameworks (Alqahtani & Atkins, 2016), and can be used with a Mobile Maturity Model 'MMM' to reach a mature mobile-enabled enterprise future state (Alqahtani et al., 2015). The following is an outline of the proposed process. However, in this case, it has resulted in implementing all functionalities that resulted from applying MHETF in one transition.

5.4.3.1 Objective Valuation

Using the Analytic Hierarch Process - 'AHP' - (Alhammadi et al., 2015), (Bruno et al., 2012), (Rezaei, 2014), (Chen & Cheng, 2010), the identified objectives are prioritised in a comparison to identify the value of each objective in relation to the overall value of the mobile initiative (Alhammadi et al., 2015) by relying on the judgment of experts, which in this case has been collated and already categorised and generated by the framework.
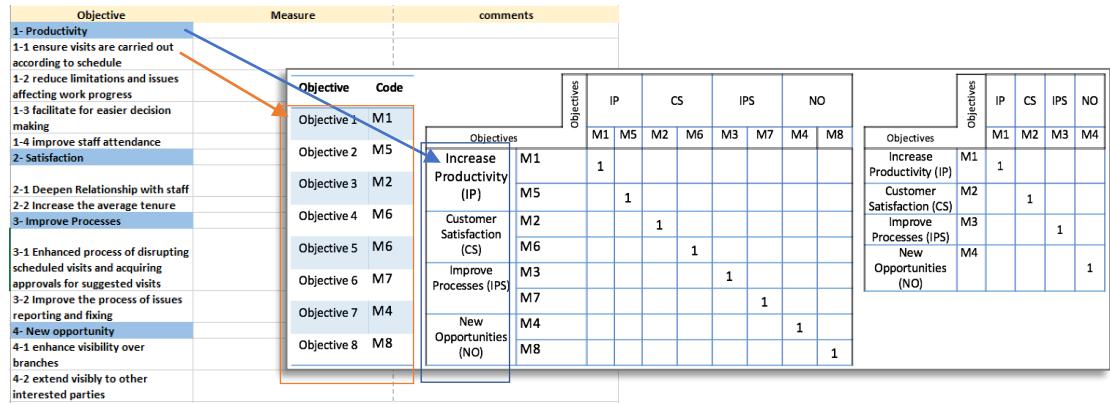

Figure 5.11. Valuation of objectives and categories derived from 'MHETF'

As outlined in Figure 5.11, the process of pairwise comparison was applied to the four main categories as well. An accumulative score was assigned to each individual objective at the end of this phase. A standardised matrix was then created to correspond to the value of each cell, divided by the sum of each column to give a weight in percentage to each objective.

5.4.3.2 Functional Valuation

Relating the values as objectives to functionalities while planning for mobile initiatives allows for more objective alignments and a better focus on the target. It paves the way for a functionalities evaluation and other decision-making techniques when required. This can be implemented with MHETF by relating the objectives table to the many functionalities tables to indicate what objectives are served by the function at hand while listing the functionalities entirely. The two columns can then be added in the functionalities table that contains the objectives and functionalities, and the score of significance to each objective that they serve. The values of functionalities are then processed with the objectives' values (Triantaphyllou & Shu, 1998) [Figure 5.12].

Figure 5.12. Valuation of functionalities describing the future state solution as listed by 'NHETF'

5.4.3.3   Solution Valuation

The final step is to categorise the functionalities in the work packages, in order to estimate the cost of implementing each package (module) and the value is then calculated by the sum of the functionalities that it contains. This leaves the decision makers with a visual tool that allows them to prioritise the modules and to decide what to include in the current transition. The value of the modules may increase or decrease with time and so does the cost [Figure 5.13].
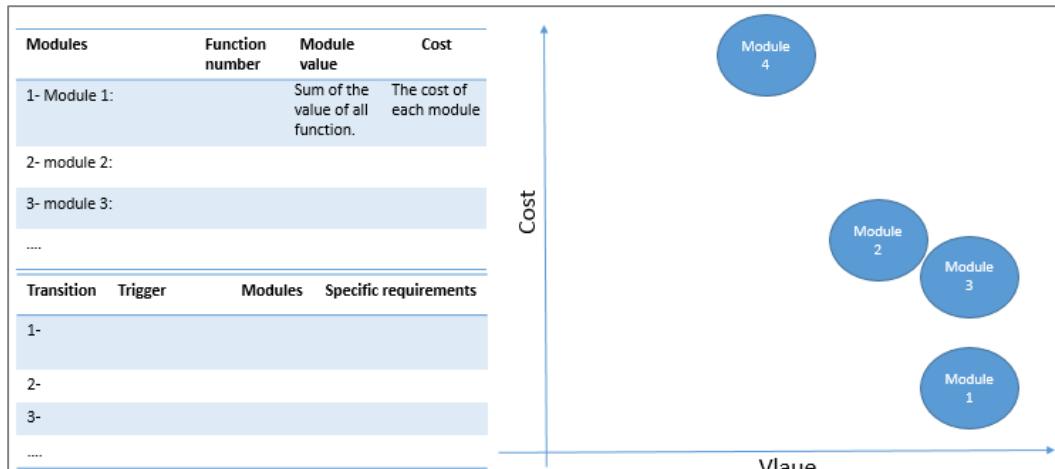

Figure 5.13. Planning future transitions.

Multi-Criteria Decision-Making 'MCDM' was presented in the workshops during the primary case study in Saudi Arabia as outlined in Chapter 6. This can be applied to other decision-making scenarios, such as device selection, application type, vendor etc. (Işıklar & Büyüközkan, 2007). However, it does not go into that level of detail for simplicity; the focus is on the business transition.

5.5 Summary

In this chapter, two additional case studies were outlined to illustrate the application of the BSC to the proposed framework. Although the framework is not supposed to manage the implementation of the mobile solution, it specifies the business requirements for the development of mobile solutions and capabilities within the enterprise, and therefore supports the development of mobile strategy. The process has been illustrated using two case studies, and the outcome has been partially evaluated for discussion pursues. The framework produced a holistic view of the case studies. However, since they have already been implemented, it was not possible to evaluate the suggested process.

The next chapter shows the application of the framework in a real-life context for further validation and refinement, including the process, and actual objectives that will measure the outcome of the transformation effort.

Chapter 6. Validation of the Framework

6.1 Introduction

Validation is generally defined as '*The process of determining the degree to which a model is an accurate representation of the real world from the perspective of the intended uses of the model*' (Oberkampf & Trucano, 2008). As '*validity is generally established through literature reviews and expert judges or panels*' (Boudreau et al., 2001), the proposed framework was developed and internally validated using eight case studies during the development of the framework, and additional two case studies (10 in total) for the development of the workshop and further validate the framework. This chapter discusses the process of validating the developed framework in real-life scenarios in Saudi Arabia, using an additional three case studies. The following chapter (Chapter 7) discusses the evaluation of the Framework, based on the validation process. In the validation process, two case studies relating to a consultancy company in Saudi Arabia were used; a third case study was based in a hospital in Saudi Arabia. In Saudi Arabia, the guidelines and policies are set by the Yasser Programme, which covers both public and private sectors. Yasser is an electronic government initiative and was established to raise the public sector's productivity and efficiency, and to provide better, easier to use services for individuals and business customers, to increase Return on Investment (ROI), and to provide any required information in a timely and highly accurate fashion.

The aim of the case studies is to validate the design of the proposed framework and adapt it in a real-life situation. The context of two out of the three case studies was a leading major outsourcing company in Saudi Arabia. The two case studies were suggested to us by one of the largest consulting and outsourcing companies that deals mainly with Saudi Governmental contracts. The company is contracted by both the public and private sector to modernise and optimise their front offices and to enhance the public services which includes the implementation of new and enhanced information systems and putting in place new processes and procedures. Two case studies were implemented in similar environments. However, the third case study was selected for use in a government hospital to further validate the framework in different environments.

The factors for case study selection were identified before embarking on the case study research. The company was interested in leveraging the case study research to enhance some of its current projects. These projects were in different phases of execution. The first project, "a Mobile Portal solution", was already implemented and fully operational - they wanted it to be reviewed and enhanced by the framework. The second project was partially implemented and available to be used on an optional basis - "Quality Assurance Solution for mobile teams". Finally, the third project was for an outpatient clinic in a major hospital in the capital city of Riyadh [Table 6.1].

In order to introduce the participants to the framework and for them to be able to apply it, three workshops were conducted for the case studies. The framework was delivered as a workshop presentation and was applied to the two additional case studies from the literature which have been previously detailed in Chapter 5, Sections 5.3.1 and 5.3.2. Key slides are appended appropriately [Appendix D].

The workshops forums were attended typically by five to six participants including management, business analysts and solutions developers. The presentations took an average of sixty minutes, including forty-five minutes for the main components (excluding the additional components, the mobile maturity model, Enterprise Architecture interoperability and Multi-Criteria Decision making). The participants took approximately two hours to complete the templates. In one of the case studies, there was insufficient documentation concerning the

objectives and measures, and the result was that the workshop overrun by approximately one hour.

Table 6.1. A Brief Description of The Proposed Three Cases.

Case Study "1":	Case Study "2":	Case Study "3":
Mobile Portal solution	**Quality Assurance Solution**	**Outpatient Clinics**
Operational	Beta - Optional	Planned
Communication portal to ensure that company's employees in distant branches are integrated with headquarter staff. This service is operational and is used by multiple units within the company. to communicate news and announcements to their staffs.	Different units within the company felt the need to automate their quality assurance visits to branches which are scattered over such a vast country. The service is partially operational and optionally used by visitors to automate checklists and issues reporting processes.	Outpatients clinics are experiencing increasing demand and longer waiting times at main receptions. Currently, booking and cancelling appointments are phone-based and they are exploring mobile solutions to enhance their services.

The framework's proposed process - which is applied to the proposed cases studies as outlined in relation to the templates used in [Figure 6.1].

Figure 6.1 outlines the phases of the framework application, whereas the following Excel sheets templates were developed to cater for the various steps of the process. The Scope, Gather Relevant Information, and Analysis and Transform phases are implemented using the excel sheet depicted in Figure 6.2, whereas phase four and five were catered for by the excel sheets depicted in Figures 6.3a and 6.3b.
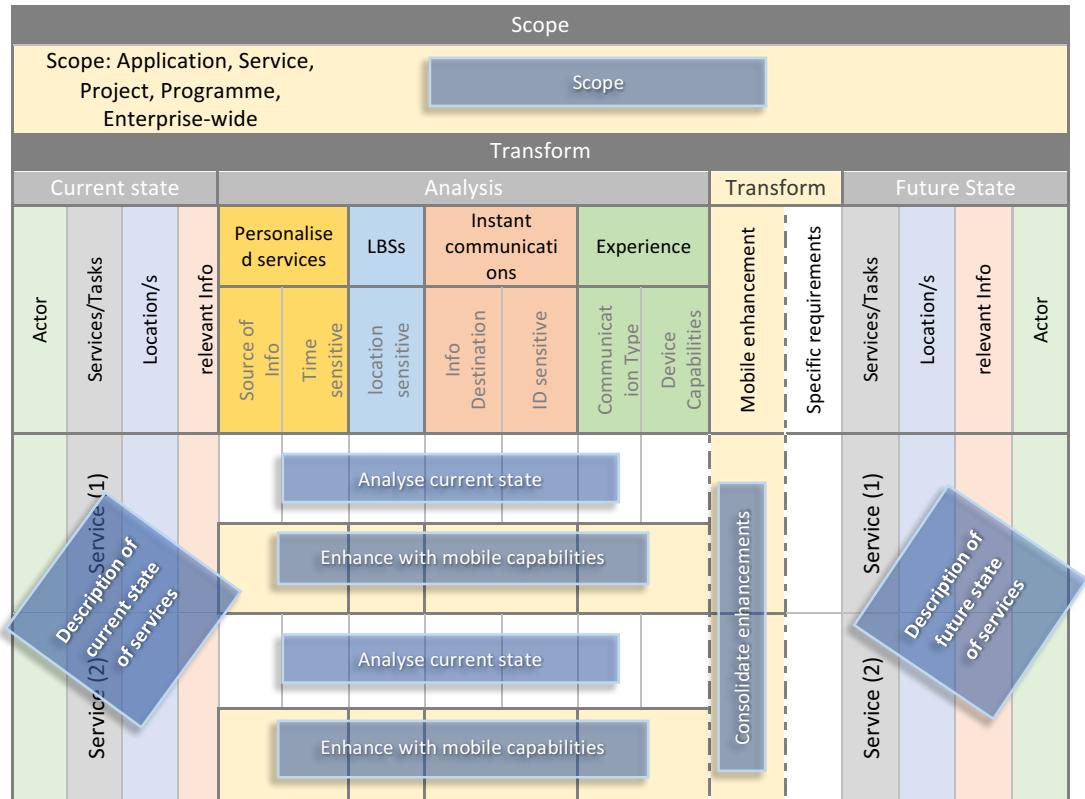
Figure 6.1. The Outline of Proposed Process

Figure 6.2. The Template Used for The First Three Phases
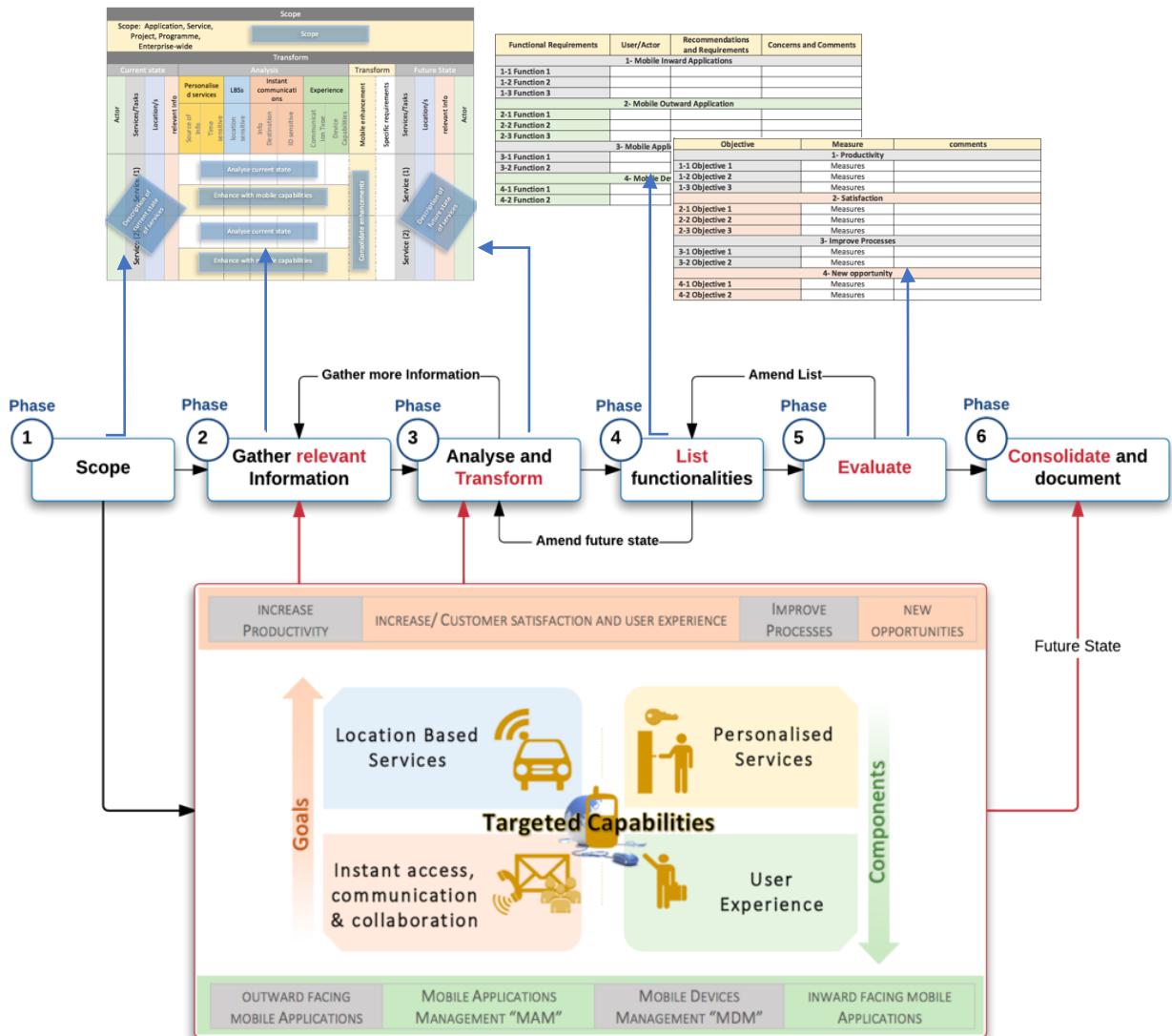
Figure 6.2. The Template Used for The First Three Phases

a

Functional Requirements	User/Actor	Recommendations and Requirements	Concerns and Comments
1- Mobile Inward Applications			
1-1 Function 1			
1-2 Function 2			
1-3 Function 3			
2- Mobile Outward Application			
2-1 Function 1			
2-2 Function 2			
2-3 Function 3			
3- Mobile Application Management			
3-1 Function 1			
3-2 Function 2			
4- Mobile Device Management			
4-1 Function 1			
4-2 Function 2			

b

Objective	Measure	comments
1- Productivity		
1-1 Objective 1	Measures	
1-2 Objective 2	Measures	
1-3 Objective 3	Measures	
2- Satisfaction		
2-1 Objective 1	Measures	
2-2 Objective 2	Measures	
2-3 Objective 3	Measures	
3- Improve Processes		
3-1 Objective 1	Measures	
3-2 Objective 2	Measures	
4- New opportunity		
4-1 Objective 1	Measures	
4-2 Objective 2	Measures	

Figure 6.3. (a) The Solution Functionalities; (b) Objectives and Measures.

The template is scalable, colour coded, and has been improved over the course of the field study. However, for documentation purposes, it is presented in the rest of the chapter in sections for each phase respectively.

6.2 Case studies

This section presents the three case studies and the proposed solution for each. The cases are as follows:

6.2.1 The First Case Study: Mobile Portal Solution

Saudi Arabia is a large country that is advanced in many ways but lacks a sufficient public transportation service, leaving privately owned cars as the first choice for travellers (Ansari et al., 2000). Saudi Arabia has a population density of 14 Km^2 (World Development Indicators, 2014). The company has over 700 employees scattered in offices all over the kingdom, and in an attempt to make the remote employees feel close and a part of the company, an application was developed and deployed on the Apple IOS and Google Android Platforms, which is supposed to offer the following services:

- Distribute news and announcements
- Receive complaints from all employees
- Receive ideas
- Poll employees

There was only one perceived benefit from using mobile, which is the user experience. The aim was to extend the communication capability to becoming popular and an intuitively used mobile device, with the hope that they will interact frequently with the company's headquarters. The outsourced mobile initiative was started to satisfy one objective:

- To deepen the relationships with remote employees

An outline of the proposed solution has been shown in Figure 6.4.

Service: *Case study*	Description: The application facilitates easy communication between the company and the branches, of over 1000 employees scattered over the kingdom.		

	increase productivity	**increase customer satisfaction**	**improve processes**	**new opportunities**
Goals	objectives: - *ensure employees are all aware of changes in the least possible time* - *facilitate for easier decision making though surveying all staff* - *improve staff attendance* - *a better understanding of the tasks at hand*	objectives: - *deepen relationship with branch staff* - *increase the average tenure* - *increase staff engagement*	objectives: - *enhanced communication with branches* - *improved process for ideas capturing, processing and evaluating*	objectives: - *increase the number of ideas collected*

	location based services		**personalised services**	
Targeted Capabilities	- *branch managers to post announcements to their staff, and suggest the content to other branches.*		- *user to submit suggestions, issues and complaints to program and receive a reply from the program manager* - *employees should be able to confirm that new announcements are read and understood (acknowledgement)*	
	- *company representative to view surveys and poll and collected ideas progress in real time.* - *program managers to receive issues, suggestion and complaints, and can take action (respond).* - *users to submit ideas, and see the status of progress until the verdict.*		- *notification of news and announcements* - *users to receive poll and surveys separately or enclosed to a news post, and can respond and attach photos, or take photos or video.* - *prefill location name, and owner of post details*	
	instant access, communication and collaboration		**user experience**	

	outward facing mobile applications	**mobile applications management 'MAM**	**mobile devices management 'MDM**	**inward facing mobile applications**
Components	- *all transitions are tagged with time and date and owners*	- *remote app removal* - *program managers to be able to act against inactive recipients, the admin could take actions against inactive users in general.*	- *sign in is integrated with the companies sign in.* - *executives, program managers to have their views of admin panels containing relevant dashboards*	- *program managers should get notifications, of their staff post.*

Figure 6.4. An Overview of The Framework's Proposed Transformation for the Mobile Portal Solution.

6.2.2   The Second Case Study: Quality Assurance Solution

The company does not hand over the offices and developed solutions to the clients only. It also operates the services on their behalf and plans for future iterations of the services' improvement. To be able to ensure that the services are carried out to the company's highest standards, including the unit of quality assurance that sends engineers, IT, human resources and other

representatives regularly to their offices around the kingdom. Visitors used to have a different agenda as set by their managers in each unit, and their work was completely paper-based. They usually report on their visit the following day by transferring written information to a PC or a laptop and emailing it to their managers.

The application was developed to streamline the visitation process, starting from assigning a visit, right up until receiving the report. The application currently provides the following services:

1- Allow the designated visitor to log in after they received an assignment on the email.
2- Carry out a checklist survey at the visited branch that is prepared by the visitor's unit.

Currently, the application is built for tablets. Apple's IPad was selected for this case study. The application is not available on the app store. It is installed on a limited number of company-owned iPads, and handed out to visitors for the duration of the visit. Although all questions are text-based, developers believed that smartphones screens are too small for the job. The decision-making process for screen size, device and application types and others can be supported by Multi-Criteria Decision Making Technique, which can be used easily in communications with the framework since the values (objectives) can be linked to functionalities, and are ready to be prioritised. This, in turn, facilitates decision-making in terms of supporting the functionalities better and achieving the highest value.

Multi-Criteria Decision Making "MCDM" was presented in the workshops, and can be applied at a later stage to the significance of the screen size factor in this case. Although the framework is actively supporting MSCM, it does not cover it in detail to keep the framework simple and focused on enhancing business functions. Once a future state is envisioned after mobile enhancement, depending on the case study, many of the decisions involved may require an in-depth evaluation process using the "MCDM". The perceived benefit was to automate the survey process, carried out by mobile visitors. The documented objective was:

- To reduce the time required to fill out a survey

An outline of the proposed solution is shown in Figure 6.5.

SERVICE: *QUALITY ASSURANCE SOLUTION (QAS)*	Description: The company operates about 60 customer service branches, five unit send representatives to visit beaches and to keep branches up to standards, including human resources 'hr', buildings and architecture unit, quality assurance, operation excellency, and technology units.

<table>
<tr><th rowspan="2"></th><th>INCREASE PRODUCTIVITY</th><th>INCREASE CUSTOMER SATISFACTION</th><th>IMPROVE PROCESSES</th><th>NEW OPPORTUNITIES</th></tr>
<tr><td>OBJECTIVES:
- to ensure visits are carried out according to schedule.
- reduce limitations and issues affecting work progress
- to facilitate for easier decision making
- improve staff attendance</td><td>OBJECTIVES:
- deepen relationship with staff
- increase the average tenure</td><td>OBJECTIVES:
- enhanced process of disrupting scheduled visits and acquiring approvals for suggested visits
- improve the process of issues reporting and fixing</td><td>OBJECTIVES:
- enhance visibility over branches
- extend visibly to other interested parties</td></tr>
</table>

(left label: GOALS)

<table>
<tr><th rowspan="5">TARGETED CAPABILITIES</th><th colspan="2">LOCATION BASED SERVICES</th><th>PERSONALISED SERVICES</th></tr>
<tr><td colspan="2">
• visit's page to be visible when visitor accept assignment, branch and branch manager information are displayed, and location ready for mobile navigation
• checklist and other visitor functions are only accessible at the branch.
• the ability to suggest a visit if they employees find themselves around a branch.
</td><td>
• the ability to acknowledge reception of assignment, agree or reschedule
</td></tr>
<tr><td colspan="2">
• the ability to instantly request a video call to the program manager or unit manager or their representative.
• program manager to be notified about commencing a visit changes to the checklist (if any) during current visit, and reported issues instantly, in addition to approval requests for visits requested by visitors, and video chat requests.
</td><td>
• program manager to be notified about a request to establish video calls, if accepted, the third application of choice can be launched.
</td></tr>
<tr><th colspan="2">INSTANT ACCESS, COMMUNICATION AND COLLABORATION</th><th>USER EXPERIENCE</th></tr>
</table>

<table>
<tr><th rowspan="2">COMPONENTS</th><th>OUTWARD FACING MOBILE APPLICATIONS</th><th>MOBILE APPLICATIONS MANAGEMENT 'MAM'</th><th>MOBILE DEVICES MANAGEMENT 'MDM'</th><th>INWARD FACING MOBILE APPLICATIONS</th></tr>
<tr><td>-</td><td>
- the ability to see visits history, and including the last update to checklist
- the ability to add tasks to scheduled and current visits, and be notified when implemented.
- periodical reports are to be generated, about the progress in visits and checklists, and reported issues with fixes
</td><td>
- admin to be able to remove applications from visitors' devices, and blacklist from all future interaction.
- admin to receive on inactive users, with the ability to take action such as emails to remind them of opening the app, withdraw privileges or remove the app.
</td><td>
- the application can be installed on any iOS devices, including the unit's own tablets.
</td></tr>
</table>

Figure 6.5. An Overview of The Framework's Proposed Transformation for the Quality Assurance Solution

6.2.3   The Third Case Study: Outpatient Clinics

In Saudi Arabia, the Public Health services are well ranked medically but lag in the provision of integrated information tools. Mobile services are more advantageous in a country that has a land area of approximately 2.15 million km^2, and a population of 29.5 million people (Abdallah et al., 2015). The Saudi health care system ranks above many other international healthcare systems such as Canada, Australia, and New Zealand with a ranking of 26th among the 190 global health systems according to the World Health Organization. However, there is increasing concern about the underutilization of electronic health systems in spite of the Ministry of Health (MoH) allocating about US\$ 1.1 billion for the development of electronic services (Altuwaijri, 2008), (Almalki et al., 2011).

