ANALYSIS OF THE EMERGING ANDROID MARKET

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ABSTRACT

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This master's project addresses the study of the recently launched Google Android platform, and its online application marketplace, called the "Android Market." The project examines the paths to success for third-party developers building applications for Android by comparing them with application development for the Apple iPhone. In addition, the project also includes a study of the Android business ecosystem. Research on related topics shows that this mobile ecosystem benefits third-party developers and those application vendors play a critical role in contributing to the success of Android.

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- Bimal Gadhavi
- Khushbu Shah

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INTRODUCTION

> Based on the evolution of communications and computer industry, a vision of mobile convergence devices emerged in the 1990s that provided voice and data communications in a mobile computing-enabled device. These devices arose from the confluence of mobile phone and personal digital assistant (PDA) design paths. Today this category is normally referred to as the "smartphone" segment of the mobile phone market.(Joel and Michael, 2009, p. 8)

Over the past few years, the battle between heavyweights like Nokia (Symbian OS), Apple (iPhone OS), Microsoft (Windows Mobile), RIM (RIM OS for Blackberry), and Google (Android) for smartphone operating systems market share has been escalating. Also, the popularity and availability of SDKs, development tools and active promotion of the application developer community by all the major OS vendors highlights the fact that applications and user interface have emerged as critical factors. These factors help developers in selecting the platform for application development and help end-users in smartphone device selection.

Android, Inc., developing software for mobile phones was acquired by Google in July 2005. In November 2007, with the establishment of the Open Handset Alliance (OHA), Google announced its entry into the mobile world, not as a handset manufacturer but as an OSV (operating system vendor) offering the Android platform.

Android is a free and rapidly growing mobile platform. It also provides a rich platform for third-party developers to build innovative applications with its available set of APIs. (Application Programming Interfaces) Android offers a complete platform to mobile operators, developers, and handset manufacturers for constructing world-class innovative devices, software, and services.

According to iSuppli (Vinita, 2010) today, all major OS vendors are working to create an active ecosystem of application developers that can help build attractive applications for their OS platforms.

1.0 SCOPE OF THE PROJECT

1.1 Objective

Our project work focuses on the study of the Android ecosystem and how it differs from other mobile ecosystems such as those surrounding the iPhone. This project includes the study of the Android Market, (online mobile application store for Android users) application developers, and which factors developers consider for selecting a platform for application development. To understand application development trends across Android and iPhone platforms, we compared the Android market with the iPhone App Store, the leading application store in current mobile market, and how different kinds of developers are working for the Android, the iPhone, or for both the platforms.

Apple launched an online application marketplace called the “iPhone App Store” before launching iPhone 3G. Currently, this store has more than 195,000 applications. To match or surpass the success of iPhone App Store, Apple rivals such as Google and Blackberry introduced their own application downloading stores called “Android Market” and “Blackberry App World” respectively. The Android Market is similar to the iPhone App Store or to any other application store; it boasts a catalog of applications, services and tools available for the user to purchase download and use. Today, the Android Market also has around 49,000 applications. Thus, the comparison between iPhone and Android application stores will help explain the new challenges faced by these two application stores, and also the demand for these stores in the near future. This study will help understand why third-party developers choose the Android over the iPhone, what determines their success, which large companies are directly involved in

developing applications for Android, and which factors they consider for developing an application.

1.2 Hypothesis

- For developing any application, development tools are the most important.
- For small Independent Software Developers, (ISVs) market size is the most important.

1.3 Experimental Procedures

This project is based on a semi-automatically collected application database and surveys to obtain necessary information for proving the hypothesis.

(A) Website Data

Firstly, application data were collected semi-automatically from the Android Market and iPhone App Store (iTunes store) and other mobile applications related websites, for e.g., Androlib.com, iPhoneapplicationlist.com. This gathered application database includes a list of the application categories on both platforms, number of applications in each category, and application information for the selected categories.

(B) Interview Data

Next, we interviewed mobile application developers to understand and know their views about Android/iPhone platforms and the ecosystem. To get in touch with mobile application developers, we attended the mobile conferences where they gather to share their views.

(C) Survey Data

Lastly, all the relevant facts about application developers from the interview data helped us prepare a survey. This web-based survey was prepared and conducted using SurveyMonkey.

1.4 Resources Utilized

The main resources used during this project were our industrial advisor, our academic reader, Android and iPhone application database, interviews and surveys from mobile application developers.

