Current Trends in Technology and Science
ISSN: 2279- 0535. Volume: 3, Issue: 3(Apr-May 2014)

Mobile Application Development Framework: Exploring and Discussion

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Abstract —Mobile computing technology allows people to access data and information from where ever they are through a variety of devices. Mobile devices are now able to operate complicated applications from different sectors/domains that could run only in servers.
Mobile devices are enabling organizations to perform business more effectively. Mobile applications are increasingly becoming a main concern across all business sectors as companies look to extend their services to people that is using smartphones. They can be used to support e-commerce with customers and suppliers, and to conduct e-business within and across organizational boundaries. These trends make it possible to increase business agility, individual productivity and job satisfaction by release people to choose the best time, place and device to get their work done.
In this paper we will introduce the enterprise business applications and how it moved towards mobility. We take a look on mobile applications development and enterprise mobile applications framework and models. In addition, we will investigate about the architecture of enterprise mobile applications and the importance of securing the mobile applications.

Keyword — Mobile applications, Application Development, Development Framework, Enterprise Mobile Applications

1. INTRODUCTION

Whether it is the domain of personal life, professional work or collective society, everyone and everything is dominated by Mobile technology; it has crept in our lives in the form of computers, cell phones, desktops, laptops, notebook computers, palmtops, PDAs, GPS, smart phones, pagers and many more. In the fast paced world of today, enterprises cannot compete without mobile technology; applications specifically developed for enterprises are largely being used for ease of communication, real-time data and information access, better responsiveness and low costs.

Some of the major advantages of using enterprise mobile application development framework are enhancement in productivity, cost cuts, make earnings, shorter development cycles and problem solving among others [1]. However, not all enterprise mobile applications are equally beneficial; it is important to target the right application development to yield maximum benefit in the form of high pay off.

One way of enhancing the application experience of enterprise employees is to allow the trend of Bring Your Own Device (BYOD) where the employees receive a set budget and have to manage their own device within it; organization can provide them with their preferred applications for specific functions, but every person can use specialized applications based on their needs [2]. The diversity that comes with this trend is hard to manage and so are the security concerns that arise. This trend is also commonly known as employee-liable devices [3]. As the variety of applications for each instance of business operation is multiplying manifold, it is hard to assess the mobile applications that are being supported on company's expense. Also if the organization decides to offer its licensed applications to its employees, how will they manage installing the same application on diverse devices?

If the same development platform is used, it will be easier to share data among applications and devices [3]. The demand curve for enterprise mobility is moving with the pull trend because the end users have realized the great utility of these applications and are asking for more convenience [4].

2. ENTERPRISE BUSINESS APPLICATIONS

Enterprises are largely using software applications to make their routine tasks easier. Developers have also targeted this niche area and developed software applications that are specific to business users. In the past, the IT developers used to create applications and when people found them useful, the applications gained popularity. The trend has changed tremendously now; today, the demand is being 'pulled' from the consumer end and they are asking for applications related to specific functions.

Enterprise business application can be understood as computer program(s) or computer software(s) that intend to

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perform specific functions for an organization. This is similar to the concept where an application is built to perform a function or a set of functions for an individual; enterprise applications fulfill the requirements of a whole organization.

Since the early days of application development, enterprises have recognized the usefulness of developing applications to serve their business functions to improve daily business operations and keep track of everyday business transaction. Since then, business applications have been widely designed and used in various business domains such as finance, accounting, inventory, human resources and many more.

3.1 BUSINESS FUNCTIONS

The domain covered by Enterprise Mobile Applications has broadened a lot; today they cover every imaginable aspect of business operations. Business functions performed by these applications can be broadly classified into two categories: core businesses and support businesses. Figure 1.1 depicts some important functions in both categories.