The case study took place in one of the country's leading hospital, which was established recently and serves hundreds of patients in outpatient clinics on a daily basis. The hospital is in Riyadh, the capital city of Saudi Arabia and was considering to explore mobile solutions to help to reduce the workload on their clerical staff, and to enable the better utilisation of the medical professionals involved. Patients normally call to book or cancel appointments. Although they may have the motive to book an appointment, they may not report a cancellation due to the discouraging waiting times. The perceived benefit was to use mobile devices to automate the visitors experience at the outpatients' clinics. The documented objectives were:

- To reduce the waiting time at the main receptions.
- To reduce appointments and no show cases.

Doctors are working at their workstation in the outpatient clinics, and the information system is on screen most of the time. The need for a mobile application is low, however, if the scope was to be extended to HR, on call doctors and surgeries, then inward-facing mobile applications would be more beneficial. Doctors are no exception to the strong binding that consumers have to their personal tools which has increased the importance of information technology in their lives (Ortbach et al., 2013), (Harris et al., 2011). Other reasons that could be used justify the implementation is if video consultations and serving patients in remote areas was in scope.

SERVICE: OUTPATIENTS MOBILE SERVICES	DESCRIPTION: The hospital is one of the leading hospitals in Saudi Arabia, the scope is to enhance the experience of the patients visiting the outpatient clinics with the mobile services.

GOALS

INCREASE PRODUCTIVITY	INCREASE CUSTOMER SATISFACTION	IMPROVE PROCESSES	NEW OPPORTUNITIES
OBJECTIVES:	OBJECTIVES:	OBJECTIVES:	OBJECTIVES:
- *reduces waiting time at main reception* - *reduces waiting time at the pharmacy* - *increase utilisation of doctors' shifts* - *increase patient awareness of hospital rules and changes* - *increase patients' awareness of their conditions*	- *increase patients' satisfaction* - *increase doctors satisfaction* - *reduce patient frustration due the complications caused by lack of knowledge*	- *improve the appointments booking process* - *improve the medicine dispensation process*	- *establish the mobile capability within the enterprise for mobile health application* - *increase data sources for research purposes.* - *explore data collection for monitoring, analysis, forecasting, and future planning.*

TARGETED CAPABILITIES

LOCATION BASED SERVICES	PERSONALISED SERVICES
- *the ability to register arrivals on the app, and see attendance confirmation message* - *the ability to receive mobile notification when the name is called to doctor room, on various mean sequentially.* - *the ability to use third party navigation applications, with information on car parks current availabilities.*	- *the ability to book appointment instantly/ or with short wait of doctor approval and be notified of confirmation* - *the ability to receive custom built information of relevance to the patient prepared to be sent to the doctor* - *the ability to request a repeat order based on repeat information presented in the app, including the number of repeat and time of next repeat availability.*

- *the ability to view:*
  o *doctors' profiles to make an informed decision*
  o *and all bookings, of the household at any time*
  o *and all the pre-requisite lab test for each appointment*
- *the ability to register interest interests in booked slots, and be notified when available again*
- *the ability to cancel appointments instantly/ or with short confirmation response that includes consequence.*
- *the ability to receive and reply to direct messages from hospital or doctors*
- *the ability to view waiting time at the pharmacy and when should the patient expect it to be ready for collection*
- *ability to view notes and questions to remember during an examination, and hospital map for faster access to the clinic.*
	- *the ability to receive notifications, and approvals and information, and confirm reception.*

INSTANT ACCESS, COMMUNICATION AND COLLABORATION	USER EXPERIENCE

COMPONENTS

OUTWARD FACING MOBILE APPLICATIONS	MOBILE APPLICATIONS MANAGEMENT 'MAM'	MOBILE DEVICES MANAGEMENT 'MDM'	INWARD FACING MOBILE APPLICATIONS
- *the ability to get and use user location and scheduled testing and appointment for notification and reminders.*	- *to push rich media information, public awareness messages, and customised notification at any time to patents, through os push notification capabilities, text, email or even automated phone calls sequentially.* - *to receive response, immediately and receive and report on the readings acknowledgement* - *to view a list of doctors, and their patients' lists, with info about their arrivals, delay, and customised reports.*	- *to verify user registration with back-end system* - *to receive on inactive users, with the ability to take actions with emails to remind them of opening the app, or withdraw privileges.*	

Figure 6.6. An Overview of The Framework's Proposed Transformation Outpatient Clinics

The application was planned on the assumption that it will communicate with Appointments, EHRs, Car Parking Management Systems, Medication Management and Pharmacy Dispensing Systems. Figure 6.6 outlines the proposed solution using the MHETF framework. An outline of the proposed solution is shown in Figure 6.6.

6.3 Case study Application Process:

In a team effort during several workshops, the framework was applied to the case studies according to the proposed process, outlined as follows:

6.3.1 Scope

The first step in the proposed process is to scope the mobile transformation. Table 6.2 shows the scope of the three case studies.

Table 6.2. The Scope of Case Studies.

Mobile Portal Solution	Quality Assurance Solution	Outpatient Clinics
Outsource is a mobile application that provides easy communication between the company and Branch employees, of over 700 employees scattered over the kingdom. It offers two-way communication where the company distributes news and announcements and receive complaint and ideas.	The company operates about 60 customer service branches for multiple government agencies, five units send representatives to visit branches and to keep branches up to standards, including Human resources 'HR', 'SSD', quality assurance and operation excellency unit. The application should allow visitors to fill out check list surveys at the branches and submit them.	The scope of the transformation is the outpatient clinics, to help organise the flow of their visits to the hospital and achieve the assigned goals through an outward mobile application. One barrier was the mixed feeling among professionals towards recommending mobile health apps (Imison et al., 2016). Although in the outpatient clinics case, Telehealth application and internal applications for the staff were excluded from the case study due to time and procedural constraints

6.3.2 Gather Relevant Information

One of the main advantages of the framework is shortcutting the information gathering phase by outlining what is relevant to the mobile capabilities. This phase starts with a business function

breakdown derived from the scope, defining the actors and the information that is communicated in the function, and the location of where the actor is expected to interact with the service.

After the business functions were identified by actor, location and information, the following information was gathered to map the current state of the scope of the transformation. In practice, this step and the following steps were completed on one Excel sheet table. If an additional function was added, the current state table will have a "None" or "Null" function. The breakdown of functions and the information gathered for each were verified in the workshops and minor amendments were made for some. Phase 2 Section in Table 6.3 shows the appendices numbers for detailed documentation of the three cases and the implementation of this phase.

Table 6.3. Appendices' Numbers of Detailed Documentation.

	1. Mobile Portal Solution	2. Quality Assurance Solution	3. Outpatient Clinics
Phase 2			
Services break down	Appendix E.1	Appendix E.8	Appendix E.15
Current state assessment	Appendix E.2	Appendix E.9	Appendix E.16
Phase 3			
Current state planning	Appendix E.3	Appendix E.10	Appendix E.17
Consolidation of enhancements	Appendix E.4	Appendix E.11	Appendix E.18
Future state services break down	Appendix E.5	Appendix E.12	Appendix E.19
Phase 4			
Functionalities list	Appendix E.6	Appendix E.13	Appendix E.20
Phase 5			
Evaluation	Appendix E.7	Appendix E.14	Appendix E.21

In analysing the current state in the Quality Assurance Solution case, the paper-based survey was ignored on purpose as it is being replaced completely by the existing – optional – application. The intention is to enhance the existing application by applying the framework.

6.3.3 Analysis and Transform

The following step is where each function is enhanced by the mobile capabilities individually. In this phase, the enhancements are suggested for each function, and the consolidated version of the mobile enhancements to the future state is presented for each function. If the mobile transformation is applied, the future state will be different as shown in the indexed Phase 3 Section in Table 6.3.

6.3.4 List functionalities

The transformation was developed during the workshops. Consequently, many functionalities were discarded such as audio and video communication, due to the obvious high cost and limited benefits as pertains to the main objective of the case studies. In many cases, all possible uses of the mobile platform should be documented, and an evaluation should be carried out for each functionality as indexed in the Phase 4 Section in Table 6.3.

A value cost matrix can then be established to indicate whether the solution module is achieving high value at reasonable cost, and including other excluded modules in future planning to be implanted when the cost decreases or the value increase due to the circumstances. At the workshop, a Multi-Criteria Decision Making technique - "MCDM" - was presented, and the analyst can add columns to the objectives which are serviced by each objective as listed.

6.3.5 Evaluate

Evaluation is a vital part of the framework; it keeps the focus on the objectives and makes sure that any investments in mobile solutions are justified and aligned with the enterprise's objectives. Based on the objective classification section of the framework, the following objectives were added [Figure 6.5]. The participants stated that some of the objectives occurred to them in the planning phase, but it was hard to articulate and measure them. Other objectives were not thought of, although the current implementation supports the realisation of said objectives. Tables 6.4, 6.5 and 6.6 shows the objectives, measures them and explains how the proposed solution is expected to improve each case.

The development of the objectives started in the workshops, and the functionalities were refined to help to measure the objectives. However, new ones were added after listing the objectives which clearly helped to stimulate ideas.

The participants stated that the improvements referenced in Phase 5 section of Table 6.3 are expected to be achieved successfully if the proposed functionalities were implemented. Often participants will agree on a number and on a few occasions, the average number was used as the score.

The framework is used in conjunction with the Balanced Scorecard (BSC) to quantify the measurement from the objectives outlined in Figure 6.4, 6.5, and 6.6. The objectives are mapped to each perspective of the BSC as outlined in Chapter 5, Section 2.3.

6.3.5.1   Case Study 1: Mobile Portal Solution

The Target column in Table 6.4 represents the improvements in value if the transition produced by the MHETF framework is implemented. Table 6.4 shows two major improvements which can be identified as follows:

1. Ensuring that employees are all aware of the changes in the least possible timeframe, which is enhanced by the employees being required to check the app at least once a day, the proper use of notifications, and everything being confirmed and measured by the acknowledgement button that is to be included in every new announcement. It is enhanced by the three of the four mobile capabilities of MHETF.

2. Enhancing communication with branches with the use of mobile capabilities. The timeframes for response are shortened, and escalation includes mobile notifications to interested parties. This would allow for issues reported to be dealt with in a timely manner.

Table 6.4. The Quantifiable Value of The Framework's Proposed Transformation of the Mobile Portal Solution.

Financial perspective			
Objectives	Measures	Target	Initiative
Ensure employees are all aware of changes in the least possible time	Average time of received confirmation	Improved by 90% (60 minutes)	Figure 6.4
	Number of reported issues of relevance	Less by 50%	
Facilitate for easier decision making though surveying all staff	Decision makers' satisfaction rate	Enhanced by 5%	
Improve staff attendance	Attendance rate	Enhanced by 2%	
Better understanding of the tasks	Number of relevant issues reported	Less by 50%	
Customer perspective			
Objectives	Measures	Target	Initiative
Deepen relationship with branch staff	Satisfaction rate	Enhanced by 5%	Figure 6.4
	Voluntary turnover rate	Enhanced by 1%	
Increase the average tenure	Average Tenure	Increase by 4-6 months	
Increase staff engagement	Average number of ideas and suggestion per employee	Increase by 3 ideas	
Internal business perspective			
Objectives	Measures	Target	Initiative
Enhanced communication with branches	The average time for responses to issues suggestions, and complaints.	Enhanced by 60% (48 hours)	Figure 6.4
Improved process for ideas capturing, processing and evaluating	Number of ideas per employee	Increase by an average of 1.5 ideas	
	Average Duration of Idea life cycle	Reduced by 50%	
Innovation and learning perspective			
Objectives	Measures	Target	Initiative
Increase the number of considerable ideas collected	The percentage of ideas that received a positive verdict	Increase by 5%	Figure 6.4

6.3.5.2 Case Study 2: Quality Assurance Solution

The Target column in the Figure 6.5 presents the improvements in value if the transition produced by 'MHETF' is implemented. From Figure 6.5, three major improvements can be identified:

1. To ensure that visits are carried out according to the schedule: With visits being assigned and accepted in less time and in a fixable way, and with the utilisation of mobile reminders, and notifications, and the reduction in the workload of each visit, more results are expected to be conducted on time.

2. To facilitate easier decision-making: that is measured through a satisfaction increase of 5%, which is considered a major advantage.

3. To deepen relationships with staff: issues are reported immediately and a workflow with mobile reminders and escalations are set up, which in turn results in quicker fixes and better relationships with remote staff.

Table 6.5. The Quantifiable Value of The Framework's Proposed Transformation of the Quality Assurance Solution.

Financial perspective			
Objectives	Measures	Improvement	Initiative
- To ensure visits are carried out according to schedule	- Percentage of conduct visits according to plan	Enhanced by 10%	Figure 6.5
- Reduce limitations and issues affecting work progress	- Number of reported issues	Less by 20%	
	- Average time of fix (Take actions)	Enhanced by 60% to be (48 hours)	
- To facilitate for easier decision making	- Decision makers' satisfaction rate	Increase by 5%	
- Improve staff attendance	- Attendance rate	increase by 1%	
Customer perspective			
Objectives	Measures	Improvement	Initiative
- Deepen Relationship with staff	- Satisfaction rate	Increase by 10%	Figure 6.5
	- Voluntary turnover rate	Increase by 1%	
- Increase the average tenure	- Average Tenure	2 months' increase	
Internal business perspective			
Objectives	Measures	Improvement	Initiative
- The Enhanced process of disrupting scheduled visits and acquiring approvals for suggested visits	- Average Time between receiving and agree to an assignment.	Enhanced by 66% to be (24 hours)	Figure 6.5
	- Percentage of conduct visits according to plan	Enhanced by 10%	
- Improve the process of issues reporting and fixing	- Number of reported issues	Less by 20%	
	- Average time of fix (Take actions)	Enhanced by 60% to be (48 hours)	
Innovation and learning perspective			
Objectives	Measures	Improvement	Initiative
- Enhance visibility over branches	- Number of new source of information	One new source in every iteration	Figure 6.5
- Extend visibly to other interested parties	- Number of beneficiaries added	One beneficiary added in every iteration	

6.3.5.3 Case Study 3: Outpatient Clinics

The solution targeted productivity, customer satisfaction, process improvement objectives, and keeping focus on future opportunities while laying the groundwork for sustained action over time. Adopting a continuous systematic approach when addressing waiting times is vital to ensure progress (Appleby, 2005).

The application of the framework was conducted in a workshop with some of IT team, analysts and the senior manager of the department. At the end of the workshop, the produced solution was evaluated as shown in Table 6.6 using the Balanced Score Card ('BSC') where the estimated objectives that resulted from the proposed solution were linked to a set of measures derived from the hospital's IT strategy. It is evident that the proposed solution is estimated to enhance the processes involved and to increase the productivity of the hospital.

The following are the potential main benefits as identified by the members of hospital staff involved in the workshop:

- Reduces waiting time at the pharmacy: although the solution is expected to reduce other waiting times, the wait at the pharmacy was regarded as the most important, and a serious cause of frustration amongst patients. The solution will have the information of the prescription, and the current waiting time at the pharmacy available. The patient can then choose to notify the pharmacy to prepare the prescription at the same time or choose to come back at an alternative time. Pharmacy staff would be notified of prescriptions and would be able to get them prepared for patients. Another feature could allow for medication price comparisons in nearby pharmacies. However, this was excluded as medications are currently free with prescriptions in public hospitals in Saudi Arabia.

- The average time to book or cancel an appointment, and the number of no-show cases measures are also able to be improved: The reason for this is that the proposed mobile solution is expected to enhance these objectives substantially as there is no automated online solution currently being used. Thus, a 60% saving in time is a considerable jump from a telephone call-based system through to a mobile automated application.

- Improvements in the satisfaction of doctors and patients: the reduction in wait times, and the availability of relevant information on demand, is expected to enhance the satisfaction rate among both the patients and medical professionals.

Table 6.6. The Quantifiable Value of The Framework's Proposed Transformation of the Outpatient Clinics Solution.

Financial perspective			
Objectives	Measures	Improvement	Initiative
- Reduces waiting time at main reception	- Average waiting time at the reception	Reduced by 25%	Figure 6.6
- Reduces waiting time at the pharmacy	- Average waiting time at the pharmacy	Reduced by 30%	
- Increase utilisation of Doctors' shifts	- The average time of doctor's waiting for next patients to show up	Increased by10%	
	- Number of no-show cases	Reduced by 25%	
- Increase patient awareness of hospital rules and changes	- Number of complaint due the lack of prior knowledge of hospital rules	Reduced by 20%	
- Increase patient awareness of their case	- Percentage of patients reading the disseminated materials relating to their cases	Increased by 30%	
Customer perspective			
Objectives	Measures	Improvement	Initiative
- Increase patients' satisfaction	- Satisfaction rate (Patient survey)	Increased by 10%	Figure 6.6
- Increase Doctors satisfaction	- Satisfaction rate (doctors survey)	Increased by 4%	
	- Average Tenure	Increased by 0.5%	
- Reduce patient frustration due the complications caused by lack of knowledge	- Number of complaints caused by patients and doctors lack of prior knowledge of rules of changes	Reduced by 20%	
Internal business perspective			
Objectives	Measures	Improvement	Initiative
- Improve the appointments booking process	- Average time to book an appointment	Reduced by 60%	Figure 6.6
	- Average time to cancel	Reduced by 60%	
	- Number of no-show appointments	Reduced by 25%	
- Improve the medicine dispensation process	- Average time taken by the patient for order/ refill.	Reduced by 20%	
Innovation and learning perspective			
Objectives	Measures	Improvement	Initiative
- Establish the mobile capability within the enterprise for mobile health application	- Number of executives backing the mobile health initiative	Increased by 20%	Figure 6.6
- Increase data sources for research purposes	- Number of citation of published reports based on the use of mobile apps	10% to 20% of relative research paper	
- Explore data collection for monitoring, analysis, forecasting, and future planning.	- The number of dashboards relying on the mobile app.	Not-known	

6.3.6   Consolidate and Document

The outputs of the framework are summarised as follows:

1- A clear vision of the future state of outsourcing that can be rolled out in one or more iterations.

2- A detailed plan with clearly stated and easily communicated functional requirements.

3- An evaluation of the mobile initiative.

4- A list of recommendations and concerns collected from the various stakeholders throughout the planning.

These four components can be formulated into a project charter that considers the future iterations (transitions) and can be evaluated and compared to the expected value for profit maximisation. However, the following template is filled out to include only the mobile capabilities, functionalities, and objectives that are added after the application of the framework.

Summary

This chapter presents the three case studies undertaken in Saudi Arabia to validate the framework. It followed the same structure for each case study and used the same templates. The application process did not take a long time and was done in few hours. The description of the proposed solutions was presented in the framework template that helped to create the image of the future state in the first place. The results were discussed using the popular Balanced Scorecard technique which is used by both organisations that the framework was applied to, which helps in populating the objective section and aligning the objectives of the mobile initiatives with the overall IT strategic objectives. The template-driven process was easily understood by the participants, the quantifiable results that the framework generated were in general satisfactory, and the third case study host organisation was also willing to proceed with implementing the proposed solution.

The following chapter is Chapter 7, which presents an evaluation of the propositional values of the proposed framework. This was done in a survey that was carried out at the end of each workshop.

Chapter 7. Evaluation of The Framework from The User Perspective

7.1 Introduction

A generally accepted definition of evaluation is '*the process of determining the significance, worth, or condition of the proposed solution'* (Fenz & Ekelhart, 2011). Several workshops were conducted in a designated meeting room where members of staff who were involved in a selected application could attend. In total, sixteen employees participated in the workshops, for an average of sixty minutes, and forty-five minutes for the main components (excluding the additional components such as the mobile maturity model, Enterprise Architecture inter-operability and Multi-Criteria Decision making). The application took an average of three hours per project, if all information was available. More time was required if there were no documented objectives and measures, or other information of relevance to the scope.

Before the first workshop, while outlining the content to the stakeholders, a suggestion was made to develop a more detailed template to document more details during the implementation stage. A generic and comprehensive MS Excel sheet was developed and used for the three cases as depicted in Chapter 6, Section 1. Some comments were collected during the workshops in terms of layout, text colours, presentation tips, etc. These comments were considered immediately, and the materials were amended accordingly for more clarity.

The chapter presents the evaluation results for each value, and compares the responses from the different case studies, and different roles.

7.2 Evaluation design

In this research, the framework was validated through ten case studies from the literature and real life case studies that were carried out in Saudi Arabia as outlined in Chapter 6. However, to evaluate the framework, a survey was developed and filled out at the end of each workshop. The questions were mainly closed questions using the five-point Likert-scale where five was strongly agree and one was strongly disagree. Then there was one open-ended question at the end to collect any participant's views and comments.

Between four to six participants attended each workshop, which made it easy to communicate and control. The minimum of six per workshop was suggested to grant the researcher the ability to identify the thought process of the participants (Freitas et al., 1998), while others suggested a minimum of four (Saunders et al., 2009). Participants in all the cases represented the business and technical sides of their organisations, and were involved at different levels in their organisations' mobile initiatives [Table 7.1]. The workshops consisted of four elements, outlined as follows:

- Ten minutes for the participants to document the current state of their mobile effort.
- A presentation, in which the framework was explained, and examples were shown from the cases detailed in Chapter 5, Section 3.
- 15 minutes for the supporting models' presentation.
- A simulation season to validate the framework as shown in Chapter 6.
- The framework evaluation through the survey.

7.2.1 Participant Profiles

The participants for each were selected by the host organisation, to cover both the business and technical sides as shown in [Table 7.1]. Participant information has been anonymised for confidentiality.

Table 7.1. Summary of Survey Participants.

	Case Study	Participant title	Role in Mobile Initiative	Sector
1	Mobile Portal Solution	Solution Analyst	Analyst, And Admin	Consultation (Outsourcing)
2		Solution Analyst	Analyst, End User	
3			Admin	
4		Project Manager	Owner, End User	
5		Project Manager	Admin, End User	
6		Developer	Technical Analyst, Development Team Leader.	
7	Quality Assurance Solution	Solution Analyst	Analyst, End User	
8		Solution Analyst	Analyst	
9			Analyst, End User	
10		Project Manager	Owner, End User	
11		Developer	Developer	
12	Outpatient Clinics	Developer	Developer	Health Informatics
13		Developer	Solution Admin	
14			Developer	
15		Solution Analyst	Analyst	
16		Project Manager	Owner, Admin	

Table 7.1 shows the participants, and they can be visualised for each case in term of their roles within the organisation in Figure 7.1.
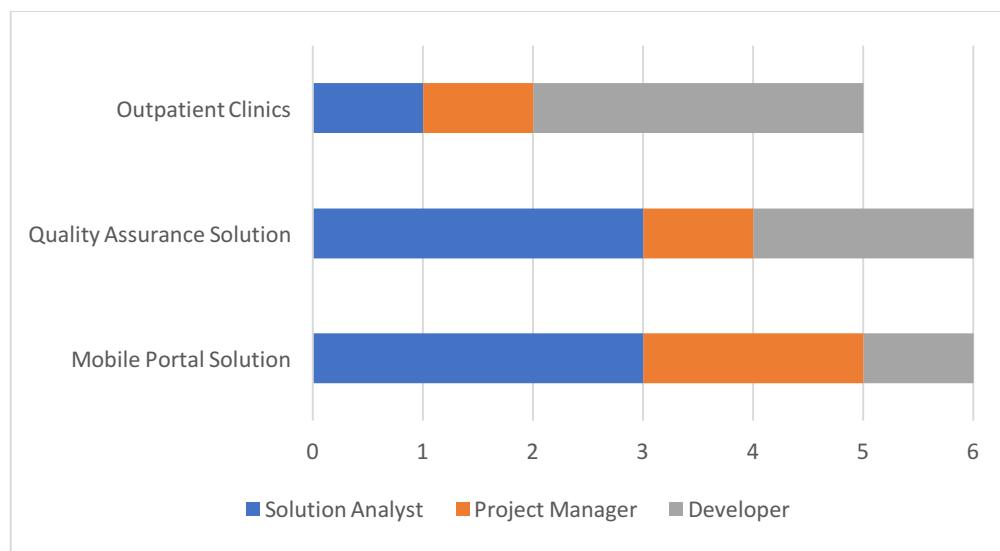
Figure 7.1. A Summary of Survey Participants.

7.2.2 The Survey

The survey was designed to evaluate the framework and workshops. It starts with gathering information about the participants and how they relate to the case studies, and then moves into validating the proposed benefits of the framework, and if the framework really delivers on the values referenced. The participants should have attended the workshops and applied the framework to their respective cases.

The survey was planned to be filled out at the end of each workshops. However, due to the time constraints and the response to the participants' suggestions, it was made into an online form and video instructions to the framework were put at the beginning of the survey to remind the participants of the content of the framework. Additionally, they were provided with a link to book a time that suited them for a video conference, and I offered to be available to guide them step by step through the survey. Hardcopies of the survey were available to those who wished to use them.

The first section of the survey is designated to getting to understand the respondents, and their roles and responsibilities in relation to the mobile initiatives. The second section is an interlocutory to the framework proposed benefits. The third section evaluates the frameworks ability to deliver the claimed proposed benefits. The respondents should have gone through the complete process of applying the framework to at least one project. The fourth section is generic, in order to evaluate their overall satisfaction with the framework.

7.2.3 Evaluation results

The framework is evaluated against its envisioned benefits as outlined in Chapter 4, Section 3.1, starting from an enhanced perception and understanding of mobile powered services, through to the successful transformation. The survey in [Appendix A] covers each question, as presented in [Appendix F].