2.0 LITERATURE REVIEW

2.1 Introduction of Literature Review

In order to achieve success in project implementation, the first step is to research and find information already available. During research, we found many articles related to our topic. This paper is based on the content from these articles. We have divided the this section in four main areas: (a) Overview of the Mobile Ecosystem (b) Overview of Platform Leadership (c) Fundamentals behind the Open Source Platform (d) Introduction to the Smartphone

2.2 Overview of the Mobile Ecosystem

As we know, mobile phone usage has been increasing dramatically over the last several years. Globally, if a usage comparison can be carried out between PCs and mobile devices; mobile devices have approximately 3.5 times more usage then PCs. These mobile devices have become a platform to support wide variety of data applications such as capturing and sharing photos, downloading, recording, and sharing audios and videos, and gathering information from the Internet, to list but a few. At the same time the way people use their mobile phones has also been changing noticeably, from voice calling and text messaging to data applications. This trend arises from falling handset price, larger phone screen size, better and faster mobile processors, affordable price of storage, etc. Thus, the mobile phone has become a complex system requiring integration of a wide range of component suppliers and an equally complex distribution system. By reviewing a paper written by Dr. Joel West and David Wood, (2008) this section is divided further:

2.2.1 Mobile/Wireless - Business Ecosystem

Any firm's performance depends on success of their own business ecosystems, which can be larger than the firm itself. A mobile/wireless ecosystem typically contains network of suppliers, distributors, product or service makers, and technology providers which have an effect on, or are affected by the creation and delivery of a company's own benefits. Moreover, a mobile/wireless ecosystem is highly interdependent among member firms (and other bodies) and some of these ecosystem members, being well-located, play a crucial role in connecting ecosystem members and catalyzing links between other members. (Joel and David, 2008) Also to optimize performance, a complex product ecosystem requires alignment of interest among various members and partition of the technical and business responsibilities among these members. The following figure gives an idea of how the mobile business ecosystem life cycle works:

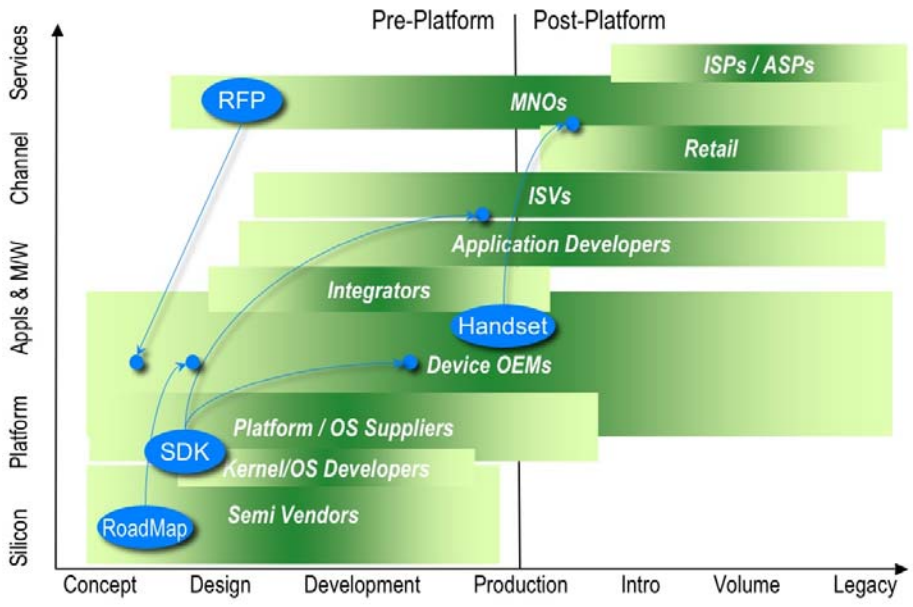

Figure 1: Mobile/Wireless Business Ecosystem Life Cycle

(Source: Weinberg, W., (2009). *Mobile Handset Teardown: Designing and Deploying with Mobil Virtualization*. Retrieved on November, 2009, from Linuxpundit.com website: http://www.linuxpundit.com/documents/white_paper_motorola_evoke_teardown.pdf.)

2.2.2 Categories in the Mobile/Wireless Business Ecosystem

The major categories include:

- **Original Equipment Manufacturers (OEMs).** They create new devices or handsets for end users by combining externally sourced or internally developed hardware and software.
- **Semiconductor Manufacturers.** They provide compatible hardware and drivers for their respective hardware components.
- **Operating System Vendors. (OSVs)** They provide platform, SDK, and features to OEMs. They also promote and support application developer communities. (William, 2009)
- **User Interface (UI) Suppliers.** They determine mobile phone companies' user interface development groups, and they work at the application level

dealing directly with users. Most UI code is distributed through platform operating system vendors (OSVs) (e.g., ACCESS, Google), original equipment manufacturers (OEMs) (Apple, Motorola) or via open source projects (e.g., GNOME, Enlightenment), or even handset OEMs (e.g., Motorola and MOTOBLUR)

- **Wireless Network Operators.** They provide distribution channels for phones in different countries, and also determine what software components should be preloaded on phones. Operators also have their developer program that includes Software Development kit (SDK) and app stores. e.g., Sprint Developer Program, AT&T Developer Program.
- **Enterprise Software Developers.** They develop company compatible software for its own employees that use company's phones.
- **Other Software developers.** They can also be referred to as independent software vendors. (ISVs) There are large ISVs, (e.g., Google, eBay, Amazon) small ISVs and individual developers who make user applications and also middleware components such as database.
- **Consultancies and training centers.** They include firms that are licensed by specific mobile phone companies to provide training courses based on firm's software development kit. It plays minor role in the ecosystem.