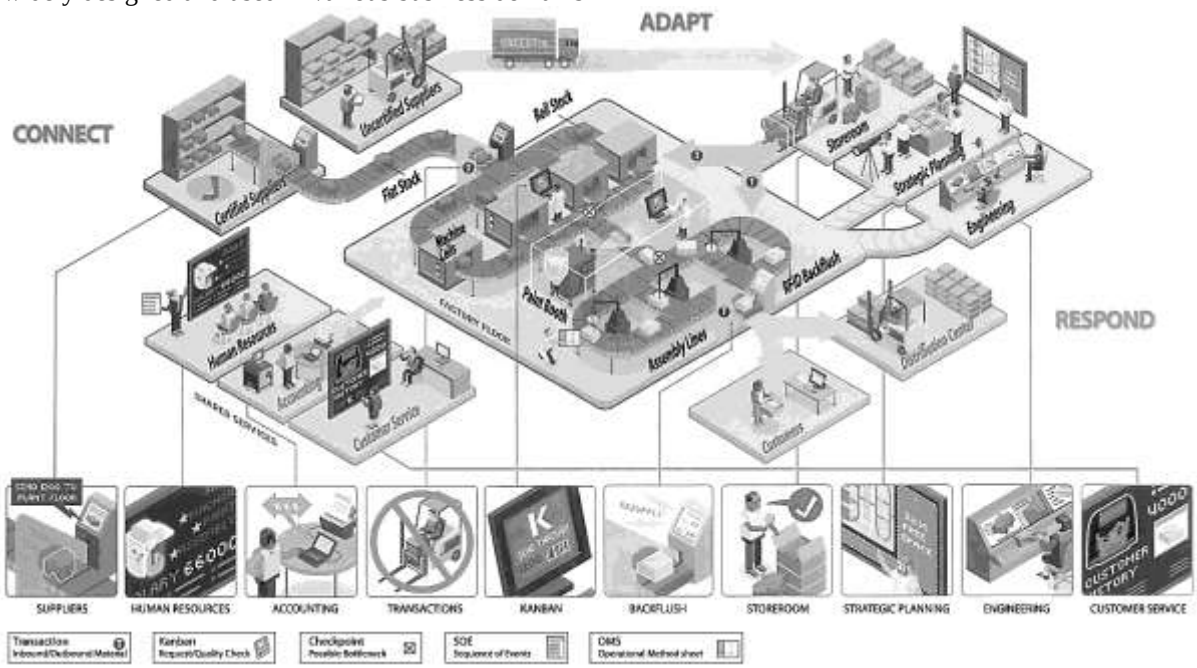

Fig. 1. The interaction among core and support business functions within an organization

3.1.1 Core Business Functions

Core business functions are the ones that are related to the central function that is performed by an organization. Enterprises pay special attention to procure applications to aid their main functions. Core business function applications can include but are not limited to Research and Development, Business Intelligence, Supply Chain Management, Strategic Planning, Marketing, Inventory Management, Customer Relationship Management and Assembly Line.

3.1.2 Support Business Functions

Support business functions are the routine functions performed in an organization that keep it working. Generic application can be procured for support functions as they are easily available in the market. Example of support business function applications include Human Resource Management, Accounting, Billing System/Finance, Communication, Payroll Processing, Enterprise Resource Planning, Payment Processing, Security, Project Management and many more.

3.1.3 Mobile Applications Development

Mobile Applications denote the use of softwares that can be used from any place, at any time, using any device. This gives complete independence in terms of time, location and device constraints. Integrated Development Environments (IDEs) are largely being used to write mobile applications for generic and specific purposes.

The trend for mobile application development has spread so vastly that today everyone is using applications for everything from health to sports, from education to games; every imaginable domain in layman's life is making use of mobile apps. Smart devices have reached everyone's hands; yesterday it seemed like a luxury, today it is a necessity. The mobile internet usage has brought forward the trend of connectivity on-the-go. The applications are becoming more useful because the user gets to use them anywhere andeverywhere[5]. Mobile applications are in

great demand because they provide an extra edge in the form of rich user experience.

Today, the competition between the mobile application developers has increased so tremendously that majority of developers are floating their application for free to gain user acceptance; very few developers opt for paid apps; yet others go for free trials, free limited versions, advertisements in applications and other models to generate revenue from their apps. The market share is not yet captured by huge companies, so pull demand is being catered by independent developers.

Table (1)Classification of Mobile applications

	Intended Use	**Application Data**	**Dependency**
Native Applications (Examples:	Single hand-held device	On the device	Device OS and environment
Web Applications	Single hand-held device	On remote server	Internet Connection
Hybrid Application	Generic devices	Local and remote	Partial dependency on both

4.1 FRAMEWORK

The rationale behind implementation of a mobile application development platform is that there should be a common ground for development so that scalability, sharing and transfer of data become easier; it also makes management of devices and applications much easier. There is no standard definition for an ideal framework because it varies according to the scope and needs of an enterprise.

Mobile Application Development is the process which is used to develop application software for handheld devices like Personal Digital Assistants (PDAs) or mobile phone. These applications are usually developed using mobile application development frameworks that are targeted towards development of applications ranging from responsive websites to Mobile Web Applications, Native Applications and Hybrid Applications.