The 10 benefits were grouped and discussed in 5 themes which are as follows:

- Perception of mobile services benefits:
    1. Understanding the concept of mobility trend.
    2. Unified language for mobile project (Initiatives).
    3. Enhance perception of mobile services.
- Object ordination benefits:
    4. Keeps Focus on targets.
    5. Clearer assessment of mobile investment.
- User Satisfaction benefits:
    6. Executives buy-in.
    7. Increase the satisfaction of projects owner.
- Interoperability benefits:
    8. Interoperable with existing framework.
- Implementation benefits:
    9. Reduce cost and time.
    10. Successful implementations.

7.2.3.1   *Perception of mobile services benefits*

On many occasions, business representatives and analysts are not aware what the smartphone platform can offer beyond the convenience of the 'anytime and anywhere' paradigm. The framework is derived from the smartphones' capabilities and is designed to match them to the business's need in a way that is specific to consumer-grade smartphones. Hence, it is imperative to comprehend the platform's capabilities in order utilise it to satisfy the business's objectives. Therefore, one main benefit of the framework is enhancing the perception of the mobile services. Multiple questions in the survey were designed to evaluate each of the proposed benefits of the framework, and the results in Figure 7.2. show that the framework performed very well in this category.
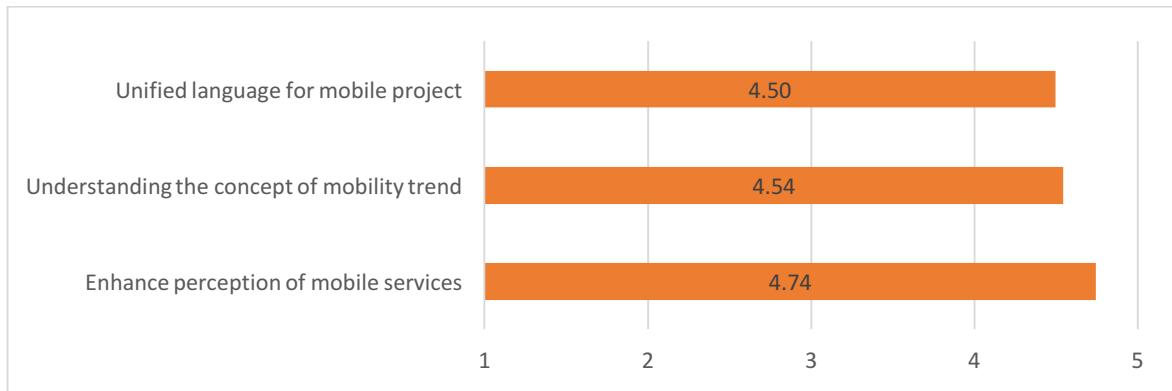
Figure 7.2. The Evaluation of The Framework Roles in Enhancing the Perception of Mobile Services.

7.2.3.2 Object ordination benefits

Enhancement of the current states were only included in the current transition if they were quantifiably justified. This facilitates better decision making and more accurate prioritisation during the transformation project. Many mobile initiatives start by gathering the requirements and then starting on the planning in a separate phase, independently from the business goals and objectives. Transformation requires a holistic approach that considers the main objectives of the business and ensures that the developed solution results in a change in the business that brings it closer to achieving said objectives. Being derived from Enterprise Architecture, the proposed framework results in a future state of the business that is empowered by mobile capabilities to add quantifiable value to the business in the designated objectives, in an alignment with the business's strategic objectives. In the first case of the outward-facing application, the realisation of this value was not at the same level as the other two cases. The score was still above four; but due to the low scores given by the business analysts, it did not match up to the other two cases. The reason could be that the objectives for internal operations are clearly established, and thus the value can be measured against them, in contrast to the outward-facing application, that is not replacing an existing system. Figure 7.3. shows this as another point of strength for the proposed framework.
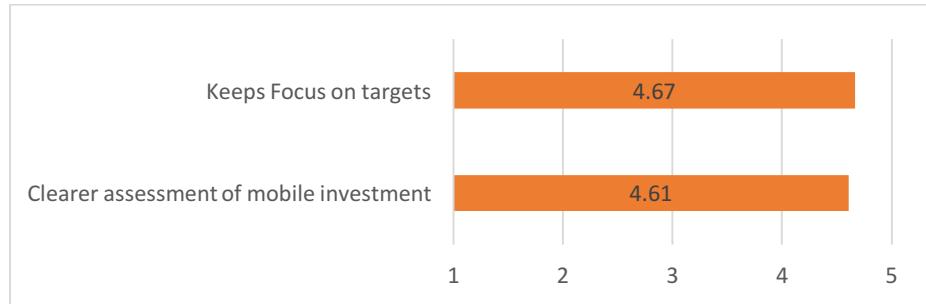
Figure 7.3. The Evaluation of Object Oriented Transformation

7.2.3.3 User Satisfaction benefits

One of the main proposed advantages of the framework is offering the ability to visualise the future state of the mobile transformation and to articulate the values quantifiably. This makes it easier to communicate the proposed plan to the decision makers including the quantifiably evaluated components that clearly justify the investments in business terms. Additionally, the framework involves the key stakeholders at an early stage, documenting and responding to their concerns, as well as taking and making recommendations to facilitate better planning and more accurate pricing. Figure 7.4 shows the proposed benefits relating to the user satisfaction, which is discussed further in the next section.
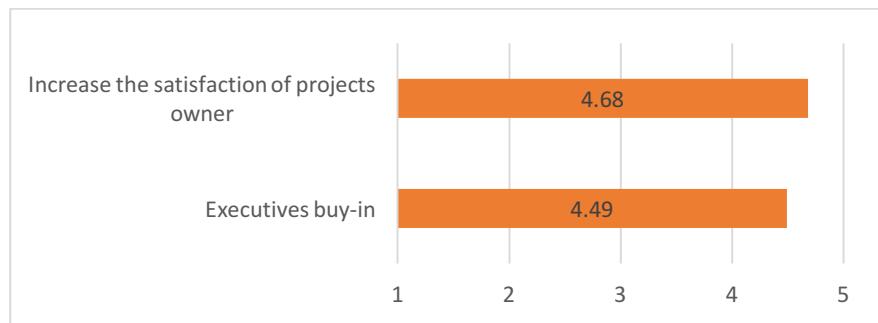
Figure 7.4. The Evaluation of the User Satisfaction Benefits of the Proposed Framework

7.2.3.4 Interoperability benefits

Mapping the current state and planning a future state of mobile transformation is a basic concept of the enterprise architecture frameworks ("EAFs") and was adopted in the proposed framework. The framework is complemented with an interoperability model that allows for it to be incorporated into the existing enterprise architecture frameworks. Employing the Balanced

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Scorecard is a popular technique to extend the objectives from the framework in order for them to be quantifiably measured, monitored and to justify investments. Figure 7.5. shows that the framework is preforming well in this category.
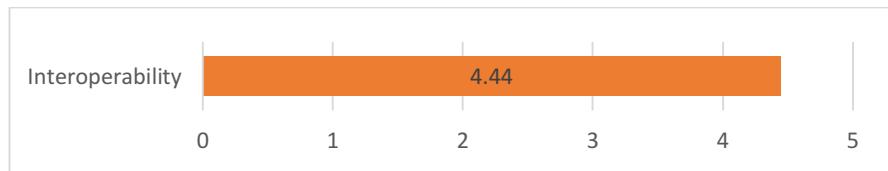
Figure 7.5. The Evaluation of the Interoperability Benefits of the Proposed Framework.

7.2.3.5 Implementation benefits

Defining a clear future state for the transformation plan helps in understanding mobile capabilities and their role in powering the enterprise. This could help in mitigating risks and increasing the chances of a successful transformation. Additionally, any cost is expected to decrease with a clear objectives assessment with the potential to reduce change requests with consideration to the concerns voiced by the various stakeholders and sufficient documentation. Figure 7.6 shows the framework performing well in this category, however, less participants 'Agreed' and 'Strongly Agreed' with the relevant statements in relation to those values than in the other benefits categories. In fact, Figure 7.7. shows them as the least agreed benefits, although over 80% of the participates still agreed with them. When the solution is implemented, the measured benefits are expected to be higher. Overall, the evaluation with specific scores is shown in Appendix F.

Figure 7.6. The Evaluation of the Implementation Benefits of the Proposed Framework

Executive buy-in (of produced plans), the satisfaction of the project owner, and successful implementation all serve the transition mainly during, or at the beginning of implementation. Since that phase did not take place during the case studies, it could have caused the participants to be more hesitant to estimate the value of those propositions to be as well as the ones that they have seen in the planning phase during the workshops.

Overall, the framework performed well in delivering the promised benefits, although it preformed slightly better in some of the proposed benefits as shown in Figure 7.7.
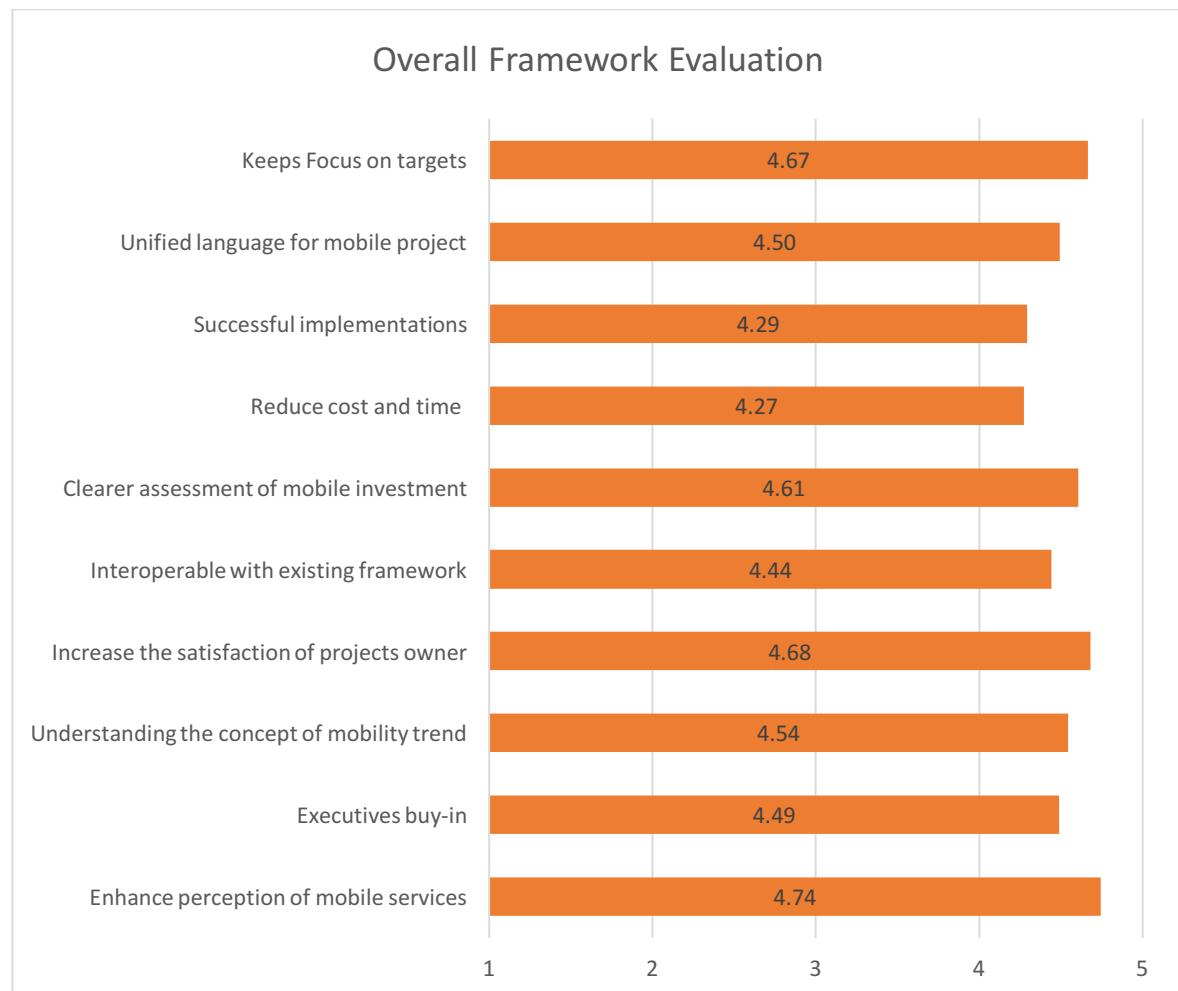
Figure 7.7. Exploring Subtle Differences in the Framework Performance in Delivering the Proposed Benefits.

The framework achieved above average in case study where the solution was aimed towards the external users (Outward Facing Application) [Figure 7.8]. During the case studies, the benefits were mostly realised when it was linked to the process, and when they had a direct impact on the operations. This could be the cause why the framework was not evaluated as well in the Mobile Communication Portal case study as in the other two case studies. The benefits of this case were often indirect, such as deepening the relationship with remote staff. The other two cases impacted on the operations significantly, and in turn, the framework was perceived to be of more value. However, the perception of the participants in the Mobile Communication Portal case study, when measuring if the framework could guide the transformation successfully concerning 'successful implementation', they strongly agreed with this.
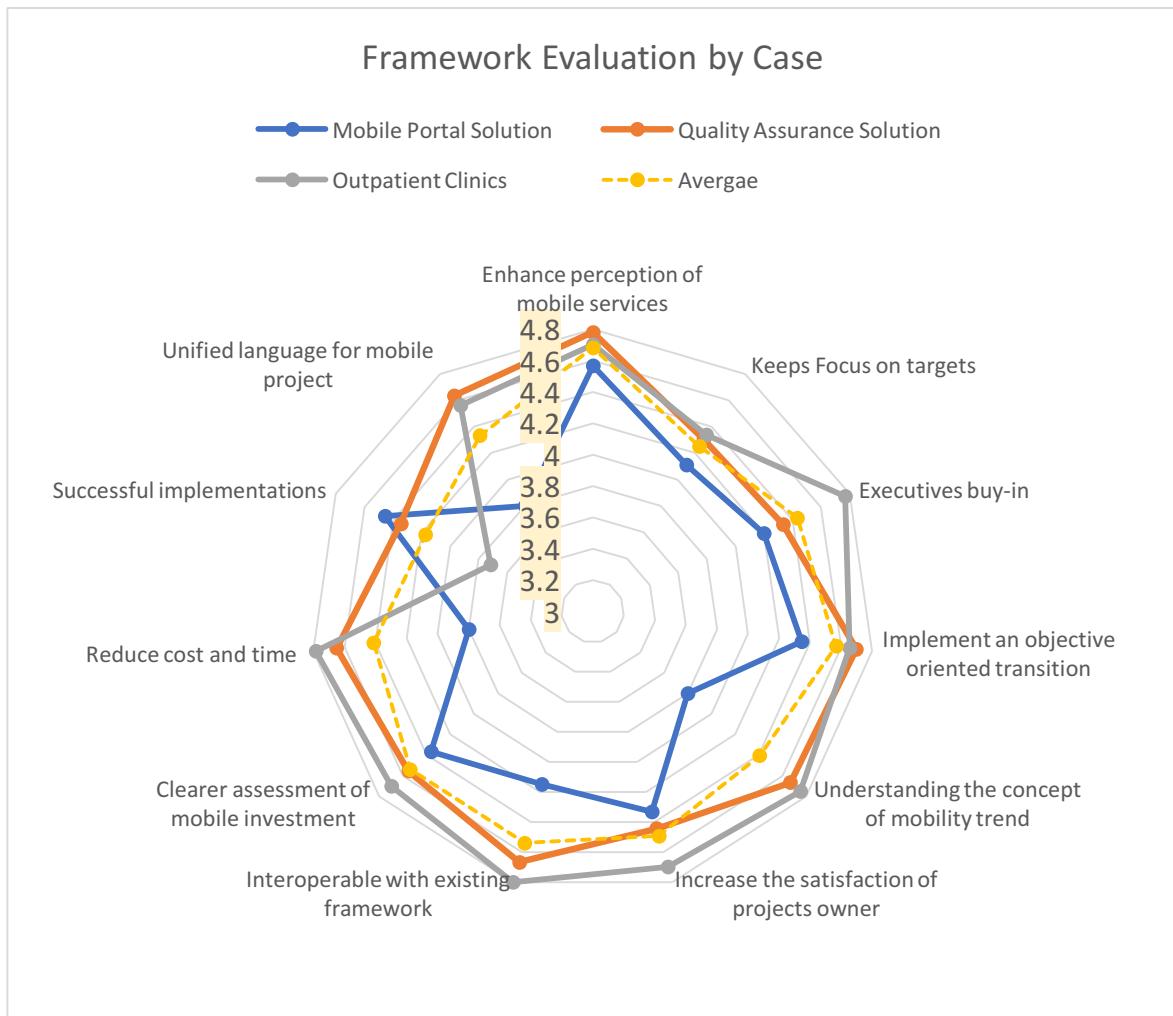
Figure 7.8. Overall Evaluation of the Framework per Case Study.

Another influential factor is the correlation between the implementation phase of the selected case studies and the perceived benefits. Although the framework performed well in all three cases, it scored highly with the planned project, slightly less in the partially operational project, and less for the fully operational solution. The difference might be insignificant in most factors, but it is noticeable in the "reduce time and cost" and "understanding of mobile trend" categories. The latter could be a result of the fact that the solution, for the most part, is common with existing solutions in the markets, however the low score in the "reduce time and cost" factor was unexpected. Realising the cost and time involved in the actual implementation and development of the mobile solution may minimise the perceived volume of the cost and time involved.

Although the participants in every case agreed the framework enhance the perception of the framework, Figure 7.8. shows a variation in the first case, where a portal took advantage of the 'anytime' of the members of staff. The application is an outward-facing application, where instant connectivity is utilised to exchange important messages and updates with remote staff, which is to an extent, the conventional perception of what a mobile service wold offer. Overall, the evaluation with specific scores is shown in Appendix F.
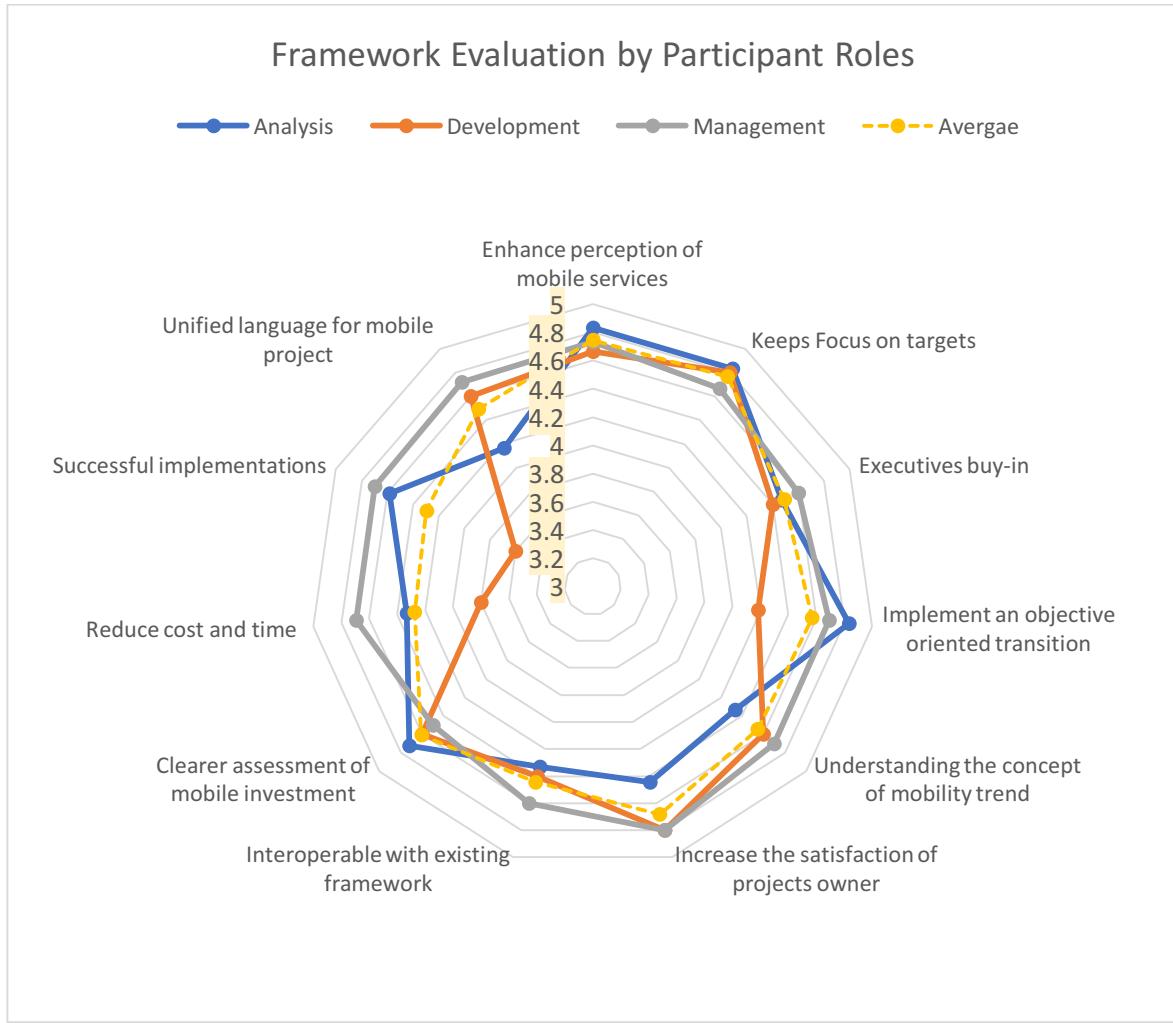
Figure 7.9. Overall Evaluation of the Framework per Participants Role.

Figure 7.9. shows that the managerial members of staff and project owners are those who are the most appreciative of the framework value. Despite the high score given to the implementation benefits by management and the analyst's, the technicians evaluated the framework slightly less, especially in the implementation benefits. This was expected as the framework is technology independent and does not provide any technical specifications. Another noticeable difference is the development's lower scoring of implementing an objective-oriented transition factor - those are business objectives, unlike the technical objectives which are set by the project management for the development during the implementation of the transition.

7.2.4 BSC Evaluation

The benefits of the framework will be listed as objectives and are evaluated in their respective categories via the Balanced Scorecard (BSC). As individual scores were given for each question, the average score of a group of questions will evaluate an objective and an overall, average value will be given to each category of the BSC [Figure 7.10]. The four categories (aka perspectives) are: The Financial Perspectives, The Customer Perspective, The Business Perceptive and The Learning and Growth Perspective [Table 7.2].
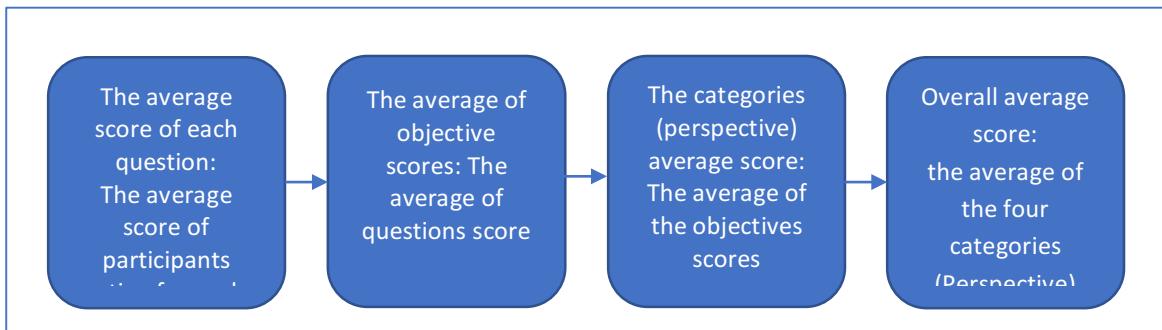
Figure 7.10. The Balanced Scorecard Adapted for Framework Evaluation

The following Table [Table 7.2], shows the questions selected to test the framework in each perspective of the Balanced Scorecard.

Table 7.2. The BSC evaluation of the framework

Financial Perspective			**Customer satisfaction Perspective**		
Objectives	Questions	Score	Objectives	Questions	Score
Accurate pricing	Q12	4.375	Framework support executive approvals	Q40	4.5
Value based prioritisation of mobile solutions	Q12	4.375	The framework is easy to understand and standardise	Q42 Q43 Q44	4.562 4.562 4.062
Focus on Value	Q18 Q27	4.5625 4.75	Sufficient Documentation of concerns and recommendation from an early stage	Q31	4.5
Better utilisation of mobile capabilities	Q25	4.5			
reduce time	Q32	4.75			
Framework support ROI calculation	Q39	4.5			
reduce cost	Q33 Q34 Q35	4.812 4.5 4.562			
Average score of perspective: 4.568 /5			**Average score of perspective: 4.437/5**		
Business Perspective			**Learning and growth Perspective**		
Objectives	Questions	Score	Objectives	Questions	Score
Framework maps correctly	Q22 Q45	4.5 4.437	Framework support EA	Q37 Q38	4.437 4.625
Facilitate of decision making and prioritisation	Q6 Q10 Q19 Q21 Q26 Q30	4.75 4.75 4.5 4.562 4.5 4.687	Understanding the values of current and future mobile implementation	Q7 Q16 Q17	4.812 4.75 4.437
Unified language and vision of mobile initiatives	Q8 Q9 Q14 Q20	4.562 4.437 4.375 4.437	Understanding the mobile platform for better planning	Q11 Q15	4.812 4.875
Understands the role of mobile to focus the analysis effort	Q23 Q24 Q28 Q29	4.625 4.562 4.625 4.687	Standardisation of mobile initiatives planning	Q36	4.625
Clearly planned transitions	Q13	4.562			
Average score of perspective: 4.562 / 5			**Average score of perspective: 4.671 /5**		

Overall Evaluation of Framework: 4.56 /5

Overall, the framework performs well in the four perspectives of the Balanced Scorecard. However, it can be seen from Figure 7.11. that the framework has performed slightly better in some perspectives. The highest rating factors pertain to the learning and growth perspective, by employing the framework as an education tool to support the creation of a future state that utilises the smartphone capabilities better. On the other hand, although the average rating of the customer satisfaction perspective is 4.4 out of 5, it is still lower than expected, as the framework is designed to be simple and easy to use. The financial and business perspective has had similar ratings. [Examine the category based on project/roles]
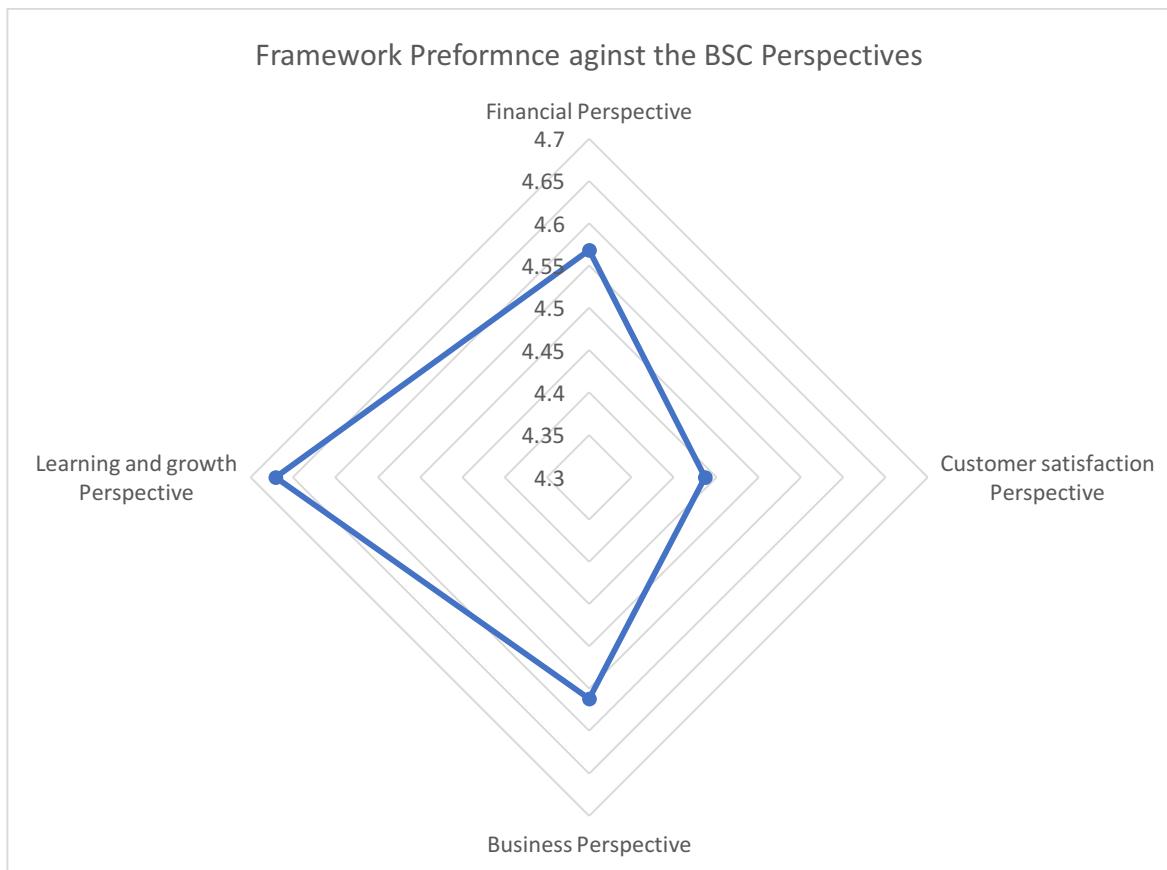
Figure 7.11. Exploring differences in the framework evaluation from the four perspectives of the 'BSC'

The user satisfaction category was evaluated by many questions; however, the more direct statements were:

- I will recommend the framework to my colleges
- I will use the framework for future mobile initiatives
- The framework will have an impact on my project

The solution analysts strongly agreed with these statements, and they are eventually going to be the main user of the framework as shown in Figure 7.12.
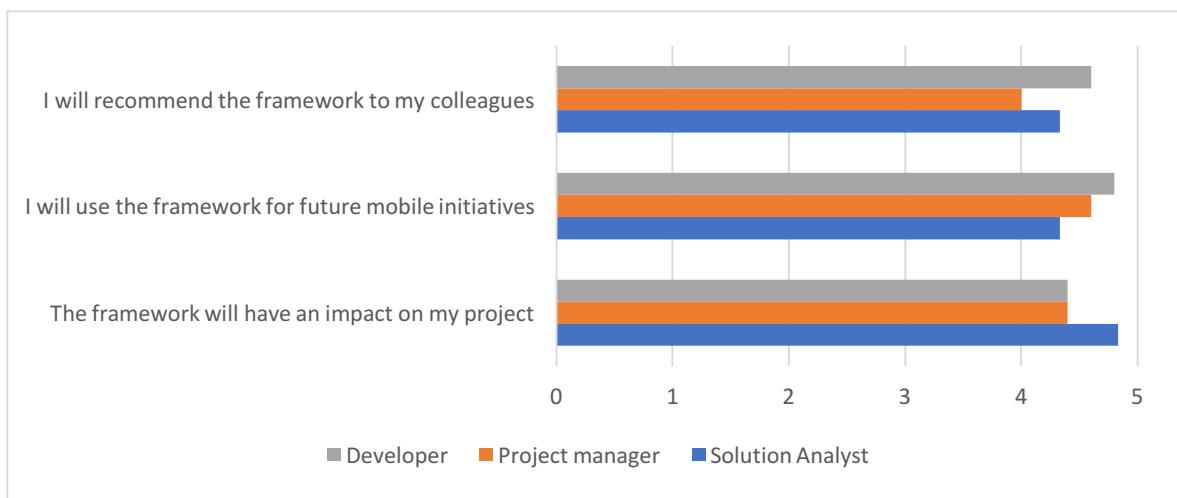
Figure 7.12. The Evaluation of the Satisfaction Related Statements per Participant Role

In terms of the case studies, the agreement with the statement "I will use the framework for future mobile initiatives" correlated with the implementation phase [Figure 7.13]. It was strongly agreed within the planned project, that there was less agreement with the partially-operated solution and additionally, slightly less in the fully operational solution. When asked about the current project, it can be expected to get the most agreement from a partially implemented project which is still under development.
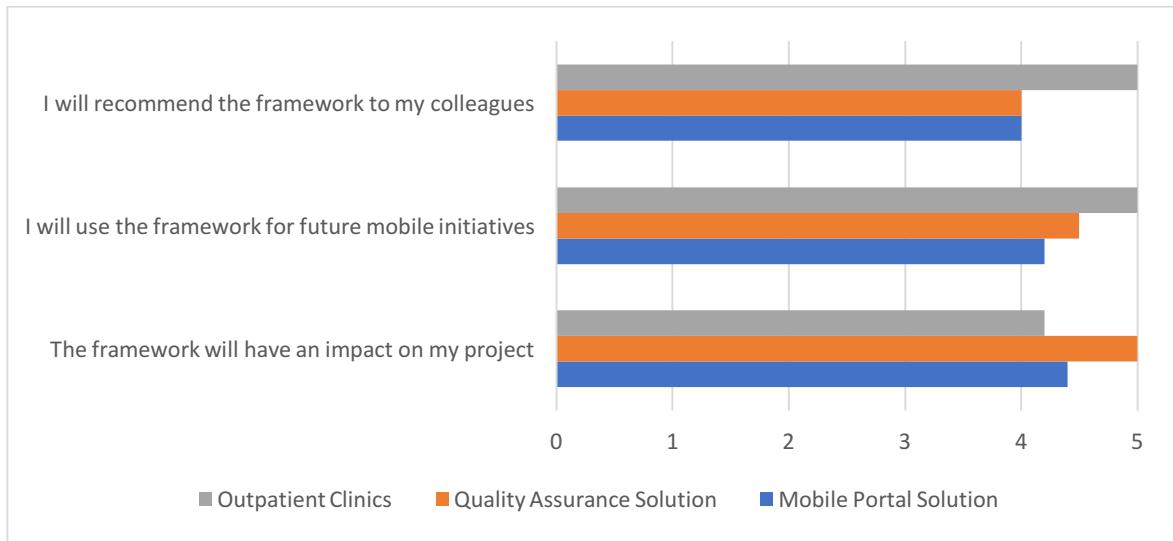
Figure 7.13. The Evaluation of the Satisfaction Related Statements per Case Study.

7.2.5 Supporting Models

The framework was applied to the case studies, including the evaluation with the Balanced Scorecard. On the other hand, the integration sections were illustrated in the workshops and evaluated with a survey at the end. Supporting models are part of the proposed framework, therefore an evaluation of the framework benefits includes the supporting models. However, additional questions were added for further assessment.

7.2.5.1 *Enterprise Architecture Interoperability*

The Enterprise Architecture is realised with the consultancy company as a capability they are familiar with and capable of the developing and operating for other enterprises. However, the practice has not evolved in the company itself for its own benefit. They are considering establishing an enterprise architecture program for the company, and the proposed inter-operability model was presented and evaluated in the survey as shown in Figures 7.14. and 7.15.
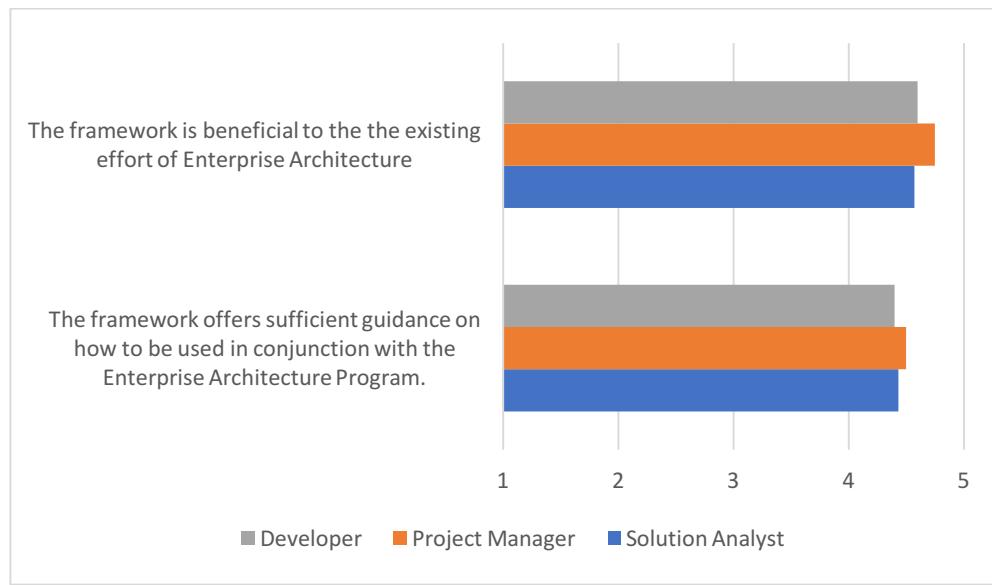
Figure 7.14. The Evaluation of the Enterprise Architecture Statements per Participant Role
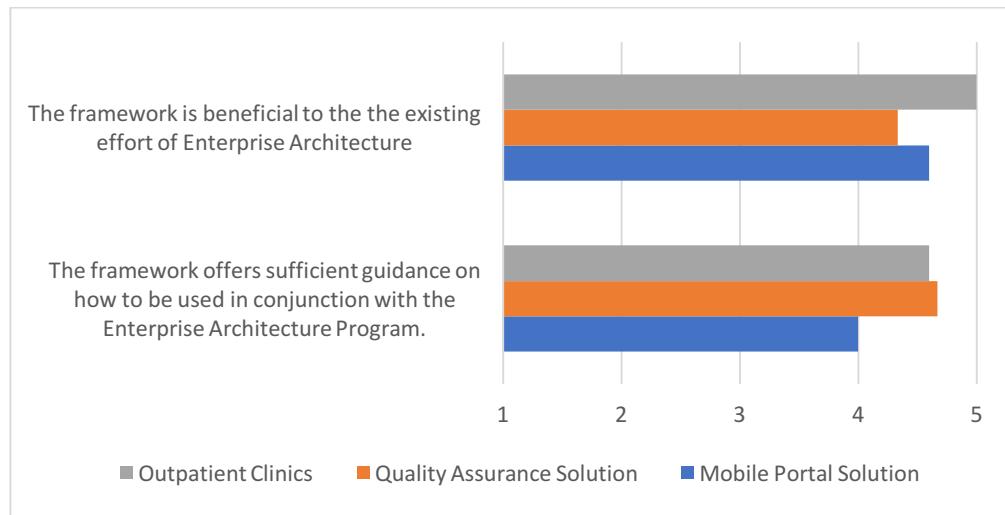
Figure 7.15. The Evaluation of the Enterprise Architecture Statements per Case Study.

7.2.5.2   *Multi Criteria Decision Making "MCDM"*

The concept of MCDM was explained during the workshop, in order for it to be considered for detailed decision-making situations in late stages of implementation to decide on a smartphone device type, for example, or an applications type.

MCDM was relevant in some cases and was presented in the workshops. However, more in-depth future work is required, to identify decision-critical points, and to provide common factors

to be considered the application of MCDM. The information provided on how the framework can be used with MSDM was evaluated as shown in Figure 7.16.

The Framework adoption of Multi criteria decision making allows for maximising the value of mobile initiatives, and comprehensive consideration of functionalities' values and decide on phases.
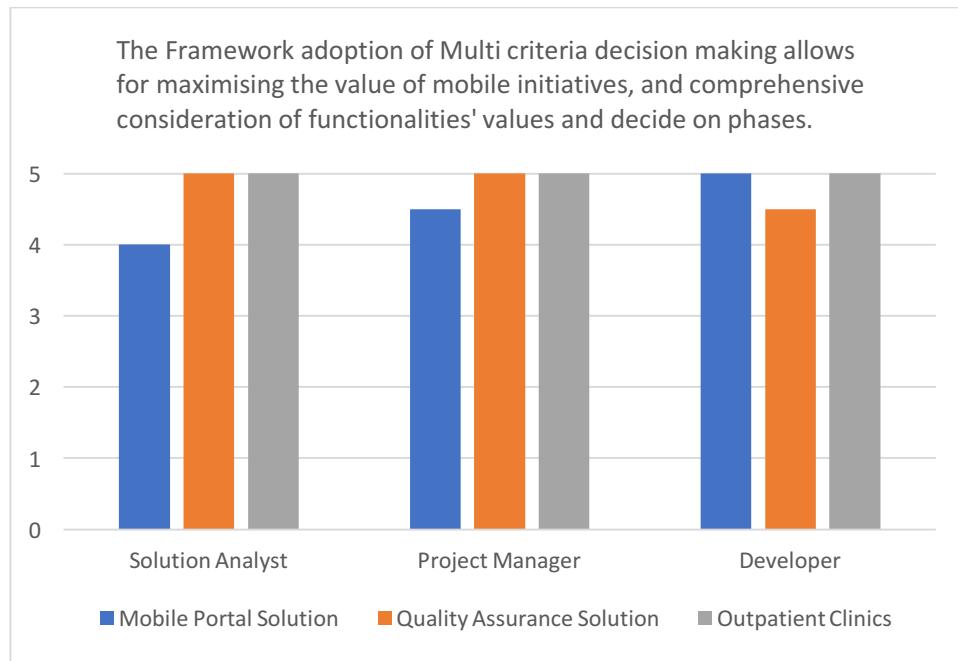
Figure 7.16. The Evaluation of the MCDM Statement per Participant Role/ Case study.

Summary

This chapter presents the framework evaluation and assesses its performance against the proposed benefits. The evaluation was carried out using a comprehensive survey that evaluated each of the proposed benefits for each individual case study. The participants represented both the business and technical sides and were all involved in their organisations' mobile initiatives.

In general, the framework performed well in all of the proposed benefits. The performance varied in different projects, and from the different participants' role and business background. The proposed values were grouped in five categories for ease of discussion.

The Balanced Scorecard was then used to evaluate the framework benefits from the financial, customer, process and learning perspectives. These perspectives are important to business decision-making and used to quantify the benefits of the framework in terms which are familiar to the business.

Chapter 8. Conclusion and Future Work

8.1 Introduction

This research aimed at developing a framework that supports organisations that utilise the capabilities of consumer-level mobile phone technologies. Chapter One of this thesis outlines the aim of this study, and the objectives that were set out to be achieved by it. The research study started with a review of the current mobile trend. This was done by reviewing the evaluation of mobile phone technologies in term of cellular networks, hardware and software advances and the current applications across multiple industries.

Transformation was also discussed through the Enterprise Architecture frameworks which are used to guide transformational efforts within an enterprise, form strategies and to control implementations. The framework was introduced also with supporting models to enhance its interoperability and the development of the mobile strategy.

The initial validation was done through cases studies from the literature, and three case studies in real life scenarios in Saudi Arabia. It was then evaluated using a survey. This chapter summaries the research and identifies areas of future work.

8.2 Research Summary

The section outlines the objectives of this research study and the methods used to achieve them.

To conduct literature research on:

1- To review the latest advancements in mobile networks and smartphones, starting from the various standardised cellular networks generations from the beginning of commercial deployment of cellular networks to 5G as detailed in Chapter 2.

2- To review the applications of mobile solutions for businesses and governments, as done in Chapter 2 and elaborated on in Chapter 4.

3- To review the current popular enterprise architecture models and frameworks adopted in businesses and government bodies, which are detailed in Chapter 3 alongside a comparison between the EA Frameworks in term of their effectiveness for mobile transformation scenarios.

4- To review the current frameworks and models for mobile implementation in business and government, which has been outlined in Chapter 4.

5- To develop a mobile framework to provide guidance and a holistic view of mobile adoption, as addressed in Chapter 4, and then expanded on in Chapter 5 to include the following:

   a. The adoption of Balanced Scorecard

   b. The Mobile Maturity Model

   c. The interoperability Model

   d. Additional guidance on the use of MSDM for transformation transitions.

6- To validate and critically evaluate the framework through the use of case studies in real life scenarios of adopting mobile technologies and applications by enterprises. This was addressed in Chapter 6.

7- To critically evaluate the research project as a whole, as detailed Chapter 7.

8.3 Discussion of Literature Review

The evolution of mobile phone technology was a main part of the literature review. Chapter 2 considered the cellular network evolution from before the first generation through to the fifth generation as the cellular network itself is regarded as the backbone of mobility. This was followed by a review of the advances in hardware and software, and the factors that helped to create the current momentum of mobile services was additionally reviewed. Chapter 2 reviewed the other trending technologies significant to enterprise which can be beneficial to mobile adoption, or influenced by it.

The literature review was also a part of Chapter four, where a review of the existing frameworks of mobile adoption was done, including an assessment of the values that they provide.

To provide better guidance on the adoption of the framework, the Balanced Scorecard (BSC), Multi Criteria Decision Making (MCDM), and Mobile Maturity Models (MMM) were reviewed in Chapter 5. However, the main theory underpinning the research is the Enterprise Architecture (EA). The EA was reviewed in Chapter 3, and the main frameworks in enterprises today were reviewed and compared within this. The proposed framework follows the same concept of Enterprise Architecture; a blue print of the current and future statistics, to facilitate the transformation.

8.4 Development of Framework and Supporting Models

The framework is derived mainly from the literature including a number of case studies as outlined in Chapter 4. It categorises the business objectives from the transformation effort, to align it with the enterprise's objectives and serves to assess the value of the proposed mobile services. The second component of the framework is a taxonomy of the mobile services, derived from the smartphone's capabilities. These capabilities are then matched to the business capabilities that they can provide.

The third component of the framework is the actual solution. During the planning, the solution categories are used to categorise their respective recommendations, concerns and constraints. They are then used to specify the function of the proposed solutions.

The framework was then complemented in Chapter 5 with an application process, maturity model, and interoperability model, and guidance was provided on the use of MCDM as depicted in Figure 8.1.
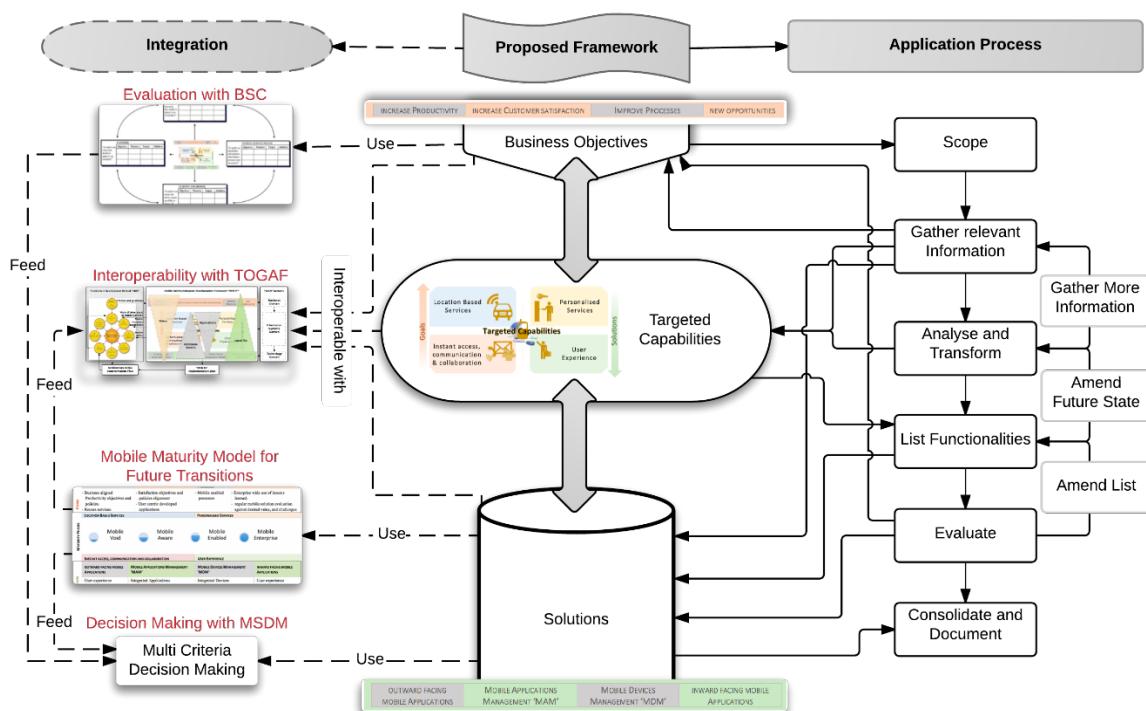
Figure 8.1. An outline of the proposed Framework and Supporting Models.

8.5 Validation and Evaluation of Framework

The framework was validated in three case studies that took place in the Kingdom of Saudi Arabia. For each case study, a scope was defined for mobile transformation to take place and a workshop was presented to the participants to apply the framework to the proposed case study. Participants were involved in these projects, and they participated in the validation of the framework by applying the Balanced Scorecard to the produced future state of the scope as

outlined in Chapter 6. In general, the results were satisfactory and the major quantifiable benefits were estimated to be gained if and when the transformation took place.

Chapter 7 presents the survey that was used to evaluate the framework and the proposed benefits, the framework was performed well in this evaluation.

8.6   Research Contribution

The research makes a number of contributions to the overall knowledge. The Enterprise Architecture frameworks were compared in term of their benefits to the mobile transformation, and also to the mobile adoption methodologies and frameworks. As a holistic framework that provides guidance on mobile adoption and relates to the business decisions that could not be found previously, the proposed framework was therefore developed.

The other contributions are:

1- Mobile transformation process, proposed with supporting documentation templates, and an Excel based assessment tool.

2- The mobile maturity model, that is proposed following the same categories of the mobile framework and after a review of the existing mobile maturity models.

3- An interoperability model, to allow for the framework to be used in conjunction with an existing enterprise architecture program.

4- Guidance on using the framework in conjunction with the Balanced Scorecard and Multi Criteria Decision Making.

A minor contribution includes the review of mobile phone evolution, and enterprise architecture frameworks.

8.7   Research Limitations

Some limitations of the research were recognised during the various phases of the study. During the literature review, it was realised that this is a commercial industry and many of the research sources are not readily available to the public. Some vendor-based source would be biased to the vendor and making evaluation challenging. Therefore, in terms of describing the existing

solutions and business applications, the resources were not available through the data sources usually available through the University.

Another vendor-related limitation is in Enterprise Architecture frameworks. This is why the research was focused on freely available frameworks, although some enterprises would decide to implement the enterprise architecture framework with a vendor in which case, the vendor would often implement their own framework.

As noted in Chapter 6, a detailed assessment tool (Excel) was developed and enhanced during the first workshops at the request of the participants. It is noted that as the scope of transformation widens, the Excel sheet may be hard to follow, and it therefore becomes harder to gain a holistic perspective of the transformation and more difficult navigate easily. This was overcome during the workshops by using the projectors, and summarising the mobile initiative at the end in the holistic view of the Word-based template.

8.8 Areas for Further Work

The following areas are suggested for future work:

8.8.1 Further development of the framework

- The framework is concerned with consumer grade mobile devices; however, the framework could be extended through an investigation to assess the framework's validity when used with additional connected devices (beyond smartphones), including smart devices that are a part of the Internet.
- The framework is technology independent but was developed to cater for the growing trend of smartphones use for mobile enterprises. The framework can be extended to support technology-specific use and to provide additional layers to support technical level decision-making. This will then be linked back to the solution components section of the framework to serve particular needs. This will support customisation of the framework and the needs of technical users
- The framework streamlines the planning process of future, mobile powered enterprise state, and it offers guidance on the use of the mobile platform. However, for additional and more case-specific needs, a model should be developed and deployed on the internet

to capture the ways that the existing enterprise uses the proposed framework, and logs the characteristics for each of them. This will enable the development of an ecosystem; a case-based reasoning model that learns the best practices overtime, and facilitates these practices to the users.