The suitability of a development framework can be judged by the development language (such as PHP, Java, Ruby on Rails, Action Script, C#, Lua, HTML, CSS, Java Script, C++ etc) it supports, hardware features (such as Accelerometer, Camera, Capture, Compass, Connection, Contacts, Device, Native Events, File, Geolocation, Notification, Storage, Gestures & Multitouch, Messages & Telephone, Bluetooth, Near Field Communication and Vibration) it enables the developer to interact with,and required user interface capabilities (such as Responsiveness, UI Widgets and Accessibility). Availability of additional features (like SDK, Encryption and Advertisement) along with licensing options (e.g. Free, Open Source) also influences the selection of a mobile application development framework.

A number of mobile application development frameworks are in wide-spread use these days. They are judged on suitability criterion like platform, potential users, available languages, supported hardware features, user interface, encryption and licensing. The table shows a comparison of different mobile frameworks for a thorough analysis.

Table (2)Comparison Chart for Mobile Application Development Frameworks

Framework	**Platform**	**Target**	**Language**	**Hardware feature**	**User interface**	**Encryption**	**License**
Apache Flex[6]	iOS, Android, Blackberry	Mobile websites, Web Apps, Native Apps, Hybrid Apps	Action Script, C++	Accelerometer, Camera, Capture, Compass, Connection, Device, Native Events, File, Geo Location, Storage, Gestures &Multitouch, Messages & Telephone	Corporate Design, Widgets, Accessibility	Yes	Free, Open Source
Application Craft[7]	iOS, Android, Windows Mobile, Windows Phone, Blackberry, Symbian, Meego, WebOS	Mobile Website, Web App, Hybrid App	HTML, CSS, JS	Hardware features are supported via plug ins	Corporate Design, Widgets, Accessibility	No	Free
Chocolat	iOS,	Mobile Website,	HTML,	Gestures &Multitouch	Accessibility	No	Free,

Framework	Platform	Target	Language	Hardware feature	User interface	Encryption	License
e Chip – UI[8]	Android, Windows Phone	Web App, Hybrid App	CSS, JS				Open Source
DHTMLX Touch[9]	iOS, Android, BlackBerry	Mobile Website, Web App	HTML, CSS, JS	Storage	Corporate Design, Widgets	No	Free, Open Source
iWebKit [10]	iOS	Mobile Website, Web App	HTML, CSS, JS	Accelerometer, Device, Geolocation, Storage, Gestures &Multitouch, Messages & Telephone	Corporate Design is partially supports	No	Partially Free, Open Source
Mono for Android[11]	Android	Native App, Hybrid App	Java, C#	Accelerometer, Camera, Capture, Compass, Connection, Contacts, Device, Native Events, File, Geo Location, Notification, Storage, Gestures &Multitouch, Messages & Telephone, Bluetooth, NFC, Vibration	Corporate Design, Widgets, Accessibility	Yes	-
MonoTouch[12]	iOS	Native App, Hybrid App	C#	Accelerometer, Camera, Capture, Compass, Connection, Contacts, Device, Native Events, File, Geo Location, Notification, Storage, Gestures &Multitouch, Messages & Telephone, Bluetooth, NFC, Vibration	Corporate Design, Widgets, Accessibility	Yes	-
Wink[13]	iOS, Android, Blackberry, Bada	Mobile website, Web App	HTML, CSS, JS	Accelerometer, Geo Location, Storage, Gestures & Multitouch	Corporate Design, Widgets	No	Free, Open Source

4.2 Mobile Application Development Technologies

There are many new technologies that are emerging in the field of Mobile Application Development; but developers like to stick with the few popular ones. Among the widely used technologies, the most favored ones are:

Native applications using iOS, Android, Mac, Windows

Java-script platforms like jQuery Mobile, Sencha Touch, Appcelerator Titanium

Frameworks like PhoneGap, Bootstrap, Meteor, Corona, iPhone, Java

4.3 Limitation and Issues

Application development for mobile devices and enterprises in not a smooth sailing, there are a number of limitations and issues that come its way. Top five of these are discussed below:

- Security

Mobile application can be accessed from anywhere, using any devices; this brings in ease but also introduces security concerns. Not every data is intended for being shared with public. The same is true for enterprise applications that aim at protecting enterprise's data from people outside the enterprise. Most applications used by enterprise users have security features embedded in them. The basic security features of mobile and enterprise applications are password protection and encryption; however, if further security is required, enhanced security applications are also available off the shelf or for customization[14].