- The validation of the framework involved the use of the BSC. Any future work that involves the design of new models to be used in conjunction with the BSC, should be able to better quantify any soft benefits and indirect values of the mobile transformations using an enhanced tool to automate the decision-making process.

- The Framework performed well with regard to most of the proposed benefits, however, when assessed from the BSC perspectives, it did not seem to perform as well in the satisfaction perspective as in the other three perspectives. This indicates the need for further consideration of this perspective in future iterations of the framework.

- Future work will be carried out to identify more complex situations, where the boundaries of the framework categories may not be as obvious to further validate the framework in those settings

8.8.2   Future proofing to reflect developments in mobile technologies

Mobile technologies continue to expand and develop, meaning that future iterations of the framework will be required to ensure that the support provided for mobile transformation remains current.

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Appendices

Appendix A. The Survey for the Framework Evaluation

Mobile Enterprise

Dear Participant:

My name is Mohammed Alqahtani and I am a PhD student at Staffordshire University in the UK. My research sponsored by government of Saudi Arabia. The purpose of the case studies and the survey is to implement and evaluate the framework based on your experiences in the applying the framework to your perspective case studies.

I am inviting you to participate in the workshops and the following survey to complete your involvement in the case study. It will require approximately 2 hours, and about 20 minutes to complete evaluation assessment. There is no compensation for any activities in relation to the case studies, nor is there any known risk. All information will remain confidential, and will be used anonymously for academic purpose.

This research will follow the Staffordshire University's code of conduct for research. The findings of this research will be made available to you upon your request. If you require additional information or have questions, please contact me at the number or email listed below. Your participation in this research is voluntary and you have the right to withdraw from the workshops and the interview and the right to decline to answer any question.

Sincerely,

Mohammed Alqahtani

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		1	2	3	4	5
1	What is your name?					
2	What is your Job Title?					
3	What Mobile Application did you work on?					
4	What is your role at the project?					
5	What is your Email Address?					
	1: Strongly Agree, 5: Strongly Disagree	1	2	3	4	5
6	The ability to visualise the future state of an enterprise makes it easier to focus on the things that matters to the end-product throughout the implementation phases.					
7	The ability to view the capabilities of the mobile platform and the objectives, enhances the perception of mobile services.					
8	The ability to visualise mobile services and articulate the values quantifiably; makes it easier to communicate them business decision makers to get their approval.					
9	The ability to visualise the mobile services and articulate the values quantifiably, makes it easier to documents requirements and clearly communicate them to developers to have a unified, aligned vision of the end-product.					
10	Implementing a goal oriented mobile initiative allows for better decision making and prioritisation during the throughout the project.					
11	The ability to view the mobile platform capabilities, business capabilities (mobile solutions) and the expected results in a single model; makes it easier for technical and non-technical members to plan mobile services, and assess value.					
12	Documenting concerns, recommendations at an early stage facilitates for better prioritising and more accurate pricing of mobile solutions.					
13	Mapping current and future state (As is - To Be) and analysing the gap between them facilitates for a smoother transitions and deeper understanding of the changes entailed.					
14	Allowing developers to understand the desired future state, and the its value to the business, helps all involved stakeholders to understand the development process					

	entails and increase the chances for successful transformation.					
15	The framework helps in better understanding the mobile platform.					
16	The framework helps in realising the potential value of mobile transformation.					
17	The framework helps in realising the value in my current mobile project.					
18	The framework helps in keeping me focus on valuable components of the mobile project.					
19	Major decision making throughout the planning are supported by the framework.					
20	The framework makes it easier to communicate the mobile initiative to executives and get their approvals by offering clear evaluation of each component.					
21	The framework helped me in term of decision making and prioritisation throughout the project.					
22	Applying the framework to the project fits the framework categorisation of the mobile services capabilities, mobile solutions, and the expected results (Objectives).					
23	The framework categorisation of current mobile functionalities, and future mobile functionalities by the 4 mobile services categories, helped me realise the value of mobile in the current implementation.					
24	The framework categorisation of current mobile functionalities, and future mobile functionalities by the 4 mobile capabilities categories, helped me focus on collecting the relevant information required to analyse the current and plan the future states.					
25	The framework categorisation of current mobile functionalities, and future mobile functionalities by the 4 mobile capabilities categories, helped me better plan and utilise mobile in the future state of the service.					
26	The framework way of Linking functional requirements to the objectives, helped me in prioritising functionality, and keep focus on end goal.					
27	The framework way of linking functional requirement to the objectives, helps in prioritising future functionalities					

	to fit the purpose better, constraining requirements, and spurring new requirement derived from objectives.					
28	The framework classification of mobile solutions, helped in realising changes required to build and operate mobile solutions.					
29	The framework classification of mobile solutions from various aspects helped in prioritising and detailing the future functionalities, constraining requirements, and spurring new requirement derived from documented concerns and recommendations.					
30	The framework succeeded in easily communicating a single model that links objectives, functionalities, and solutions, to technical and non-technical member of staffs alike.					
31	The framework aids the documentation of concerns, recommendations, requirements from various stakeholders from an early stage of the transformation, and takes them in consideration throughout the planning phase.					
32	The framework reduces time required to plan for mobile transformation					
33	The framework reduces cost of planning for mobile initiatives by focusing effort on the aspects of enterprise those of relevance to mobile transformation.					
34	Framework reduces cost, by allowing functionality to be evaluated against expected values, and dismissing invaluable mobile functions.					
35	Framework reduces cost by allowing for a comprehensive consideration of influential factors and requirements to be considered at an early stage, which reduces the number of Change Requests (CRs) later.					
36	The framework helps standardising and structuring current and future mobile initiatives.					
37	The framework offers sufficient guidance on how to be used in conjunction with the Enterprise Architecture Program.					
38	The framework is beneficial to the existing effort of Enterprise Architecture.					

39	The framework evaluation components were sufficient for prioritisation and RoI calculation.					
40	The framework evaluation component is sufficient to get executives' approvals.					
41	the Framework adoption of Multi criteria decision making allows for maximising the value of mobile initiatives, and comprehensive consideration of functionalities' values and decide on phases.					
42	The framework will have an impact on my project.					
43	I will use the framework for future mobile initiatives.					
44	I will recommend the framework to my colleagues.					
45	The framework components were easy to understand.					
46	What changes would recommend to the framework?					

Appendix B. The Story of Mobile Evolution

- **Apex B.1: Voice-only networks (1G)**

The first commercial cellular network was set up in Tokyo, Japan in 1979 by NTT and by 1981, it covered the whole country, today it is known as 'DoCoMo', the first to deploy a 3G service nationwide in the world (Patil et al., 2012) followed by NMT in Sweden, followed by Europe and the US. All the pioneer countries used different technologies and standards, leading to one of the biggest disadvantages of the first generation of cellular networks which was the lack of interpretation between cellular networks as they were unable to connect to each other and users could not make international calls. The one exception to that was in Scandinavia where the roaming concept was started by NMT (Arnold et al., 2008). The most popular 1G systems were AMPS in the US, ETACS in Europe and Japan and NMT in Scandinavia: 'Denmark, Finland, Sweden and Norway'. During the 80s, users experienced limitations in the service in voice quality, coverage and loss of service while travelling abroad as interoperability between cellular networks was not realised until later in 2G. However, there was an advantage of using the analogue system, which was its capability to perform in bad conditions (Kumar et al., 2010). Voice in the first generation is only modulated to higher frequency, but the radio cell would digitally signal from the radio tower to the rest of the telephone system. Therefore, the network was not capable of transferring data at all and because it was a circuit switched system, it meant a connection was established when you made a call until you hung up, and the costs were calculated by duration. Finally, by the use of special modems, the first generation of mobile cellular networks was capable of providing internet service at a very low data rate, by using a special modem that converted the signal from digital to analogue and then reversed it at the base station, and as it was connected through a base interface station to the internet router, the CDPD (Umar, 2004).

- **Apex B.2: Digital switching circuits (2G)**

Cellular networks were revolutionised with second generation cellular networks when digital switching circuits was introduced in the late 80s. These transmitted voice digitally between the base stations (cells) and the user handheld devices and allowed for data at low rates (at 9.6

Kbit/s) to be communicated and for digital multiple systems to be used, to increase spectrum efficiency and provide better data service (Umar, 2004).

In the second generation, more effort was put into providing single unified standards to facilitate interconnection between cellular networks. The most common standard was GSM (Global System for Mobile Communication), which was deployed in Europe first and then accounted later on for about 80% of subscribers around the world, in combination with another popular system (CDMA2000) used by about 60 operators (Patil et al., 2012).

GSM was initiated by CEPT (European Conference of Postal and Telecommunications Administrations) and other standards were deployed in Japan (Personal Digital Cellular - PDC) and the US (IS-54, IS-139, IS-95, CDMA 2000) (Patil et al., 2012). The rest of the world is using GSM, CDMA or both (Curwen & Whalley, 2008). In addition, with GSM, the number of mobile phone subscriptions increased exponentially to unexpected numbers at about 3 billion subscribers around the world, which no one could have predicted just five years previously (Sauter, 2013).

GPRS was introduced later, based on GSM, enabling wireless access to the Internet to increase, reaching 150 kbps in optimum conditions, by allowing packet data to be sent, introducing a packet-switching protocol with shorter setup time and the ability to charge by the amount of data used. This is why it is sometimes referred to as 2.5G; it was the most important step towards 3G (Kumar et al., 2010). On the other hand, cdma2000 also evolved to cdma2000xRTT. The last phase of the second-generation development that coexisted with 3G services was the enhanced data rates in GSM environments (EDGE) and, according to GSA (2010), the global mobile suppliers' association, as of 2010 there were 503 EDGE networks around the world, in 195 countries. EDGE allowed for a speed up to 384kbps to be reached. Allowing many users to communicate with the base station by using TDMA (time division multiple access), the same technology used by GSM, GPRS is a channel access method based on time division, dividing signals into multiple time slots, thereby enabling different users to use the same frequency at the same time (Curwen & Whalley, 2008). 1G technologies used FDMA (frequency division multiple access) where the frequency itself is divided, and 3G tends to use CDMA (code division multiple access) where users communicate with the base station at the same time but with using different code 'labels' to differentiate them (Arnold et al., 2008).

The second-generation technologies moved from delivering 9.6 Kbit/s speed with GSM to 115 Kbit/s to 384 Kbit/s with GPRS + EDGE, and it allowed for 'always connected' to be achieved. Hence, new services were offered such as encrypted digital voice calls, push to talk, SMS short messaging service, conference calling, caller ID, voicemail and simple data applications including web browsing and email service (Motorola, 2012).

- **Apex B.3: Mobile Broadband (3G - IMT 2000)**

Third generation technology was developed in response to the need for a new generation of networks capable of providing service independently from the technology platform, as there were different standards for networks around the world (Kumar et al., 2010). GPRS kept improving to form the basis of UMTS standards. These were identified by ITU (International Telecommunication Union) and called ITU-2000 (known as 3G or IMT 2000). Systems to meet the requirements of ITU-2000 were then identified by 3GPP (3rd Generation Partnership Project).

CDMA2000 was another system developed to meet the ITU-2000 requirement. Japan was the first to launch a commercial 3G network in 2001 (Sørensen, 2014), followed by South Korea, followed by Europe and then the US (Kumar et al., 2010). The ITU standards of 3G services were to deliver high-speed data up to 2 Mbit/s indoors and up to 384 Kbit/s outdoors. 'Key features of IMT-2000 are the high degree of commonality of design worldwide, compatibility of services within IMT-2000 and with the fixed networks, high quality, a small terminal for global use, worldwide roaming capability, capability for multimedia applications, and a wide range of services and terminals' (ITU, 2013).

In 2006, UMTS developed into HSPA (high-speed packet access), which encompasses HSDPA (high-speed download packet access) that uses time multiplexing if required; if not, it uses code multiplexing. HSPA uses HSUPA (high-speed upload packet access) and, according to Wireless Inelegance's live counter and as of 18th January, 2013, it was used by 1,351,153,479 devices around the world (UMTS Forms, 2013). Later, HSPA developed into HSPA+ which is the first protocol to introduce MIMO (multiple input and multiple outputs) and higher order modulation which multiplies the speed by the addition of another antenna on the phone (Sauter, 2013). This offered massive data rate speeds and was called 3.5, or 3.75 in some countries. Some telecoms even advertised HSPA+ as a 4G service. The CDMA2000 1xRTT

system evolved to 'Cdma2000 EvDO rev B', providing higher speed data rates of up to 46 Mbps. HSPA offers download speeds of up to 14.4 Mbps, HSPA+ offers up to 42mbps. These technologies do not apply to the 4G requirement nor do they have the capability to do so and this is why they are classified as 3G, regardless of the fact that in practice, speeds are very close to fourth generation technologies (Kumar et al., 2010).

With the advent of new technology and in addition to greater recognition of world telecoms' ability to interconnect, cellular networks became capable of providing more fixed wireless internet access such as watching mobile TV or downloading videos and music, 3D gaming, faster web browsing, video conferencing and location based services (Patil et al., 2012).

The move to 3G was not the same as the process for moving to 2G, when 2G replaced 1G. However, in the move towards 3G, both systems coexist (Curwen & Whalley, 2008). The download speed and upload speeds experienced by users on the networks using the following technologies are shown in Table Apex B.1.

Table Apex B.1. The download speed and upload speeds experienced by users on the networks using different technologies (Sauter, 2013).

Technology	Typical download speed with light cell load	Typical download speed with average cell load	Typical upload speed with light cell load
GPRS	60 kbps	40 kbps	36.6 kbps
EDGE	250 kbps	200 kbps	150 kbps
UMTS	384 kbps	128 kbps	128 kbps
HSPA	1 Mbps (operator restrictions)	800 kbps	384 kbps
HSPA	2.5 Mbps	800 kbps	with HSUPA 1.4 Mbps
HSPA+	5 Mbps	1.6 Mbps	--

- **Apex B.4: All IP Networks (4G – IMT-Advanced)**

The HSPA was developed further into LTE through the 3GPP under the ITU in 2004, basing future work on OFDM multiple access (orthogonal frequency-division multiplexing) in the download link, with an upload link which is similar to FDMA but much more efficient. The first release of LTE was in 2007 (Dahlman et al., 2011). IMT-Advanced is the standard for the current

fourth generation of cellular networks in the market (known as 4G), and work on delivering the standards initiated in 2008 by ITU.

The 4G network is all-IP (Internet Protocol) and the main reason for this is to have a common platform for all of the technologies that have been developed so far; in addition, it reduces the cost of infrastructure as all-IP only deals with data (Kumar et al., 2010). Other benefits are to implement the IPSec (the internet security protocol) in addition to the TLS (transport layer security) and SSL (secure sockets layer) (Kulkarni, 2008), introducing new types of encryption and firewall approaches as mobile cloud, over-the-top (OTT) driven applications and social media strategies evolve (Russell, 2016).

The requirement for 4G (IMT-Advanced) are 'a high degree of commonality of functionality worldwide while retaining the flexibility to support a broad range of services and applications in a cost efficient manner, compatibility of services within IMT and with fixed networks, capability of interworking with other radio access systems, high quality mobile services, user equipment suitable for worldwide use, user-friendly applications, services and equipment, worldwide roaming capability and enhanced peak data rates to support advanced services and applications (100 Mbit/s for high and 1 Gbit/s for low mobility were established as targets for research)' (ITU, 2007).

Another promising technology is WiMAX, but neither WiMAX nor LTE can deliver to IMT-Advanced standards in practice. Therefore, 3GPP is working on an improved version of LTE (up to 150 Mbps), LTE-Advanced, to reach a target of 1Gbps (Kumar et al., 2010). '3GPP LTE-Advanced and IEEE 802.16m (next generation WiMAX networks) are viewed to be the top candidates for fulfilling needs and in some particular situations, even increasing the IMT-Advanced needs' (Rani & Singla, 2016).

- **Apex B.5: Future of Cellular Networks (5G)**

Aryaputra and Bhuvaneshwari (2011) suggest that the way forward in thinking about 5G is by considering the optimal goal as 'any rate, anytime, anywhere, affordable' and see how far the current 4G standards are from that. Another initiative is the mobile and wireless communications enablers for the twenty-twenty information society project, '**METIS',** which aims to increase the capacity and efficiency of cellular networks, respond to the huge increase in the number of devices caused by 'the internet of things' and comply with the requirements

of new cases [Figure Apex B.1]. The following concepts are believed to impact the design of fifth generation cellular networks:

- Device-centric architectures, instead of being base-station-centric.

- Millimetre wave (mmWave) to overcome scarcity of microwave frequencies.

- Massive MIMO: utilising a very high number of antennas.

- Smarter devices: allowing device-to-device (D2D) connectivity or exploiting smart caching on the mobile side.

- Native support for machine-to-machine (M2M) communication (Boccardi et al., 2014).
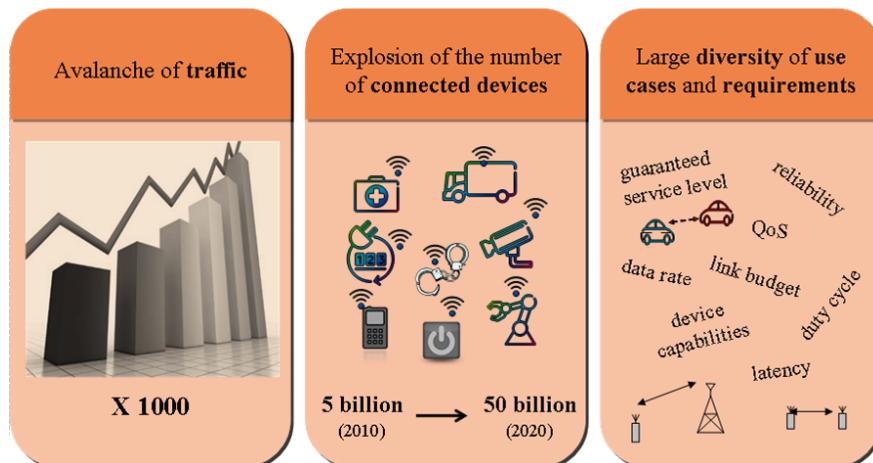
Figure Apex B.1. Project rationale (METIS, 2013).

An optimal vision is set by GSMA (GSMA et al., 2014): the majority of the vision criteria has to be met to qualify as 5G, offering more speed, lower latency level and a higher number of connected devices than 4G, outlined as follows:

- 1-10Gbps connections speed.

- One millisecond (latency).

- 1000x bandwidth per unit.

- 10-100x number of connected devices.

- A perception of 99.999% availability.

- 100% coverage.

- 90% reduction in network energy usage.

- Up to 10-year battery life for low power, machine-type devices.

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Figure Apex B.2 summarises the way the technology of mobile cellular networks has developed during the last 30 years and where it stands now, with 5G showing where we are from the optimal goal in term of the technologies used, speeds and standardisation bodies.
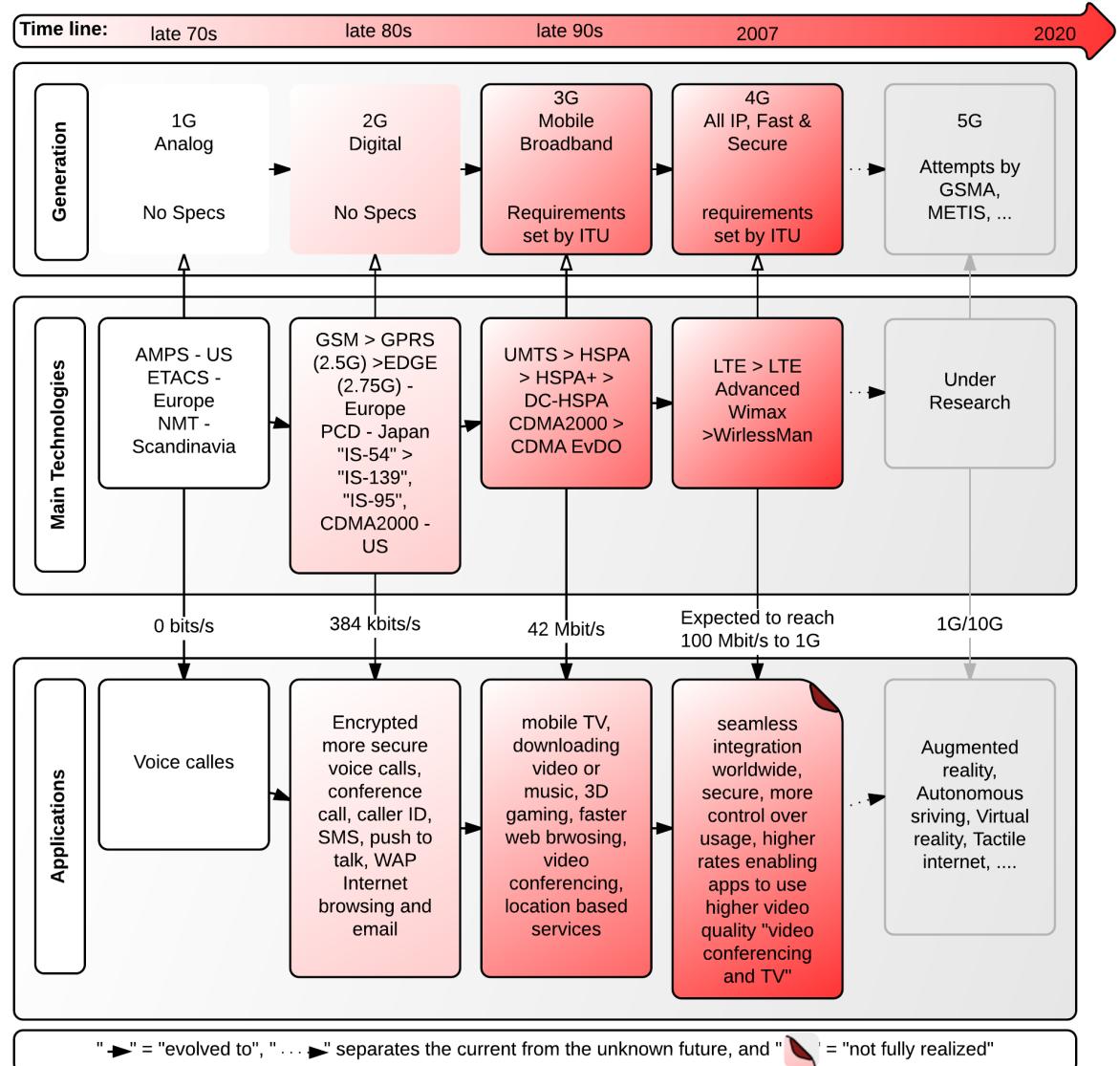
Figure Apex B.2. Evolution of Cellular Networks From the 1970s Onwards.

- **Apex B.6: Standardisation of cellular networks:**

In the early 80s, the convention of cellular generation did not exist and there were no standards for cellular networks until the advent of new types of cellular network (generation). Then the first notion of cellular networks generations was found to refer to an advanced system replacing an old one (Patil et al., 2012) .

ITU is the United Nation's body for information and technology and is the organisation that made the standards of cellular network today, to facilitate for interconnection between telecom providers around the globe by setting the standards for countries' codes with a unique code for each country and providing the codec used to encode voice. It is working to underpin all the new telecommunications that are using the Internet (ITU, 2015). With the advancement of technology in cellular networks which have enabled data transfer at faster rates, the ITU has set the standards that shaped the new generation of telecommunications, 3G, which is called ITU-2000 by ITU.

The work on building more reliable networks, and with abilities to deal with data at ever faster rate will never stop as demand is increasing and mobile phones are getting smarter and doing much more than calling and texting. When ITU realised the need to standardise the technologies beyond 3G standards, they came up with the 4th generation standards. Current research beyond the 4G standard is classified as 5G up to this point; there are no standards for 5G [Apex B.2].

Table Apex B.2. Standardisation of cellular technologies

Generation (requirement)	Standardisation Body	Technology
1G	NMT	NMT
2G	Qualcomm	CdmaOne
	ETSI	GSM, GPRS, EDGE
3G (ITU)	3GPP2	CDMA2000 1xRTT, CDMA2000 1xEVDV, CDMA2000 1xEV-DO
	3GPP	UMTS (WCDMA) , HSPA, HSPA+
	IEEE	Wimax
4G (ITU)	3GPP	LTE, LTE Advanced
	3GPP2	UMB
	IEEE	WirelessMAN-Advanced

During 2G and 3G, there were times where telecoms deployed new technologies and realised the need to differentiate them from the existing ones, as they were considered stepping-stones from their generation. They were informally called 2.5G (GPRS), 2.75G (EDGE), 3.5G (HSPA) and 3.75G (HSPA+). Some of the active bodies standardising for 3G and 4G services are:

- '3GPP' (3rd Generation Partnership Project), representing six telecoms companies (ARIB - Japan, TTC - Japan, ATIS - US, CCSA - China, ETSI - Europe, TTA - Korea) and they have built on ETSI's (GSM) and standardised for UMTS, HSPA, HSPA+, LTE and LTE advanced in several releases, started in 1998.

- '3GPP2' (3rd Generation Partnership Project 2), representing (ARIB - Japan, TTC - Japan, CCSA - China, TIA - US, TTA - Korea) They built on Qualcomm's (CdmaOne) started and built on, they standardised CDMA2000 1xRTT, CDMA2000 1xEV DV, CDMA2000 1xEV-DO and UMP. Started in 1998.

- IEEE: an organisation that standardised wireless communication that set the standards for Wimax.

- **Apex B.7: Radio frequencies of cellular networks**

Electromagnetic waves, electromagnetic radiations, fields or radio waves are the same name for the technology used to transmit signals. The frequency is the number of times the wave oscillates in one second; hertz is the measuring unit for frequency and 1 Hz means one oscillation per second. Low frequencies are used for transferring lower rates, like radio stations, and as you move up more rates can be delivered, like TV and mobile carriers, so frequencies between 30 KHz and 300 GHz are used for telecommunication (Stewart, 2000). According to Robert (2007), Table Apex B.3. shows some of examples of the main uses of radio frequencies.

Table Apex B.3. Examples of main uses of radio frequencies.

Frequency band	Designation	Typical service
3-30 kHz	Very low frequency (VLF)	Navigation, sonar
30-300 kHz	Low frequency (LF)	Radio beacons, navigational aids
300-3,000 kHz	Medium frequency (MF)	AM broadcasting, maritime radio, Coast Guard communication, direction finding
3-30 MHz	High frequency (HF)	Telephone, telegraph, facsimile; shortwave international broadcasting; amateur radio; citizen's band; ship-to-coast and ship-to-aircraft communication

30-300MHz	Very high frequency (VHF)	Television, FM broadcast, air-traffic control, police, taxicab mobile radio, navigational aids
300-3,000MHz	Ultrahigh frequency (UHF)	Television, satellite communication, radiosonde, surveillance radar, navigational aids, common- carrier land mobile communication
3-30 GHz	Super high frequency (SHF)	Airborne radar, microwave links, satellite communication
30-300 GHz	Extreme high frequency (EHF)	Radar, experimental

For mobile service providers to use a spectrum, they usually must have a licence and most governments auction new licences and consider them as a national resource (Patrick, 2005). They are given to the highest bidders as they will appreciate it most and will try to utilise it fully, and they are encouraged to relinquish their licence later to allow more entrants according to the FCC (Federal Communications Commission) of the US. An example of how governments benefit from auctioning licenses is the story of the UK auction for the 3G network, which is a success story where the government earned about 600 dollars per head of the population (Klemperer, 2004). In 4G, EE was allowed to utilise its spectrum for 4G; however, other operators including EE will bid on the new spectrum 2.6GHz soon, according to the regulator body, Ofcom (the independent regulator and competition authority for the UK communications industries) (Ofcom, 2013). The government gives the right when selling a licence simply to deploy receivers and transmitters that utilise the spectrum, as spectrum is only the medium (Staple and Werbash, 2004).

ITU maintains that every country owns its spectrum and has the right to allocate it; however, there are standards for technologies used around the world that enable interconnectivity between countries (ITU, 2004). Frequency bands are divided into two types: FDD (frequency division duplex) and TDD (time division duplex). FDD bands use channels for the download link and others for upload links whereas TDD transmits and receives on the same channels but in a time division duplex (Ghassan, et al., 2012). Operators have used different bands for mobile services since the first generation, using 800MHz, 900MHz, 1700MHz and 1800MHz, and with the advent of 4G, 2100MHz, 2600MHz used with TDD and FDD, on GSM systems or CDMA (Stewart, 2000), However, the most popular systems now are the GSM 900/1880 MHz in

Europe, Asia, Africa, Australia and the Middle East and GSM 800/1900 MHz in North and South America.
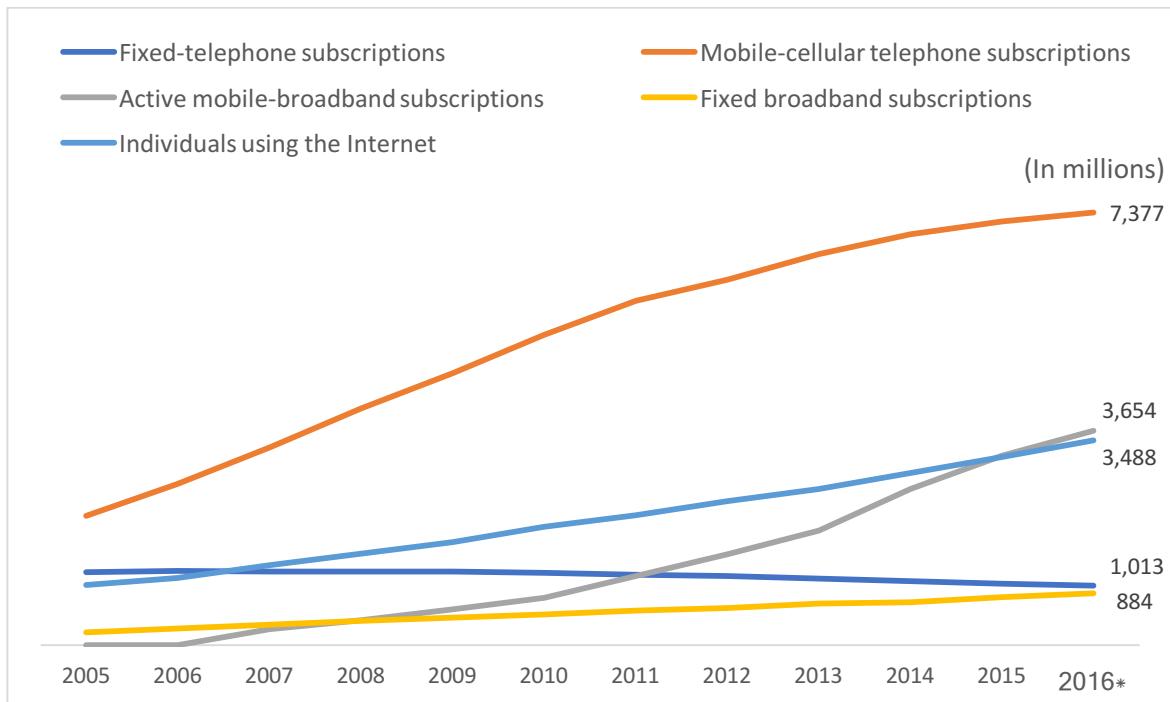
Figure Apex B.3. The Increase in Mobile Subscribers' Base in Comparison to Fixed Services Subscriptions (Data source: ITU).

- **Apex B.8: Smartphone Evolution**

The advancement in connectivity in mobile phones has not only been in cellular networks [Figure Apex B.3] but in Wi-Fi, the addition of Near Field Communication (NFC) to smartphones, Bluetooth and others; for example, the breakthrough in the latest version of Bluetooth (Bluetooth 4) extends the range, speed data rate and battery life, allowing it to stay powered for years on coin-

Figure Apex B.4. An Example of External Sensors Application in Health (Safe Heart, 2016).

cell batteries. This will allow many applications to be available using Bluetooth (Bluetooth SIG, 2016). Beside the advancement in cellular networks, the number of distributed 'Hot Spots' is increasing. In the UK, for example, BT alone has provided more than 5 million hot spots around the country(BT, 2016).

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Smartphones are fitted with many sensors beside the camera and microphone; this includes GPS for location-based services, three-dimensional gyroscopes for device movement, a compass for directions, an accelerometer for movement speed and proximity sensors for objects close to the device (Otebolaku & Andrade, 2013) (Laurila et al., 2013).

Figure Apex B.5. Mobile Payment Market Is Booming (Abaitua, 2016).

Embedded sensors do not usually cover applications such as healthcare and remote control. Fortunately, the wide set of communication interfaces of smartphones allows easy connection to external sensors needed by applications [Figure Apex B.4] (De Dominicis et al., 2012). External sensors can include:

- Gas sensors for precision electrochemical, oxidising gases and reducing gases.
- Temperature, humidity, pressure and non-contact thermometer.
- Proximity.
- Colour intensity.

In addition to context values being captured by mobile sensors, web services enrich context value, for example, weather reports or public transportation information service; the supporting infrastructure or peer users provide useful context parameters such as location, distance from POI, budget, time, weekday, season, time available for sightseeing, means of transport, weather conditions, mobility history, social environment, payments which utilise fingerprint and near field communication through 'NFC' sensors [Figure Apex B.5] (Gavalas, 2013) (Ceipidor et al., 2013).

Lately, with the advent of long range, low power consumption and one way communication Bluetooth technology, the concept of Beacon devices has emerged where Bluetooth devices broadcast messages and do not listen for a response; additionally, with the unprecedented popularity of smartphones, new applications for one-way Bluetooth technologies emerge (Ireland et al., 2015), (Bouchard et al., 2016), (Saraswat & Garg, 2016). Applications vary from

indoor positioning, customer and user tracking [Figure Apex B.6] and marketing and messages propagation, to health care.

a

b
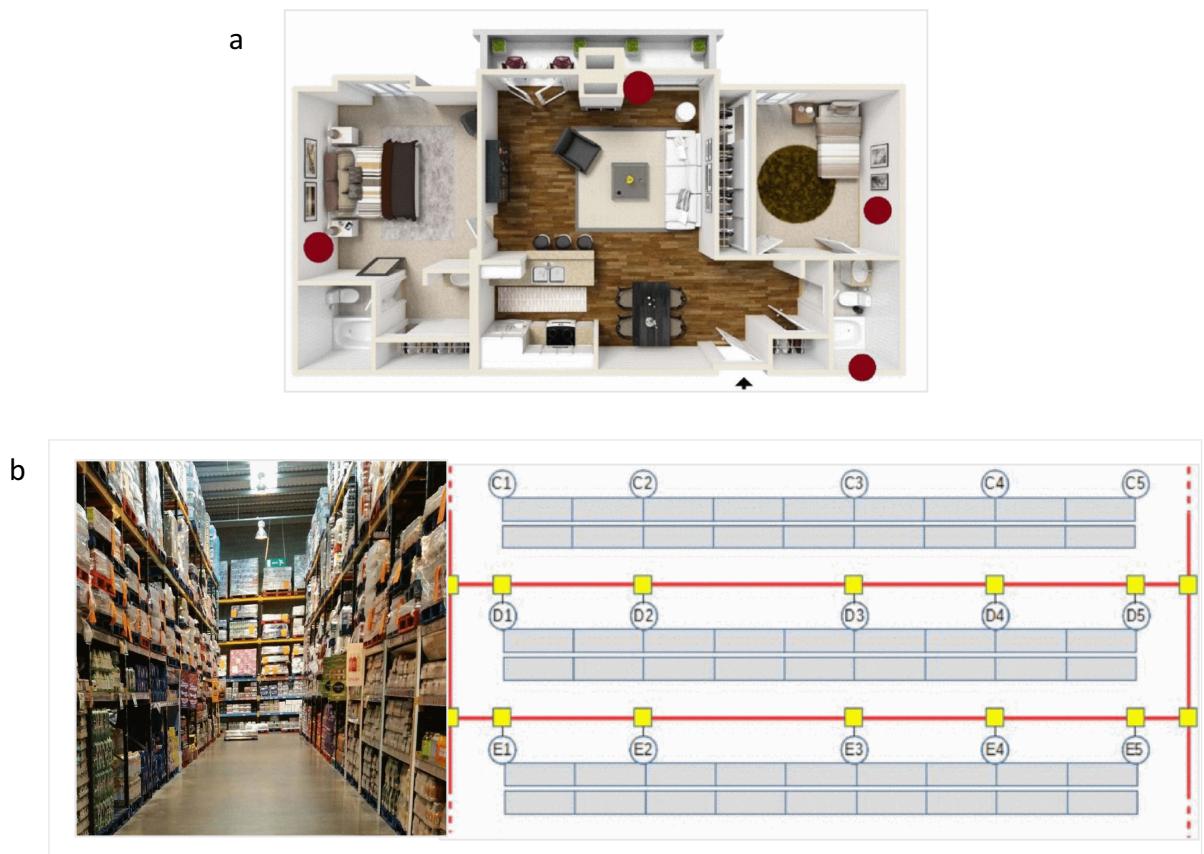
Figure Apex B.6.(a) The Positioning of Users on Floor Plans Inside Properties and Stores (Bouchard et al., 2016); (b) Positioning of Customers Inside Wholesalers (Dickinson et al., 2016).

The touch screen era allowed for more control over apps, better displays and special markets for apps that serve as a development platform; its predecessors were the smartphone era, the WAP era and the very first era with limited data services to the phone (Tracy, 2012). The next era is suggested as one that will combine the use of a family of interactions and sensors to enrich the input experience of smartphones beyond the touch screens (Zhang et al., 2016).

One of the improvements in mobile technologies is the computing power of mobile devices with steady increases in CPU, RAM [Figure Apex B.7], graphics cards and other parts of the device. Smartphones have multiple microprocessor cores and gigabyte RAMs (Specout, 2017); they are capable of processing more computation power than the personal computers of a few years ago (Wu et al., 2013).

Mobile phones' additional value-added services and products can be clustered into the following categories: additional communication features such as text messaging, e-mail and video conferencing; additional computing features including business productivity, games, commercial content, for example, news, information services, movies, music, ringtones and other professionally generated content; user-generated content such as photo sharing, video sharing, blogging, wikis and social networking, and E-commerce, conducting transactions online (West & Mace, 2010).
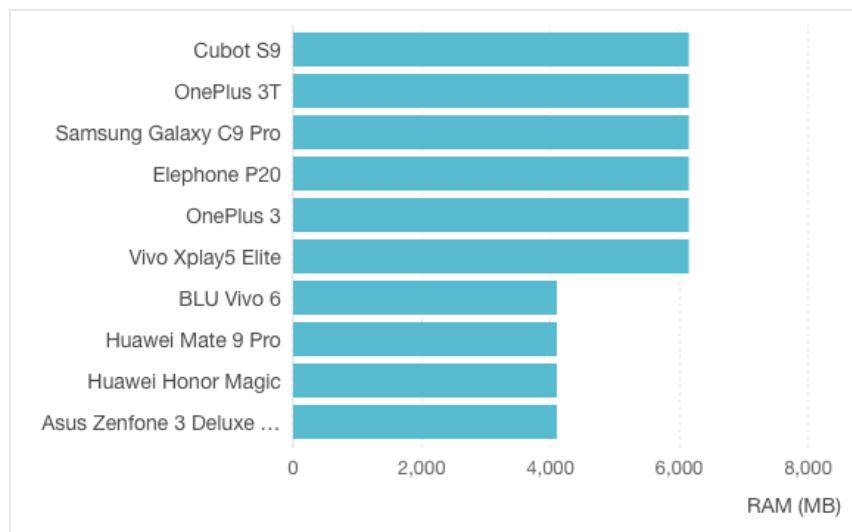
Figure Apex B.7. RAM Capacity in Current Latest Smartphones (Specout, 2017).

- **Apex B.9: Mobile Operating Systems and Apps**

The new mobile ecosystem has changed the way mobile applications are produced, distributed and consumed. The major mobile app stores in particular, for example, the Apple App Store or Google Android Market, have around two million applications, with billions in revenue (Statista, 2016). Mobile apps are popular due to pervasive high-speed data networks, relatively cheap, high-performing devices, the introduction of easy-to-use marketplaces, support for third-party mobile app development and the need for simple, targeted applications while mobile (Tracy, 2012).

Mobile app stores are usually operated by the device manufacturer or by the operating system provider. They are accessible via the Internet and the distribution of the actual mobile apps takes place via a preinstalled application on the mobile device. Additionally, third party developers are provided with an SDK and developers are allowed to offer free and paid applications from which the app store provider deducts its share of the revenue (Giessmann et al., 2012).

- **Apex B.10: Mobile Related Trends**

Other technological advances are impacted by mobile and vice versa. In this section, four trending technologies are briefly discussed in their relation to mobile. These relevant technologies are cloud computing, the Internet of Things, Big Data and social networks, which are often combined to enhance each other's experience, expand the scope and maximise value, such as the solution architecture shown in Figure Apex B.8.
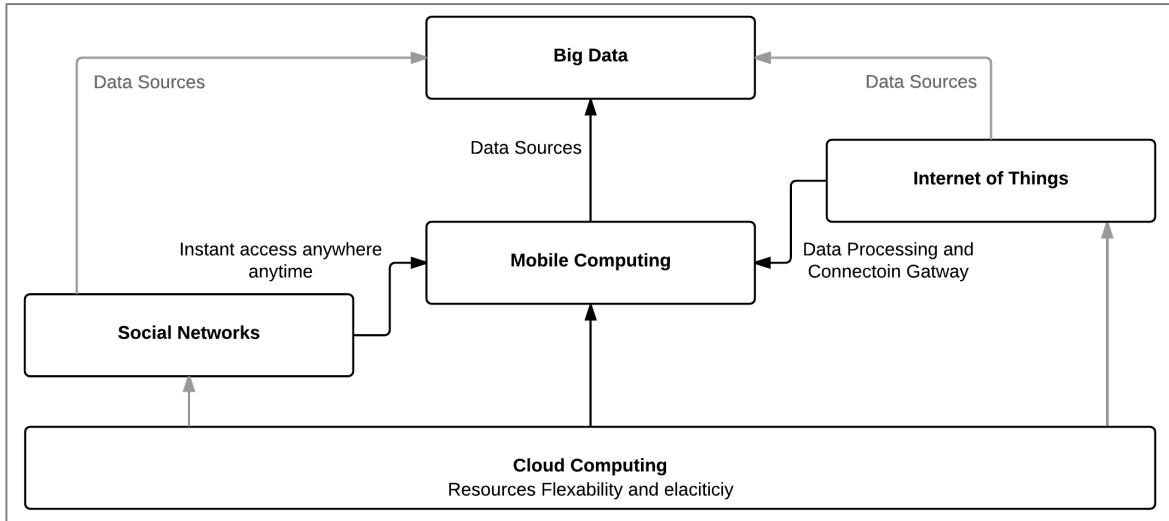
Figure Apex B.8. Mobile Solutions Impact on Other Trending Technologies (Zhong et al., 2015).

- **Apex B.10.1: Cloud Computing**

Cloud can be defined as "an information technology service model where computing services (both hardware and software) are delivered on-demand to customers over a network in a self-service fashion, independent of device and location. The resources required to provide the requisite quality-of-service levels are shared, dynamically scalable, rapidly provisioned, virtualized and released with minimal service provider interaction" (Marston et al., 2011). Cloud capabilities integrated with mobile devices offer the opportunity to extend rich content to mobile devices and media to be accessed from anywhere, on any device, platform or network (Sarddar & Bose, 2014).

Utility computing is used where storage or other utilities can be provided, and a commercial service platform is employed where SAAS and MSP are mixed and pitched (Wu et al., 2013). Mobile cloud computing, 'MCC', is the exploitation of cloud computing by mobile handhelds. It is a state-of-the-art computing paradigm comprising three domains: mobile computing, cloud computing and networking (Abolfazli et al., 2012). A properly designed cloud can offload the computation and other tasks involved in a mobile application and reduce battery consumption at the mobile devices (Wu et al., 2013).

Sanaei et al. discussed the use of cloud computing technology in MCC and argue that MCC has multiple visions: 'computing augmentation, storage extension, cost reduction, battery conservation, and data safety enhancement' (Sanaei et al., 2012). MCC refers to mobile cloud applications moving the computing power and data storage outside mobile phones and into the cloud, which brings applications and mobile computing to smartphone users and a much broader range of mobile subscriber (Dinh & Lee, 2011). However, many applications are still unsuitable for smartphones due to constraints such as less processing power, limited memory, unpredictable network connectivity and limited battery life (Khan et al., 2013). Many of these constraints exist despite rapid improvements in smartphones (Al-Turjman et al., 2016). Applications do not have the resources to run antivirus or malware detectors in real time while handling other smartphone functions without a degradation in performance and response time, which may require an image of the mobile device software to be sent to the cloud-based server so the image can be scanned (Mastrianni, 2013).

The use of cloud for mobile has increased the trust in mobile applications by giving users access to cloud features such as elasticity of resources, reliability, robustness and stability, security and privacy (Sanaei et al., 2012). This has supported the realisation of ubiquity and increased the power efficiency of mobile devices through services including remote execution, distributed resources to end-users and enabling them to access services and data at anytime, anywhere and with energy trading-off execution quality with energy conservation (Sanaei et al., 2012).

Mobile enterprise cloud services are driven by shifting the IT budget from capital to operating expenses and enabling staff to work anywhere, regardless of the device (Pakath, 2015). Similar drivers for consumer cloud services have the ability to access media anywhere on any device and platform and on any network (Dey, 2012).

- **Apex B.10.2: Internet of Things**

In 1966, the German scientist Karl Steinbuch indicated that 'in a few decades time, computers will be interwoven into almost every industrial product' (Tripathy et al., 2016). This idea of the Internet of Things aims to make computers sense information without human intervention (Atzori et al., 2010). The phrase Internet of Things (IoT) was coined some ten years ago by the

founders of the original MIT Auto-ID Center, with a particular mention to Kevin Ashton in 1992 and David L Brock in 2001 (Guillemin & Friess, 2010).

The IoT European Research Cluster (IERC) conceptual view of the Internet of Things (IoT) is as a dynamic global network infrastructure with self-configuring capabilities based on standard and interoperable communication protocols where physical and virtual things have identities, physical attributes and virtual personalities, use intelligent interfaces and are seamlessly integrated into the information network as depicted in Figure Apex B.9 (IERC, 2014). It is a network of networks with many unique characteristics. It is envisaged that things will be fitted with sensors and be connected to the internet by means of wireless technologies. However, there are different views identifying the IoT (Atzori et al., 2010).
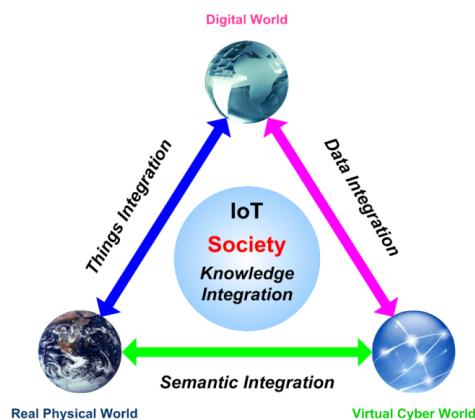
Figure Apex B.9. Digital, Physical and Virtual World in IoT (IERC, 2014).

The ultimate vision is an IoT linking thousands of sensor networks using a convergence of technologies that will allow companies and individuals to keep track of every physical item at every moment while still addressing their privacy and security concerns (Guillemin & Friess, 2010).

In 2011, the number of interconnected devices overtook the number of the entire population, and the number was expected to be double that of the entire population by 2015, and to reach 50 billion devices by 2020 (Evans, 2011). However, growth has been slower than originally expected; the estimates seem generous today as it only reached 4.9 million by 2015, and now is projected to reach over 20 billion by 2020 (Gartner, 2015), or 30 billion by another estimate

(Lucero, 2016). The economic impact of the IoT is predicted to be between US$2.7 to US$6.2 trillion until 2025 (Ip, 2016), (Accenture, 2016).

Since smartphones are connected to the internet through a constantly improving cellular network, in addition to their ability to sense, many applications of the IoT could be deployed using only smartphones connected to the system (Ghose et al., 2012).

Table Apex B.4 Illustrates the resulting information network's promise to create new business models, improve business processes and reduce costs and risks. The benefits and roles of the IoT come under two domains, information and analysis, and automation and control, identifying three benefits under each of them (Manyika et al., 2013).

Table Apex B.4. Classification of the Benefits of IoT (Manyika et al., 2013).

	Benefits	Descriptions	Examples
Information and analysis	Tracking behaviour	Monitoring the behaviour of persons, things or data through space and time	• Presence-based advertising and payments based on locations of consumers • Inventory and supply chain monitoring and management
	Enhanced situational awareness	Achieving real-time awareness of physical environment.	• Sniper detection using direction of sound to locate shooters
	Sensor-driven decision analytics	Assisting human decision making through in-depth analysis and data visualisation	• Oil field site planning with 3D visualisation and simulation • Continuous monitoring of chronic diseases to help doctors determine best treatments
Automation and control	Process optimisation	Automated control of closed (self-contained) systems	• Maximisation of lime kiln throughput via wireless sensors. • Continuous, precise adjustments in manufacturing lines
	Optimised resource consumption	Control of consumption to optimise resource use across network	• Smart meters and energy grids that match loads and generation capacity to lower costs • Data centre management to optimise energy, storage, and processor utilisation
	Complex autonomous systems	Automated control in open environments with great uncertainty	• Collision avoidance systems to sense objects and automatically apply brake • Clean-up of hazardous materials using swarms of robots

Cloud computing opens the door to endless possibilities, such as the building of smart cities where the cloud could combine services offered by multiple stakeholders, and the IoT should be able to inherit the scalability of cloud (Fei Li et al., 2013). Boundaries between cloud and mobile computing are not always clear, even for the service providers (Schubert & Ery, 2012).

- **Apex B.10.3: Big Data**

With an overwhelming amount of web-based, mobile and sensor-generated data arriving at terabyte and even exabyte scale, the Big Data era has impacted both the public and private sectors and new science, discovery and insights can be reaped from highly detailed, contextualised and rich content of relevance to any organisation (Chen & Storey, 2012).

Big Data is increasingly important in business analytics, and Big Data can be generated from mobile technologies using transactions such as emails, images, social networking interactions and common mobile phone applications (Sagiroglu & Sinanc, 2013).

The ubiquity of mobile phones and the increasing volume of generated data from sensors and applications are ushering in a new research domain across computing and social science (Laurila et al., 2013). Big Data is necessary for revenue assurance, risk mitigation, customer lifecycle, market execution, product innovation, business models, operations management and advanced advertising (Gerhardt et al., 2012).

The smartphone is a major resource that has contributed to the increased volume and velocity of data; smartphones have impacted the information types generated as well, such as "Calls, SMS, Photos, Videos, Application Events, Calendar entries, Phonebook Entries, Location Points, Unique Cell Towers, Accelerometer Samples, Bluetooth Observations Unique Bluetooth Devices WLAN Observations, Unique WLAN Access Points, and Audio Samples" (Sagiroglu & Sinanc, 2013).

In the context of this research, data generation can be considered as falling into two categories: human and/or electronic input. People are employing new ways to connect to information sources and with others. In the process, they become data sources themselves in daily growing numbers, although electronic devices are the potentially larger data source (Webster, 2012). On the other hand, data generated by smartphones can be divided into two categories: mobile network operator, 'e.g., caller ID, caller ID, time, duration' and data and

smartphone sensing data which are generated by the phone sensors and applications (Laurila et al., 2013).