- Privacy

Many mobile applications and enterprise applications need user data to perform in the proposed way; the users risk their personal and sensitive information by feeding it in. if proper privacy features are not abided by, the user data may

become available to public at large and hence become prone to misuse. In order to prevent this situation, every application developer should sign the privacy agreement with the user before using it.

- Performance

Another significant issue with applications is their performance decline. The normal trend is that applications perform well when they start working, but as the user load increases, their performance starts declining. Many mobile and enterprise applications do not have the ability to improve their performance as their usage load increases.

- Usability

It is of utmost importance to ensure that the application performs the desired function effectively and efficiently. In real world, there are usability issues with applications as they fail to deliver up to the mark.

- Reliability

In normal circumstances, most applications perform well; but under unforeseen circumstances, the applications fail. Reliability is a considerable issue where the developers fail to assess the scenarios where the application may crash down. As the application is modified to bring new versions, the consistency in certain performance features may also decline, thus damaging its reliability.

1. Enterprise Mobile Applications

Decision makers in today's fast paced world need enterprise applications that are available on the go. Everyone needs to stay connected in order to transfer information in real-time. Enterprise employees may be using different mobile applications to perform their routine and specialized functions, but they need to integrate data for effective and timely decision making. The business need for enterprise mobility is also evident from the fact that if the organizations need to cater to over two hundred million potential customers who are using smart phones and tablets, then they need software solutions that can travel with these people.

The dilemma with enterprise mobile application development is to create such applications that are mobile from the end user's point of view (he or she can carry it and use it from anywhere) and still manageable from the enterprise's point of view (tracked and administered from the business servers). Enterprise applications have moved towards mobility where the application is stored on the remote server or using cloud computing, and the data resides on the user device, thus providing access of use from any location. This enterprise mobility has its own disadvantages but has given a huge leap to the application features.

Enterprise Mobile Applications took a huge leap from an old era where the IT department of any organization had complete hold on the mobile devices that were used and how they were used. As mobility improved in mobile devices, there came the trend of "Bring Your Own Device". Along with many of its benefits, there also came certain drawbacks in the form of security issues, standardization and cost concerns among many others. Tracking these devices is vital but today it is considered as an attack on personal liberty. With this greater independence came a variety of mobile applications that are being used for work functions. Previously only the IT managers approved the applications to be used and purchased them on the behalf of the organization; now everyone can use any additional applications that they deem useful. The competition in every work domain also calls for out-of-box applications that can provide something more than what competitors are doing.

5.1 PLATFORM

In the realm of enterprise wide mobile applications, it is nearly impossible to manage a single platform for business applications. There should be a framework in place that combines diverse work formats from different persons/work teams/departments and yields the results in a single format. It is of critical importance to have a defined layout for the final results. It is best practice to have a single development platform throughout the organization, but an organization can have more than one platforms (on department, geographic basis, may be) if needed.

In 2008, a Mobile Enterprise Application Platform (MEAP) came to surface which aimed at bringing uniformity among the diverse mobile devices and handling varied networks. MEAP was used by companies to develop a multi-purpose mobile application that can later be deployed on multiple devices using the same logic.

There is a variety of platforms that a development framework needs to support for mobile application development such as iOS, Android, Windows Mobile, Windows Phone, Blackberry OS, Symbian, MeeGo, Maemo, WebOS, Bada and JavaME. All the development frameworks do not support all the platforms therefore there is a need to analyze the requirements of the application and select a suitable framework for development of a mobile application under any platform.

International Data Corporation published a research according to which the percentage of platforms used in 2016 for mobile application development will be as follows:

Table (3)Mobile Platform Percentage Use As Anticipated In 2016

Mobile Platform	Percentage Use
Android	68.8%
iOS	19.1%
Windows Phone	11.4%
BlackBerry OS	4.1%
Miscellaneous	1.6%

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5.2 Enterprise Mobility Framework

In order to manage the enterprise mobility factors and keep a check on the drawbacks that come with it, every organization needs a framework. A reference framework sets a pattern on which the enterprise employees are supposed to act. If the organization desires to have consistency and effective collaboration, there should be a single distinct reference framework in operation.