Variety, volume and velocity are widely considered to be the characteristics of Big Data although there is a range of definitions (IBM, 2013) (Verma et al., 2015) (Opresnik & Taisch, 2015). Big Data comes from a large variety of data sources that are structured, semi-structured and unstructured. Data are now available in volumes which outstrip traditional storage and analysis techniques. Velocity is also seen as a major factor in Big Data, as shown in Figure Apex B.10 (Sagiroglu & Sinanc, 2013).
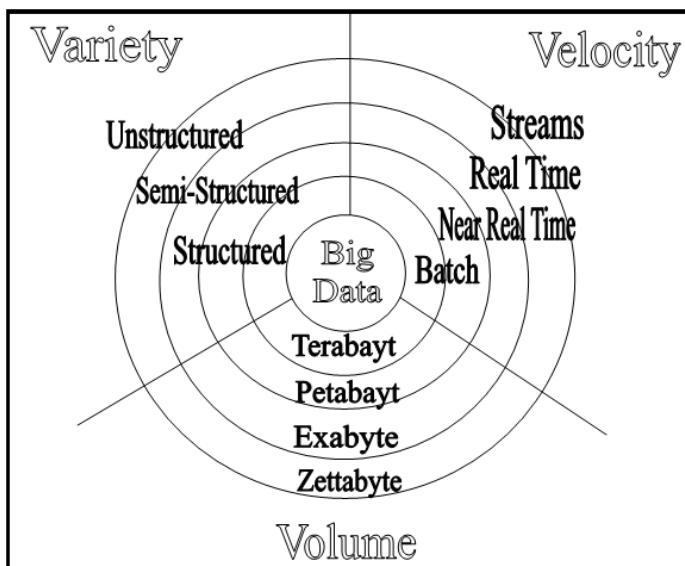
Figure . Description of the Three Main Characteristics of Big Data (Sagiroglu & Sinanc, 2013).

Organisations consider Big Data to be important and Big Data can be impacted greatly and enriched by the capabilities of the smartphones' platform.

- **Apex B.10.4: Social Networks**

A widely-used Big Data source is social network interactions which have been in use since the emersion of Web2. However, there is a trend for using social networks on mobile devices (Rana et al., 2009). An example of value generated by this trend is 'bricks-and-mortar' retailers who are delivering the added value of an internet shopping experience to customers through social network access, via a smartphone or tablet, to be combined with the immediacy of a retail sale with the objective of generating more revenue, profit and deepening customer loyalty (Webster, 2012).

Social networking services for mobile devices should proactively offer advice and recommendations to the users. Changes in user context such as location and activities can be used to provide the user with context-aware services directly relevant to their current situation. For social networking applications, it means that social interaction can be supported on a new level where a recommender system can use the user's current context to improve and simplify a service (Rana et al., 2009).

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Date certified: 1 May 2015
Certification Number: 95705

_____
Steve Nunn, President and CEO, The Open Group

Evaluation

The Objectives are to be used in conjunction with the organisation's objectives.

The functionalities offered by mobile initiatives capabilities defines the desired targets.

The solutions components define the outcomes of mobile initiatives

Process: Transform

Using capabilities outlined in the framework, transforming services individually, link proposed functions to the desired objectives and gather requirements and concerns for each solution category

← Objectives

← Initiatives

← Concerns

Second Objective valuation, and function valuation, allows us to calculate the exact value of each functionality
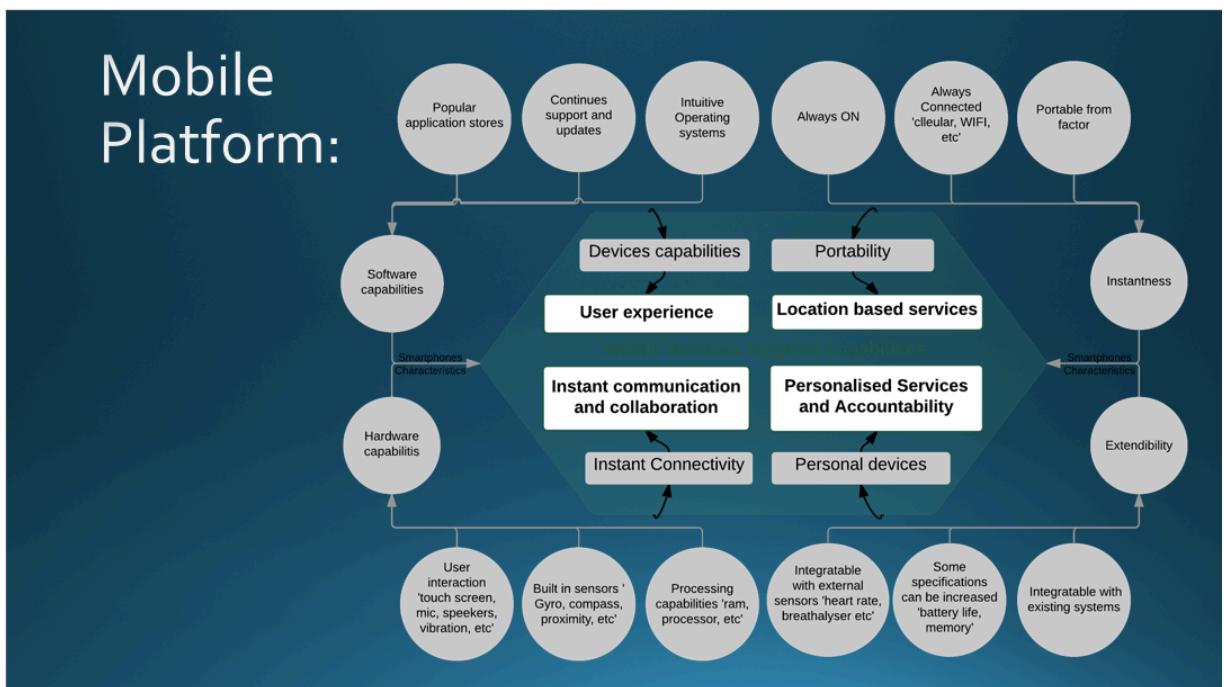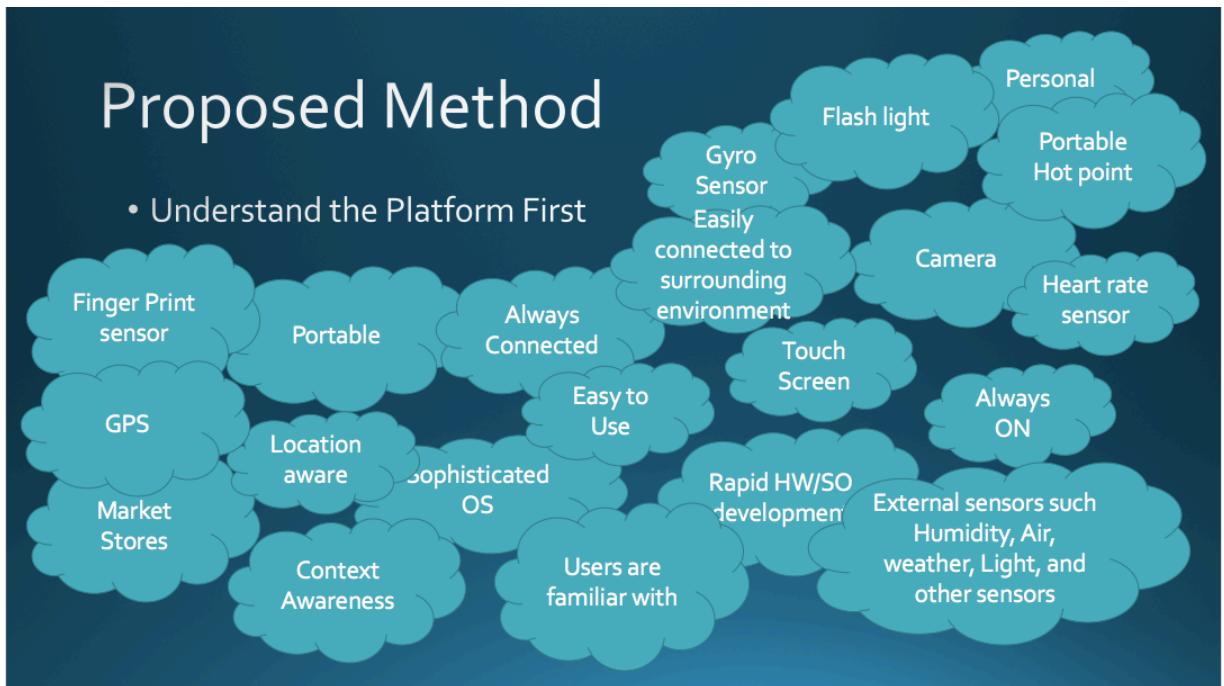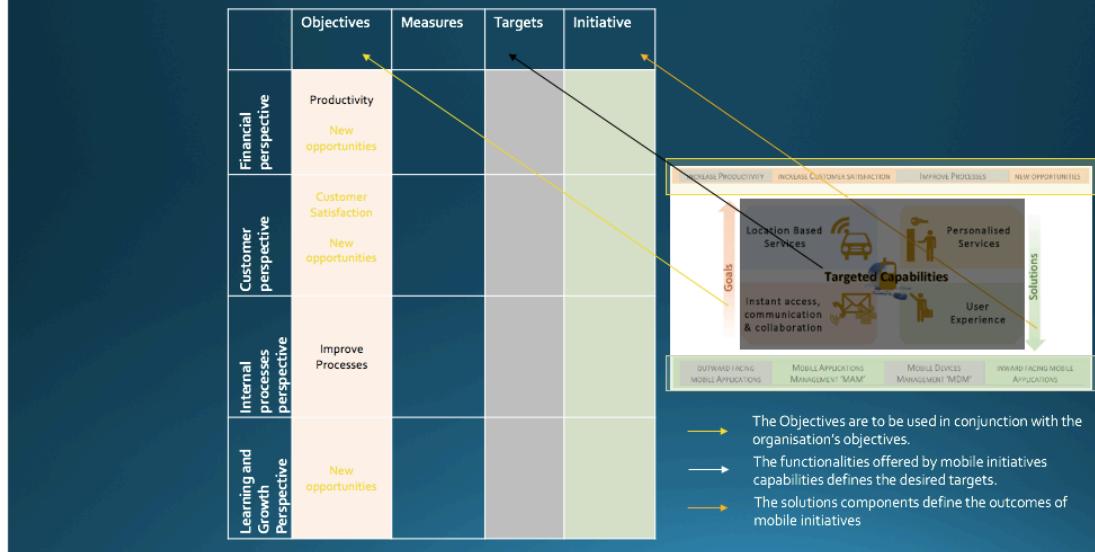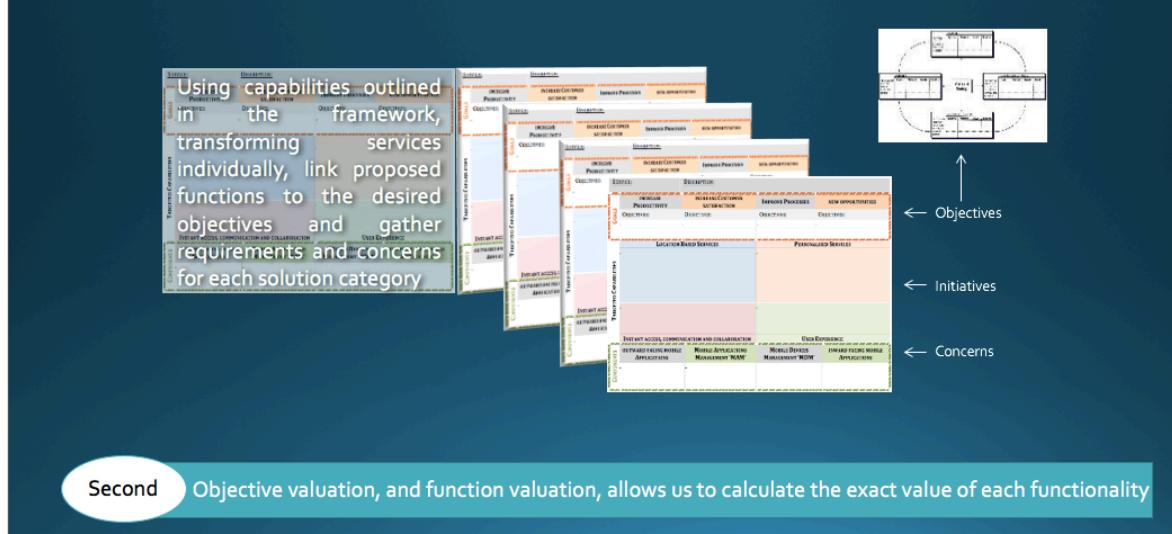
Mobile Maturity Phases

	Mobile Void	Mobile Aware	Mobile Enabled	Mobile Enterprise
Vison	None	None	Partially for some initiative	Enterprise wide vision for mobile services.
Road map	None	None	Partially for some initiative	Enterprise wide roadmap for mobile services.
Polices and standards	None	Some	Developed policies and standards	Enforced polices and standards.
Business Mobile alignment	None	None	Initiatives are mainly in response to business needs, or direct demand for mobile	Mobile Initiatives are creating values for business goals. And anywhere any time principle is enforced enterprise wide
Mobile Enabled processes	None	Ad-hoc	Some process are mobile enabled	Enterprise wide principle for mobile enabled services
Use of lessons learned	None	None	Separate silos of lessons learned	Enterprise wide principle and approach lesson learned recording and consumptions.
Continues assessments for future improvements	None	None	None	Continues exploratory effort improvement and innovation.
Integrated platforms and reusability	None	None	Some reusable products and functions. Simple API integration.	Enterprise wide reusability principle for integrated development and deployment platforms. Might include the use of Backend-as-a-Service solutions.

Appendix E. The Details of the Framework Application to the Case Studies
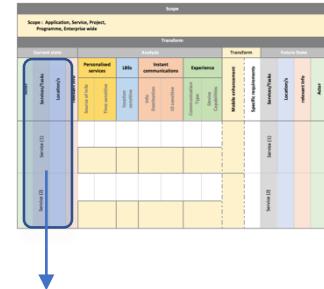
Table Apex E.1. A Breakdown of Business Function

Function number	Actor	Services/Tasks	Location/s	relevant Info
1	Branch staff	receive news	All Branches and Headquarter (HQ)	news that is related to (HQ). and programmes
2	Branch staff	receive Announcements	All Branches and (HQ)	Announcements from (HQ) and programmes
3	Branch staff	submit issues	All Branches and (HQ)	Issues details
4	all staff	Submit Idea	All Branches and (HQ)	ideas from all staff
5	QA Admin	Send News and announcements	All Branches and (HQ)	News and announcements prepared by program managers
6	QA Admin	Process Ideas	(HQ)	Ideas, Owner
7	QA Admin	Post polls	(HQ)	questions and votes
8	Program manager	prepare news// announcements// receive ideas	(HQ)	news and announcements
9	(HQ)	None	(HQ)	None
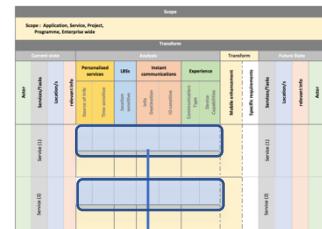
Table Apex E.2. Information Gathered Which are of Relevance to The Framework

Function	Location Based Services	Personalized Services		Instant access, communication and collaboration		Experience	
	location sensitive	Source of Info	Time sensitive	Info Destination	ID sensitive	Communication Type	Devices capabilities
1	none	QA and programme managers and line of management	Instant, scheduled news is sent regularly	All employees	QA and member of staff verification	Text	Basic
2	none	QA/ programme managers and line of management	Instant, scheduled	All employees	QA and member of staff verification	Text	Basic
3	None	details of employees are automatically supplied	None	None	None	text	None
4	None	All Staff	Instant, with date and time tag	QA admin/Ideas Bank	Staffs verification	Text	Basic
5	None	QA and programme managers and line of management	Instant	All staff, specific program or branch	QA and member of staff verification	Text	Basic
6	None	coordinate Ideas	Instant	Admin and Ideas bank through admin	QA and member of staff verification	Text	Basic
7	none	Admin	instant	All employees	all staffs	Text	Basic

Function number	location sensitive	Source of Info	Time sensitive	Info Destination	ID sensitive	Communication Type	Devices capabilities
8	None	Program manager	Instant	program staffs	QA receives emails from Program manager	Text	Basic
9	None	None	None	None	None	None	None

Table Apex E.1. Enhancements with Mobile Capabilities

Function number	Location Based Services	Personalized Services		Instant access, communication and collaboration		Experience	
	location sensitive	Source of Info	Time sensitive	Info Destination	ID sensitive	Communication Type	Devices capabilities
1	news that has location details to allow location grab, and reader navigation through other apps	Branch Staff to report urgent news		and Branch staffs' records of contributions for award and auditing program		Receiving rich media news, provide proper notifications and motivational messages after arrivals and departure	
2	automated announcements to be sent if no staffs are present at a branch between 8-5 or if all are in the branch if all are in the branch by 8:30 etc.	Program managers and branch managers to send instant, scheduled and automated announcements and messages to their own staffs		branch staffs and program staff to receive customised announcements. Read and understood report to be collected, and visible in real time to Stakeholders		announcements related to performance if a branch exceeds targets. contest for snapping pictures of certain characteristics (snap a picture of a college who is not holding his phone now) or snap a picture of how many steps you have walked today etc. Pictures, Audio And Video Materials to be supported.	
3	Include location, and prefill branch name	Branch staffs, Program Manger to submit instantly		submission to reach Program Manager with owner information		Rich media support, Notifications	

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4	allow for location grabbing where a location is of relevance	None	Staffs verification, ideas log for employees to be used for awards or performance measures	Rich media support, notification throughout the life cycle of the idea evaluation process. and allow for drawing
5	awareness messages could be sent to certain locations.	Program manager to send Instant, scheduled and automated news and announcements, could choose to suggest a content to other program managers, admin to process corporate-wide news and announcements	program managers to send news and announcements, read and understood option. The option to collect responses with a certain announcement. setup performance related motivational messages	rich media support, notification, ability to take pictures, audio and video in responses to surveys
6	View location if included	View Ideas and the history log	Admin, program manager, ideas bank and (HQ)	Notification, and support for rich media materials
7	forms can be sent to locations	Program Manager. Admin. automated action can be taken against late recipients.	All employees and specific new to program staffs. responses to be collected by admin and program manager. and allow for actions against inactive recipients. allow for an anonymous collection of responses	Rich media support, notification, location grab, picture, Audio videos to be recorded as responses
8	location grab	Program managers and branch managers and (HQ). And admin can send instant, scheduled and automated news and announcements	Branch managers, program managers, and (HQ) to send customise messages to their respective employees	Rich media support, allow for drawing, and survey question types support
9	None	admin Panel	(HQ) managers and representative	Admin views of current poll, survey, ideas, and issues reported through the mobile app
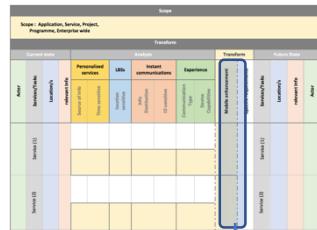
Table Apex E.2. The Vision for Mobile Transformation

Function number	Mobile enhancement	Specific requirements
1	Employees could be targeted with a deferent news that is akin to their respective programs. Employees to suggest news and awareness messages. Grab location if required when suggesting news, and allow the reader to navigate to the location within the text.	
2	branch managers could send messages to their staffs and pictures and video could be used for more personalised motivational messages, performance, contests, messages could be automated. Admin or branch manager could see the progress of messages sent until reports indicates %100 have received and understood it, could choose to resend to those who haven't read or pull their names to try other means of communication. (HQ) to have visibility over all communications.	
3	User to submit suggestions, issues and complaints to program and receive a reply from the program manager.	
4	Ideas to include pictures, audio or video options to ease up illustration. employee to be notified throughout the idea evaluation processes. ideas logs-verdict to be accumulated in case they are been used in an award system.	logins are required, accounts to be linked to staffs account. videos, audio and images should not be shareable through the app.
5	program managers to send news and announcements and suggest them to others. Admin to manage Corp news and announcements. automated news and announcements can be set based on location. rich media content. Add an optional survey option to announcements and news.	

6	Ideas Bank to see ideas, and update status throughout the lifecycle and add verdict.	
7	Admin, Program Mangers can send simple polls, or surveys with popular surveys question types, supported by rich media and locations if needed, the option to make responses anonymous, monitor progress of submissions, option to view list of members who haven't responded and take actions (automated if needed) such as (resend, other means of communications: email, phone etc.). automated data collection should be available where needed, such as current location of a certain group of staffs.	
8	program manager to send news, announcements, surveys and contests. And view ideas, monitor reading reports and act against inactive recipients, Branch Mangers (only) to post to their staff, and suggest the content to others.	emphasis on making employees aware of that, all information transmitted through the app are owned by the company including Ideas.
9	view admin panel, view scheduled contents and automated mail, view surveys poll and the responses reports, view ideas log, process and verdicts, all can be filtered by program or branch.	
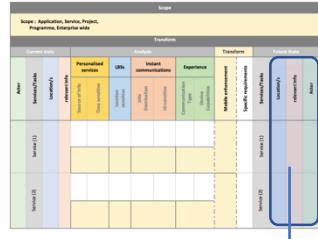
Table Apex E.3 The Future State of The Project

Function number	Business Function	Location/s	relevant Info	Actor
1	receive news. motivational messages. and send prospects materials to be evaluated for distributions	All Branches and (HQ)	news that is related to (HQ). their respective programs and from their branch managers. Motivational messages. Prospect materials.	Branch staff, Branch manager, QA admin, (HQ) and Management line
2	receive announcements and send read and understood report for acknowledgement. receive context that is easily carried out with a phone. receive target performance cheers and boos.	All Branches and (HQ)	announcements related to (HQ). their respective programs and from their branch managers. Info about performance against targets. contest details. staff participation. Staff acknowledgments	Branch staff, Branch manager, QA admin, (HQ) and Management line
3	Submit suggestions, complaints and report issues	All Branches and (HQ)	Complaints, issues, suggestions, responses	Branch staff, Program Manager
4	submit idea	All Branches and (HQ)	ideas from all staff. the process of ideas evaluation. Ideas-verdict log	all staffs
5	Send News and announcements	All Branches and (HQ)	News and announcements prepared by a program manager. surveys and contests	QA Admin and program managers
6	Process Ideas	HQ	Ideas, owner details, process details, and verdicts	QA Admin
7	Post surveys and contests and receive and monitor responses	HQ	text pictures, audio and video questions forms and answers	QA Admin and program managers

8	post news. Post announcement, surveys. And receive responses and ideas	HQ	News, announcements, ideas, surveys and responses. contest and responses automated location grab.	Program manager and Branch Mangers (only post)
9	View admin panel content	HQ	Admin view content	(HQ)

Table Apex E.4. The Technical Functionalities of The Proposed Mobile Solutions

Functional Requirements	User	Recommendations and Requirements	Concerns and Comments
1- Mobile Inward Applications			
The ability to view surveys and poll progress in real time	(HQ) representative		
The Ability to view ideas, issues, reports' progress in real time	(HQ) representative		
The ability to post announcements to their staff, and suggest the content to other branches	Branch Manger	all transactions should be logged and tagged with date and time, and location if requested	
The ability to receive issues, suggestion and complaints, and respond		proper notification is required, with auto-generated info about the owner interactive contact details and branch info	
2- Mobile Outward Application			
The ability to receive news, announcements, contests in the specified time frame, and be notified according to sender requirements	End User	the average time of receiving contents, and total time until the last recipient should be counted	

The ability to receive poll and surveys separately or enclosed to a news post, and be able to respond and attach photos, or take photos or videos	End User	all transactions should be logged and tagged with date and time, and location if requested	
The Ability to submit ideas, and see the status of progress until verdict	End User		
The ability to submit suggestions, issues and complaints to program and receive a reply from the program manager	End User	the lifetime of suggestion, issues and complaints scheduled be counted and displayed to admin, and the average time per in total or per responder	
3- Mobile Application Management			
The ability to view all admin information, a dashboard that contains all communications, all future automated or scheduled communications, the progress of ongoing polls and surveys, and the history, issues, suggestion and complaints log with the responses and the idea logs with status and verdicts. And by able to filter by program and branch	(HQ) representative	Intuitive Dashboards are required to for easier decision making. (HQ) a representative can filter communications by program, branch, a member of staff, and verdict or status, type of communication ()suggestion, complaints etc.)	If a process is created to handle complaints in branches, then the status of complaints should be visible to (HQ) representative, Program Manager, and complaint owner, and when issues are escalated, (HQ) is notified as well.

The ability to view their program information in a dashboard that contains all communications, all future automated or scheduled communications, the progress of ongoing polls and surveys, and the history and the idea log with status and verdicts.	Program Manager	the duration between sending the poll or survey, and receiving the response should be counted, as well as their average, and the time it took until last response is collected. They can filter communications by branch, member of staff, and verdict or status, type of communication (suggestion, complaints etc.)	
The ability to Post news, announcements, polls, surveys, contests, to all employees, a specific program or branch	Admin, (HQ) representative, program manager, Branch Manager	program managers and branch managers can only send to their employees; however, they could suggest the content to other branches, and program manager could choose also to suggest the same content to other programs, suggested content is opened in an editing view for the recovery to edit before agreeing to post. the same goes for the (HQ) Representative for the content suggested by other program managers	
The ability to view reports of opened, read, or read and understood can be requested with all types of posts, and are visible in reading time with option to resend or take action towards inactive recipients	Post Owner, Admin and (HQ) representative	as all transactions display date and time, the average time of content delivery, and the total time until the last user received the content should be counted	
4- Mobile Device Management			

The ability to send the installation link to end users	Admin		No customers or private data to be used in the application, thus, no extra measures of security are requested
The ability to be able to remove applications from user's device, and blacklist from all future interaction	Admin		
The ability to receive on inactive users, with the ability to take action such as emails to remind them of opening the app, withdraw privileges or remove the app.	admin		

Table Apex E.5. The Objectives and Measures of The Mobile

Transformation Explained

Objective	Measure	comments
1- Productivity		
1-1 Ensure employees are all aware of changes in the least possible time	the average time of received confirmation Number of reported issues	All the important assignments will have read and understood feedback, which allows for the average time of receiving the message to be counted automatically
1-2 facilitate for easier decision making though surveying all staff	Decision makers' satisfaction rate	Program managers, and (HQ) representative visibility of branches increased by the app which enables them to make better decision, additionally, they can survey their staff, and harvest their ideas
1-3 improve staff attendance	attendance rate	knowing that physical location is known to the line of management, may incentivize employees to be present more during working hours

1-4 better understanding of the tasks at hand	Number of reported issues	Since all staff are accountable and must officially confirm receiving and understanding new announcements, fewer issues of relevant to new changes are expected.
2- Satisfaction		
2-1 Deepen Relationship with staff	Satisfaction rate Voluntary turnover rate	A slightly enhanced satisfaction rate and turnover rate are expected as employees heard and served better.
2-2 Increase the average tenure	Average Tenure	feeling appreciated, in touch with head quester, heard and your ideas are making a deferent might influence your opinion when wanting to leave
2-3 Increase staff engagement	Number of ideas and suggestion	being able to contribute, suggest or report an issue instantly, and being responded to, could incentivize you to contribute more
3- Improve Processes		
3-1 enhanced communication with branches	Average Time for responses to issues suggestions, and complaints	easier, instant method for 2-way communication between staff and their line of management
3-2 Improved process for ideas capturing, processing and evaluating	Number of ideas per employee Average Duration of Idea life cycle	Intuitive way of ideas capturing, and users now are able to see the status and receive a verdict, enjoying the experience through the app should tempt more staff to contribute
4- New opportunity		
4-1 Increase the number of ideas collected	Number of ideas considered	An intuitive process of submitting ideas, proven ownership of ideas, and been assured ideas are conceded fairly should increase the number and quality of ideas.

Table Apex E.8. The Current State of The Project

Function number	Actor	Services/Tasks	Location/s	relevant Info
1	Visitor	receive assignments	HQ, Branches	Location, Time, checklists
2	Visitor	conduct survey	Branches	Responses
3	Visitor	View previous reports	HQ, Branches	reports and issues from previous assignments
4	Visitor	report issues	Branches	issues, location, owner details
5	Quality Unit	schedule assignments	HQ	time, visitors' details, locations

6	Quality Unit	Manage visitors	HQ	visitors' details, checklists types
7	Quality Unit	Follow up on reported issues	HQ, Branches	issues, location, owner details, resolutions and providers

Table Apex E.6. Information Gathered of Relevance to The Framework

Function number	Location Based Services	Personalized Services		Instant access, communication and collaboration		Experience	
	location sensitive	Source of Info	Time sensitive	Info Destination	ID sensitive	Communication Type	Devices capabilities
1	QA Dept.	instant, assignments are scheduled	anywhere	Unit representative	QA, Unit representative only	Text	Basic smartphone features
2	branch employees, and Visitor	Instant	only at the branch	QA	from assignment owner	Text	Basic smartphone features
3	the mobile app	instant	none	visitor	QA, Unit representative only	text based	basic smartphone features
4	Visitor	instant, after visits, if excel or paper solutions are used	none	QA	Visitor only	text	Basic smartphone features
5	QA Dept.	once a year	HQ	Unit representative	Unit representative	Text	none
6	QA Dept.	instant	None	visitors	Visitors logins details	Text	None
7	QA	Instant	None	Unit representative	email	text	None

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Table Apex E.7. The Framework's Proposed Enhancement for Each Function

Function number	Location Based Services		Personalized Services		Instant access, communication and collaboration		Experience	
	location sensitive		Source of Info	Time sensitive	Info Destination	ID sensitive	Communication Type	Devices capabilities
1	Ability to add to phone calendar, or set up reminder		location to be sent to the user, with the ability to navigate through third party apps		Visitor to acknowledge receiving the request, agree to visit or propose rescheduling		Notifications	
2	Responses are to be filled up, visitor to update		time spent at the branch to be calculated		Program managers to be notified about changes in the chick lists, periodical reports to be generated		issues report to include rich media, ability to record induction sessions in video or audio to confirm staff are aware of measures taken to tackle a reported issue	
3	the application can start with the previous reports info filled up, visitors only document changes		the previous report in the new form can only appear at the branch		QA and unit representative and program manager		the app could support conducting audio or video interview with Branch managers for example, on reporting an issue, or confirming fix, as well as take pictures	
4	Instantly		branch information, or be looked up including branch managers contact details		program managers to be notified instantly about the report		rich media to be supported, and video call can be launched if need with a program manager	
5	Additional assignment to be added at the request of a visitor		HQ and Branches		Unit representative, and program manager to approve visit, and tasks to the visits		assignments to be received on the app, and copied to the calendar	

6	QA Dept., instantly, Visitors could request permissions	Visitor can log in to checklist only at the branch	program manager and QA to view all planned visits table and their process	QA and program manager to be notified about visitor starting the visit
7	QA and Unit representative to be notified about issues fix completion	None	owner program manager, Unit representative	text, and Notifications

Table Apex E.8. Consolidated View of Framework's Proposed Enhancement

Function number	Mobile enhancement	Specific requirements
1	proper notifications are sent using the app, user to acknowledge reception, agree to assignment or propose rescheduling, navigation to the location through third party apps.	
2	program managers are to be notified about new updates in checklists. reports to include rich media. time spent at branches by visitors to be calculated and reported on. periodical reports to be generated to fit in the program performance report.	
3	Previous from information to appear as pre-filled form, where the visitor can make changes. Only changes are reported to Program managers. previous reports are only visible at the branch location. The visitor could carry out video & audio interviews about issues or fixes if needed, as well as take pictures.	
4	program managers are to be notified instantly about new reports, with branch details and person responsible for the branch contact information. the possibility of establishing video calls from app	other video conferencing solution at enterprise might be used.

5	The visitor can suggest visit through the app, and have them approved by the program manager. visitors can receive assignments on the app and save them to the calendar. Additional tasks can be added by the program manager.
6	visitors can only login to the checklist at the branch. program manager and QA to view all planned visits table and their process and be notified about a visitor starting a visit.
7	QA and Unit representative to be notified about issues fix completion.

Table Apex E.9. The Future State of The Project

Function number	Business Function	Location/s	relevant Info	Actor
1	receive assignments, and send agreement or counter proposal	HQ, Branches	Location and coordinates, time, checklists, acknowledgement and agreement or counter proposals	Visitor
2	conduct survey	Branches	Chick lists	Visitor
3	View previous reports	Branches	Chick lists, issues history	visitor
4	Report issues	Branches	rich media Issues, location, owner details, live video chat	visitor
5	schedule and assignment	HQ, Branches	time, visitors' details, locations, program manager, and approvals, additional tasks	Quality unit, Visitor, program manager
6	Manage visitors	HQ, Branches	visit table and progress, visitor information at current visit	Quality unit, program manager
7	Follow up on reported issues	HQ, Branches	issues, location, owner details, resolutions and providers, completion reports	Quality unit, program manager

Table Apex E.10. The Technical Functionalities of The Proposed Mobile Solutions

Functional Requirements	User	Recommendations and Requirements	Concerns and Comments
1- Mobile Inward Applications			
The ability to acknowledge reception of assignment, agree or reschedule	Visitor	Notification of assignment, and notification at QA and program manager of user-proposed rescheduling. Assignment can be saved to calendar app for reminders	
Visit's page to be visible when visitor accept, branch and branch manager information are displayed, and location	visitor	the location is clickable, to launch third-party navigation app.	
once a visitor is in the branch, the checklist become accessible, in addition to the additional tasks, and the rich media issue reporting forms	visitor	Checklist is to be pre-filled with last visit reports, so user could only update changes, and video call can be requested as well. Reporting form could include pictures, audio and video of a situation or an interview. Reports to include a visitor, owner, and solution provider, location time details.	
The ability to request a video call to program manager or unit manager or their representatives	visitor	when requested, the time a visitor is willing to wait for is supplied, after it runs out, a video call cannot be established, if the call was approved, the third party of choice can be opened, and the call is awaited from concerned stakeholder	

The ability to suggest visits if they find themselves around a branch, and receive approvals	Visitor	the visitor can suggest time they could wait for before the request is cancelled in case of no repose	
Program manager to be notified about visitor commissioning a visit changes to check list if any during current visit and reported issues instantly, in addition to approving new visits requests made by visitors	Program manager, or representative		
Program manager to be notified about a request to establish video calls, if accepted, the third application of choice can be launched.	Program manager		
2- Mobile Outward Application			
3- Mobile Application Management			
The ability to see visits history, and including the last update to checklist	program manager, admin		
The ability to add tasks to scheduled and current visits, and be notified when completed	Program manager, admin		current visits include the ones requested by visitors
periodical reports are to be generated, about the progress in visits and checklists, and reported issues with fixes	admin, program manager	reports to be customised and made available to interested parties. Time spent by visitor at every branch to be visible in reports as well	
Notification of issues reported fix	Program manager, admin		
Update reported issues status (fixed / in progress)	Admin, program manager		
4- Mobile Device Management			
Admin to be able to remove applications from Visitors	Admin		

devices, and blacklist from all future interaction				
admin to receive on inactive users, with the ability to take actions such as emails to remind them of opening the app, withdraw privileges or remove the app.	Admin			

Table Apex E.11. The Objectives and Measures of The Mobile Transformation Explained

Objective	Measure	comments
1- Productivity		
1-1 ensure visits are carried out according to schedule	Percentage of conducted visits according to plan	counted automatically
1-2 reduce limitations and issues affecting work progress	Several reported issues of relevance. Average time of fix	besides reducing the number of issues, accountability of all report issues or limitations in the checklist, and progress monitoring by program managers
1-2 facilitate for easier decision making	Decision-makers' satisfaction rate	custom report are generated om progress of visits and issues
1-3 improve staff attendance	attendance rate	enhanced mentoring and obstacles elimination should boost staff moral
2- Satisfaction		
2-1 Deepen Relationship with staff	Satisfaction rate Voluntary turnover rate	Issues are heard, reported and monitored until fixed. regular visits by all managing units are conducted
2-2 Increase the average tenure	Average Tenure	regular, well-managed visits should enhance the working environment constantly
3- Improve Processes		
3-1 Enhanced process of disrupting scheduled visits and acquiring approvals for suggested visits	Average Time between receiving and agree to an assignment. Percentage of conducted visits according to plan	Through the mobile application
3-2 Improve the process of issues reporting and fixing	Number of reported issues Average time of fix	Through the mobile application, and close mentoring from program managers
4- New opportunity		

4-1 enhance visibility over branches	Number of new source of information	new source could include the ones collected by employees at branches, customers, other company's staff in the area in an exchange regular visits between programs etc.
4-2 extend visibly to other interested parties	Number of beneficiaries added	other interested parties could include the government agencies owning the branches

Table Apex E.15. The Current State of The Project

Function number	Actor	Services/Tasks	Location/s	relevant Info
1	Patient, Doctor, clerk	appointment Booking	All	Date, Time, Patent Number, Doctor, Case
2	Patient, Doctor, clerk	appointment Cancelation	All	Date, Time, Patent Number, Doctor, Case
3	Patient, Doctor, Reception	register arrival (expected waiting time, call to doctor room)	At Hospital only	arrival registry, call to room

Table Apex E.16. Information Gathered of Relevance to the Framework

Function number	Location Based Services	Personalized Services		Instant access, communication and collaboration		Experience	
	location sensitive	Source of Info	Time sensitive	Info Destination	ID sensitive	Communication Type	Devices capabilities
1	remotely by the phone	caller	during working hours	clerks	None	phone call	None
2	remotely by the phone	caller	during working hours	clerks	None	phone call	None
3	None	patient	before appointment	Clerks	None	None	None

Table Apex E.17. The Framework's Proposed Enhancement for Each Function

Function number	Location Based Services	Personalized Services		Instant access, communication and collaboration		Experience	
	location sensitive	Source of Info	Time sensitive	Info Destination	ID sensitive	Communication Type	Devices capabilities
1	anywhere, any time booking	interests can be collected, and a user can be notified if the desired slot/doctor is available. And notified with confirmation if a slot is booked.		Patient registration is required once; app is always signed on		doctor could have profiles with rich multimedia content so patent could make informed decisions	
2	anywhere, anytime cancellation	patients can view bookings of their household, and click to cancel. If cancellation is too soon to an appointment, they can be informed of consequences.		the app is always signed on		text-based communication, if prove of a reason of cancellation is required, photos or rich media can be used to enclose evidence	
3	anywhere, any time notification. Location specific notification can be sent if the patient is far from the hospital too soon to the appointment.	information can be texted, or pushed through the notification centre. Notifications are specific to a user, for example, if pre-request tests for follow-up appointments, a user can be reminded before it is too late to get the results before the appointment.		notifications are sent to the registered phones; acknowledgement may be required for important notification (patent has to click on read and understood report)		notifications can be sent with rich media, text messages, email, or even trigger automated phone calls.	

4	location based information can be sent to patent, example if the appointment is in a different building to the one the patient is in.	public awareness messages, information relevant to the case can be sent automatically, however, the doctor may decide to push more custom built information. Other information like change in policies, locations etc.	reading acknowledgement or feedback about the usefulness of pushed information may be required from patients	information can be pushed in rich media; third party app can be launched including maps or browser.
5	none	pre-request tests are added by the doctor, appear to the patient in the upcoming appointments	laboratory is aware of test immediately, and can change the status from immediately to asking the patient to choose a time slot.	reminder notification of tests are sent, with information of what is required from patient part
6	only at the hospital, a patient could register arrival on the app, and see attendance confirmation message	from the main system, information about expected wait can be presented. And the user can be notified on the phone when the doctor calls.	Doctor (or reception) can view a list of upcoming patients, with information about their arrivals	notification can be sent when doctor call, a text message could follow in case of no show for those who registered attendance
7	anywhere, anytime	Doctor could update patients	reading acknowledgement or responses can be collected	Patient and doctor are notified of messages and responses
8	can be requested from anywhere	Patient can view the number of repeats order left, and when they are able to request the next repeat order	repeat request are sent the doctor and pharmacy, along with the patient pick up selected time	the app could make use of third party calendar apps and booked appointments

9	none	A patient is notified of how long will it take to prepare medicine, and notified when ready to collect.	none	various methods of notifications can be used orderly

Table Apex E.18: Consolidated View of Framework's Proposed Enhancement

Function number	Mobile enhancement	Specific requirements
1	Users can view doctors' profiles to make an informed decision, book, register interest from anywhere at any time, and they can be notified if their interests are available and if they are bookings are confirmed. Patient register once, and the app is always signed on.	
2	cancellation from anywhere, anytime, appointments are listed for all household, and cancellation is possible with one click, the patient can be informed of consequences if cancelled too soon to an appointment. And evidence of reason of cancellation can be collected in rich media format if needed.	
3	customised notification can be sent anytime to patients, through OS push notification capabilities, text, email or even automated phone calls. Acknowledgement reports can be collected and used to employ another means of delivering the notification to a patient. User location and scheduled testing and appointment can be used for notification and reminders.	
4	rich media information can be pushed public awareness messages, information relevant to the case can be sent automatically, however, the doctor may decide to push more custom built information. Other information like change in policies, locations etc. additionally location based information can be sent to patent, example if an appointment is in a different building to the one the patient is in.	
5	pre-request tests are added by the doctor, appear to the patient in the upcoming appointments, if not marked as immediately, the user has to book a slot for the test, and reminders are sent accordingly with information detailing what is required from the patient before the test.	

6	only at the hospital, a patient could register arrival on the app, and see attendance confirmation message, and from the main system, information about expected wait can be presented. And the user can be notified on the phone when a doctor calls. Doctor (or reception) can view a list of upcoming patients, with information about their arrivals and notifications and messages can be used to ensure the patient aware of the doctor calling them to the room.	
7	doctors can send messages to patients and receive a response, immediately with notifications	
8	from anywhere, a patient can request a repeat order based on repeat information presented in the app, including the number of repeat and time of next repeat availability, currently booked appointments and pharmacy pickups for a household. Slots for pick up are displayed for a patient to select.	
9	Patient is notified of the waiting time at the pharmacy, wand when to come for collection	

Table Apex E.19. The Future State of The Project

Function number	Business Function	Location/s	relevant Info	Actor
1	Booking and confirmation	All	Date, Time, Patent Number, Doctor, Case	Patient, Doctor, Booking SYS
2	Booking Cancelation	All	Date, Time, Patent Number, Doctor, Case	Patient, Doctor, Booking SYS
3	Reminders and notifications	All	appointments, pre-request tests, arrival, call to the room, booking slots availability, confirmations and cancellations.	Patient, Doctor, Booking SYS, Pharmacy, Laboratory
4	Pushing relevant information	All	awareness information relevant to the case, general information	The patent, Doctor, (public awareness?)
5	pre-request tests	All	pre-request tests	Patient, Doctor, Laboratory

6	register arrival (expected waiting time, call to doctor room)	Only at Hospital	arrival registry, call to room	Patient, Doctor, Reception
7	Push Messages	All	Doctor messages	Patient, Doctor
8	Auto-repeat	All	repeat information	Patient, Doctor, pharmacy
9	pre-prepare prescriptions	Only at Hospital	prescription information	Patient, Doctor, pharmacy

Table Apex E.20. The Technical Functionalities of The Proposed Mobile Solutions

Functional Requirements	User	Recommendations and Requirements	Concerns and Comments
1- Mobile Inward Applications			
2- Mobile Outward Application			
The ability to view doctors' profiles to make informed decisions	Patient		
The ability to view all bookings, of the household at any time	Patient		
The ability to view all the pre-requisite lab test for each appointment	Patient	if tests are not marked as immediate, the user must book a slot for the test, and reminders are sent accordingly with information detailing what is required from the patient before the test (such as fasting).	
The ability to book appointment instantly/ or with short wait of doctor approval and be notified of confirmation	Patient	patients register, and signed in once until sign out again	
The ability to register interest interests in booked slots, and be notified when available again	Patient		
The ability to cancel appointments instantly/ or with	Patient	appointments are listed for all household, and	"too soon", is defined by the

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short confirmation response that includes consequence.		cancellation is possible with one click, consequences are displayed to a patient if cancelled too soon to the appointment, and the patient can accept and cancel or not cancel	hospital. And evidence of reason of cancellation can be collected in rich media format if needed.
The ability to receive custom built information of relevance to the patient prepared to be sent to the doctor	Patient		
The ability to register arrival on the app, and see attendance confirmation message	Patient	only at the hospital, and information about expected wait can be presented.	
The ability to receive mobile notification when name is called to doctor room, on various mean sequentially	Patient		
The ability to receive and reply to direct messages from hospital or doctors	Patient		
The ability to view waiting time at the pharmacy and when should the patient expect it to be ready for collection	Patient		
The ability to request a repeat order based on repeat information presented in the app, including the number of repeat and time of next repeat availability.		current booked appointments and pharmacy collections for the household are presented as well. Slots for pick up are displayed for the patient to select.	
The ability to view doctors' profiles to make informed decisions	Patient		
The ability to view all bookings, of the household at any time	Patient		
The ability to view all the pre-requisite lab test for each appointment	Patient	if tests are not marked as immediate, the user has to book a slot for the test, and reminders are sent accordingly with	

			information detailing what is required from the patient before the test (such as fasting).	
3- Mobile Application Management			
the ability to send customised notification at any time to patents, through OS push notification capabilities, text, email or even automated phone calls sequentially.	Admin		the ability to send customised notification at any time to patents, through OS push notification capabilities, text, email or even automated phone calls sequentially.
The ability to receive and report on the readings Acknowledgement	Admin		The ability to receive and report on the readings Acknowledgement
The ability to get and use User's location and scheduled testing and appointment for notification and reminders.	Admin	if the location is far from the hospital too soon to the appointment for example	The ability to get and use User's location and scheduled testing and appointment for notification and reminders.
The ability to push rich media information and public awareness messages, or information relevant to the case automatically	Admin	Other information like change in policies, locations etc.	The ability to push rich media information and public awareness messages, or information relevant to the case automatically
The ability to view a list of doctors, and their patients' lists, with information about their arrivals, or delay	Admin and doctor		The ability to view a list of doctors, and their patients' lists, with information about their arrivals, or delay
The ability to send direct messages to patients and receive response, immediately with notifications	Admin and doctor		The ability to send direct messages to patients and receive response, immediately with notifications

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4- Mobile Device Management			
The ability to verify user registration with back-end system	Admin		
The ability to receive on inactive users, with the ability to take actions such as emails to remind them of opening the app, or withdraw privileges.	admin		

Table Apex E.21. The Objectives and Measures of The Mobile Transformation Explained

Objective	Measure	comments
1- Productivity		
1-1 Reduces waiting time at main reception	average waiting time at the reception	with more patients using their phones to register the arrival
1-2 Reduces waiting time at the pharmacy	average waiting time at the pharmacy	patients are arriving on time, and placing the request for medicine preparation remotely
1-3 Increase utilisation of Doctors' shifts	the average time of doctor's waiting for next patients to show up	enhanced calling system, with more accurate arrival registration system
1-4 Increase patient awareness of hospital rules and changes	number of complaint due the lack of prior knowledge of hospital rules	better knowledge dissemination system with acknowledgement of patient read
1-5 Increase patients' awareness of their conditions	percentage of patients reading the disseminated materials relating to their cases	better knowledge dissemination system with acknowledgement of patient read
2- Satisfaction		
2-1 Increase patients satisfaction	Patient survey	due to enhanced services
2-2 Increase Doctors satisfaction	doctors survey	due to enhanced services
2-3 Reduce patient frustration due the complications caused by lack of knowledge	number of complaints caused by patients and doctors lack of prior knowledge of rules of changes	better knowledge dissemination system with acknowledgement of patient read
3- Improve Processes		

3-1 Improve the appointments booking process	average time to book an appointment	due to enhanced booking services
3-2 Improve the process of issues reporting and fixing	average time to cancel	slots are available instantly to new patients
4- New opportunity		
4-1 establish the mobile capability within the enterprise for mobile health application	number of executives backing the mobile health initiative	based on the success of current imitative

Appendix F. Evaluation Results

Table Apex F.1. The Link Between the Questions and proposed benefits.

	proposed benefits:	Questions numbers	evaluation	overall
1	**Enhance perception of mobile services:** the ability to view the capabilities of mobile services and objectives enhances the perception of mobile services.	Q7 Q15 Q16 Q17 Q23 Q25	4.812 4.875 4.75 4.437 4.625 4.5	4.666
2	**Keeps Focus on targets:** the ability to visualise the future state make it clearer to decide on what matters to the end results throughout the implementation phase.	Q6 Q16 Q17 Q18 Q19 Q21 Q26 Q28 Q29 Q31 Q33 Q35	4.75 4.75 4.437 4.562 4.5 4.562 4.5 4.625 4.687 4.5 4.812 4.562	4.604
3	**Executives buy-in:** the ability to visualise the mobile services and articulate the values quantifiably, make it easier to communicate to business decision makers and developers, and have a unified vision.	Q8 Q14 Q16 Q20 Q31 Q40	4.562 4.375 4.75 4.437 4.5 4.5	4.521
4	**Implement an objective oriented transition:** which facilitate for better decision making and prioritisation during the transformation project.	Q10 Q16 Q17 Q18 Q19 Q21 Q25 Q26 Q27 Q28 Q41	4.75 4.75 4.437 4.562 4.5 4.562 4.5 4.5 4.75 4.625 4.687	4.602
5	**Understanding the concept of mobility trend:** the ability to view mobile capabilities, business	Q14 Q15 Q23	4.375 4.875 4.625	4.594

		Q25	4.5	
	capabilities and the expected results in a single model makes it easier for technical and non-technical people to comprehend the latest trend of mobile services.			
6	**Increase the satisfaction of projects owner:** Documenting concerns, recommendations at an early stage facilitates for better planning and more accurate pricing, since the transformation projects have to respond to these concerns and recommendations, and not move on to later stages until they are tackled.	Q11 Q12 Q13 Q14 Q20 Q31	4.812 4.375 4.562 4.375 4.437 4.5	4.510
7	**Interoperable with existing framework:** the framework was developed on the basic concepts of the enterprise architecture frameworks "EAFs" which is mapping current and future stages, and manage the transformation as a project. Therefore, other components of the different EAFs can be incorporated into the process and example of TOGAF interoperability will be presented in later chapter.	Q37 Q38	4.437 4.625	4.531
8	**Clearer assessment of mobile investment:** Mapping current and new future state and the gap between them allow for a simple ROI calculation and decision to be made on whether the transformation is urgent.	Q16 Q18 Q34 Q35 Q39 Q40	4.75 4.562 4.5 4.562 4.5 4.5	4.562
9	**Reduce cost and time** of mobile transformation planning through one Holistic and simple approach.	Q14 Q18 Q24 Q28 Q29 Q31 Q32 Q33 Q34 Q35	4.375 4.562 4.562 4.625 4.687 4.5 4.75 4.812 4.5 4.562	4.602

		Q41	4.687	
10	**Successful implementations:** Understanding underlying concerns and issues of mobile transformation, reduces risks and increases the chances of successful transformation.	Q12 Q13 Q14 Q18 Q19 Q21 Q22 Q24 Q26 Q28 Q29 Q30 Q31 Q36	4.375 4.562 4.375 4.562 4.5 4.562 4.5 4.562 4.5 4.625 4.687 4.687 4.5 4.625	4.545
11	**Unified language for mobile project:** framework allows developer to understand the business result of the transformation, and the business to understand the implementation process and the parts of concern to them.	Q9 Q11 Q14 Q35 Q36	4.437 4.812 4.375 4.562 4.625	4.562