Any framework and infrastructure chosen for achieving enterprise mobility should be able to provide the following functionalities:

- 24/7 connectivity
- Tendency to adapt with changing technology
- Independence of place, product and time
- Capability to perform simple and complex tasks
- Flexibility regarding mobile infrastructure
- Strategic security planning
- Access across multiple channels
- Compliance with industry standards
- Generic and adaptable business model
- Cross browser support

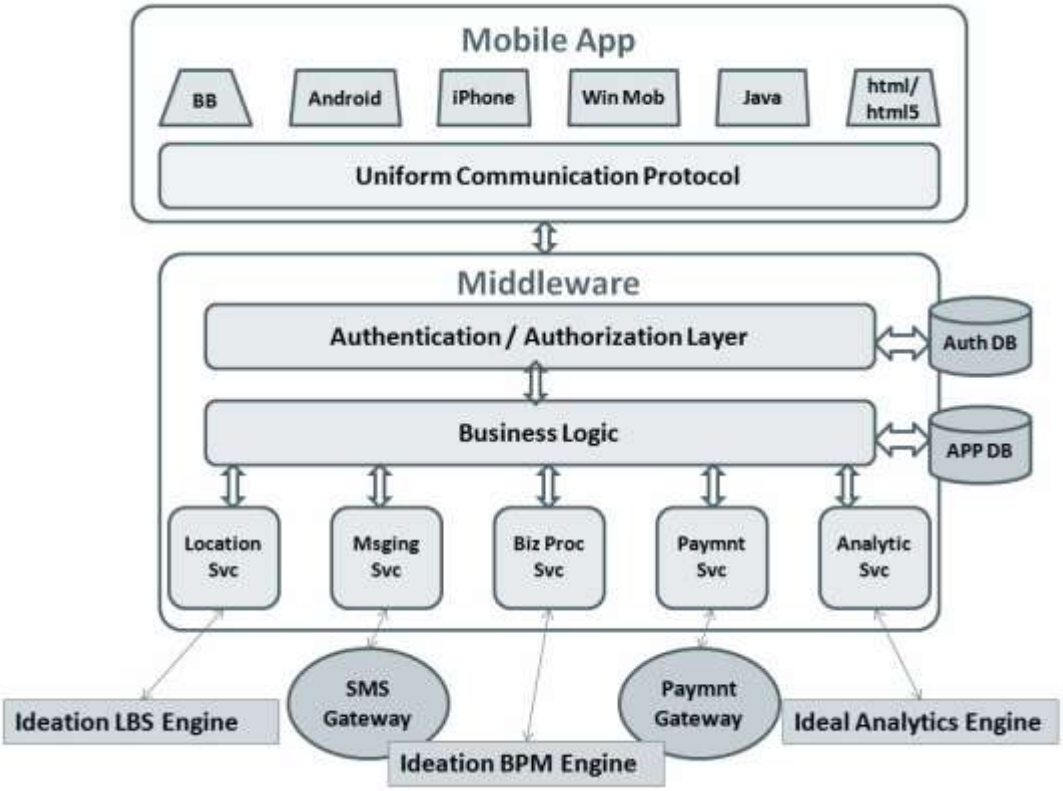

Fig. 2. A framework of Mobile Application development

Figure shows an enterprise mobility framework that shows the interaction among various components. The 'Mobile App' is the part where the actual development takes place in development languages like Action Script, HTML/HTML 5, CSS, JS, C, C++, CSS, Android, jQuery, Lua, VB.Net, XML, Pascal, Python, QML and many others. Middleware is the part where security features are implemented on the application that surrounds all its core functionalities. The actual business logic is also implemented here.

Cross platform frameworks are preferred for mobile application development so that the application can be supported on various platforms and does not remain specific to a native solution. Some of the renowned cross platform frameworks include Titanium SDK, Xamarin, PhoneGap, Oracle ADF Mobile,

1.3 Software Architecture

The underlying architecture that is used for developing enterprise mobile applications differs variedly; at this point in time, it seems near impossible to bring all development platforms to a single reference point. Understanding of the software architecture helps in understanding the functionalities and operation of the enterprise application. The chosen architecture should be such that satisfies the user requirements, developer's goals and device constraints.

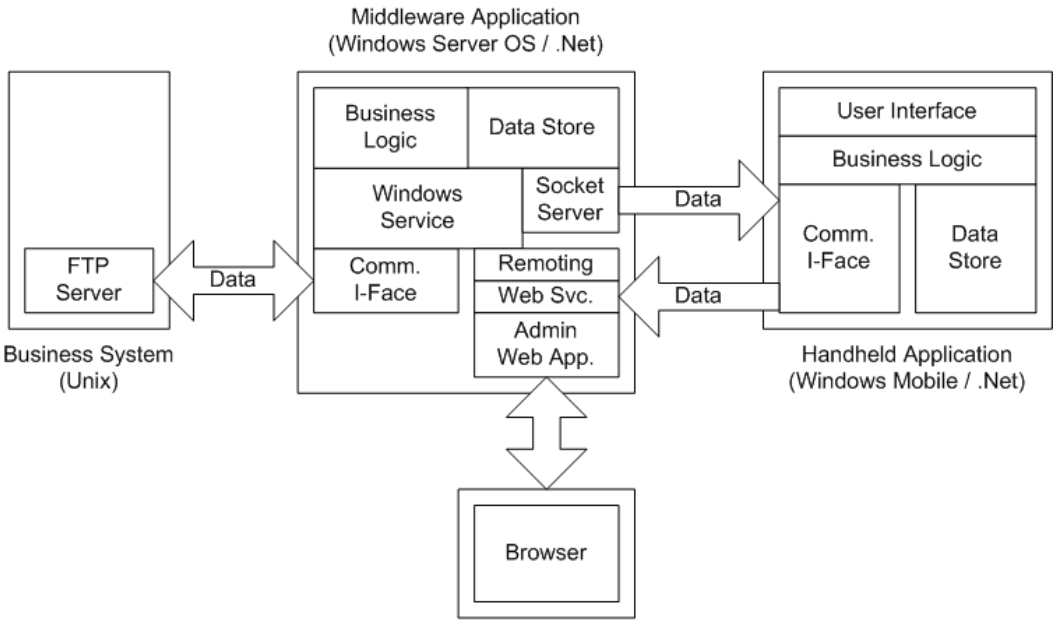

Fig. 3. Architecture of Windows Mobile development Framework

Figure shows software architecture at work. The data is residing at FTP server; application layer consists of all the functions and logics that are performed on the data; user can interact with the mobile application through mobile (handheld) devices or via a browser.

5.4 Building Enterprise Mobile Applications

With the fast influx of mobile applications that are hitting the market, the development cycle of the application development has become smaller and smaller. There are many platforms, technologies and languages that provide built-in features that can be used to further speedup the development process. Software distribution channels have also advanced to accommodate newer applications, thus reducing the time-to-market for new developers. This advancement has its own merits and demerits.

Mobile enterprises rely on the concept of cloud computing and network infrastructure that supports every concept of enterprise mobility. According to a research, 71% people believe that security is the top most priority of any mobility endeavor; so no building block of mobile application can ever be complete without some protocol for security. The framework used for enterprise mobile application development should also focus on complexity and integration issues to avoid any issues that arise later on. A proper, well-thought and detailed strategy must be available at hand that lists all the detail of how mobility will be implemented in the organization.

5.5 Securing Enterprise Mobile Applications

Enterprise Mobile Applications took a huge leap from an old era where the IT department of any organization had complete hold on the mobile devices that were used and how they were used. As mobility improved in mobile devices, there came the trend of "Bring Your Own Device". Along with many of its benefits, there also came certain drawbacks in the form of security issues, standardization and cost concerns among many others. Tracking these devices is vital but today it is considered as an attack on personal liberty. With this greater independence came a variety of mobile applications that are being used for work functions. Previously only the IT managers approved the applications to be used and purchased them on the behalf of the organization; now everyone can use any additional applications that they deem useful. The competition in every work domain also calls for out-of-box applications that can provide something more than what competitors are doing.

6. DISCUSSION

This paper discusses Enterprise Application Development Frameworks. The related concepts of this field have been explored and discussed in this paper. The paper starts with a study of other similar research papers and moves on to explain what Enterprise Applications are. The core and support business functions that are supported by enterprise applications have been duly discussed. Mobile Applications are discussed in depth in terms of their development frameworks, their comparison, development technologies along with the limitations. Next follows a discussion of Enterprise Mobile Applications (EMAs); highlighting their business need, infrastructure, software architecture and building blocks of EMA. The paper can be improved by discussing the development technologies in detail and including their comparison.

7. Conclusion

This paper explores Enterprise Application Development Frameworks and its related concepts. This paper contributes to the existing study material in this field by highlighting the comparison of these frameworks. It also adds by jotting together all the related concepts of this field.

Acknowledgment

I would like to thank my MSc students for her initial work on this paper. Also, I am very grateful to my colleague Dr DanialGhazawi and Eng. Mohamed Saleem for their proof reading and editing feedback.

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