In many cases, however, it happens that members of a mobile phone ecosystem, for e.g., Symbian ecosystem, are also members of competing mobile phone ecosystems such as Windows Mobile, Google's Open Handset Alliance, etc.

2.2.3 Study of Mobile/Wireless Ecosystem Tradeoffs

The firm that sponsor a business ecosystem, also inherit issues such as how to collect the ecosystem requirements for a new product, how to balance between interested participants and ecosystem leader, and how to prioritize the conflicting needs of various ecosystem participants (Joel & David, 2008). To overcome these above mentioned difficulties, firms have to face a series of tradeoffs in managing ecosystem relationships. These tradeoffs could be made under conditions of limited sources, time, and knowledge of the future which include:

- **Breadth vs. Depth.** A sponsor, who participates in the mobile/wireless ecosystem, can deeply engage with a limited number of key partners to maximize their chance of success without increasing amount of time and money. Or a sponsor can engage with a large group of partners to make sure that all possible important partners are addressed.
- **Scale.** The sponsor can provide personal attention, but it has a limited reach. A large mobile/wireless ecosystem will provide less personal attention compared to a small mobile/wireless ecosystem, but it can reach a large audience. So the firm has to consider economy of scale during implementation of their own business ecosystem.
- **Customization vs. Standardization**. The customized business programs, made to fulfill individual needs, could be more effective but less efficient. But by doing standardization of these programs, a sponsor could support all its members in more efficient way except their elite partners.

- **Prioritization and Tiering.** A random distribution of partner importance can result in unbalanced attention by giving an importance of two-to-four levels. To tier this business program, the sponsor needs a number of decisions such as how many partners should be in each category, how much resources need in each category, what is the potential revenue, what is the size of channel, etc. If an important partner is neglected by sponsor, it could turn out as a missing an unfamiliar one.

The biggest challenge for a real business ecosystem is how to capture loyalty and attention of its partners who could be members of multiple competing ecosystems. In mobile phone ecosystem, these partners include software developers, handset manufacturers, operators, etc. Thus, a mobile/wireless business ecosystem is the interdependence of technical and economical relationships, and it has a significant degree of variation between firms.

2.3 Overview of Platform Leadership

As mentioned above, a mobile phone ecosystem is very complex; it requires the involvement of many participants with different expertise. There are two fundamental forces behind the creation of a complex product – interdependency and innovation. These high-tech companies are able to produce what they want, by getting the required components from suppliers. Sometimes, these suppliers deliver some other complementary products so called “complements” along with main components. So the main product made by firm has interdependency with these complements. Platform leaders have to work very closely with other firms to built innovative and new generation of complement products in their competitive market. In order to achieve platform

leadership, firms can use a framework called “the Four Levers” to design a platform leadership strategy, more effectively (Gawer, A. & Cusumano, M (2002).

1. **Scope of the Firm:**

This lever determines what things are necessary for a firm to understand such as, what complements should be produced inside the firm, which complements depend on outside the firm, and whether make them with the help of a new group of firms or already exist one.

These decisions help platform leader to recognize their dependency on their own business ecosystem to produce these complements. To do so, they need a clear vision of what they want to produce in order to create a valuable platform in evolving industry or technology.

2. **Product Technology:**

This lever helps platform leaders take decisions regarding the architecture of their products or platform. Basically, it helps to take decisions about how much information they want to disclose outside the firm, what degree of openness need for their platform, etc. This lever can be carried out to make decisions in architecture, intellectual property, and interfaces.

3. **Relationships with external complementors:**

This lever helps to determine what kind of relationships a platform leader should need with their complementors. It also helps in resolving conflicts with their partners and arriving at a common decision.

4. **Internal Organization:**

This lever helps organization to deal with internal or external conflicts. An organization can form a special group having specific goals to deal with these conflicts.

2.4 Fundamentals behind Open Source Platform

2.4.1 Introduction to Open Source Platform

"Open source software is typically created within open source software projects, often initiated by an individual or a group that wants to develop software product to meet the needs of the consumer." (Krogh et al., 2006, p. 975) The concept of open source software can be traced well before the start of the 80s. In early 1970s computer manufacturers had a control over both the hardware and software implementation. The manufacturers called these as their standards for that particular computer system. Later, with the invention of the UNIX operating system by AT&T, intended for internal use and use by technical and academic peers, the era of open source software began. (Joel & Jason, 2007, p. 4)

In open source platforms, application developers develop and perform code check-in via a development kit in an effective and timely manner. The developed application source code can then be used by any developer who wants to develop a new application. On Open Source Software, (OSS) with source code freely available, new application development process becomes fairly easy and attractive. A developer can send a quick update to the consumers via distribution channel. There are also certain standard rules and procedures agreed upon by all

the members in that particular community using or wanting an access to the open source code for developing a new application.

2.4.2 Advantages of Open Source Platforms

Open source platform can accommodate various features and applications which are made by different groups of developers. It gives users the freedom from the vendors and their policies, but it can subject them to the policies of the project/developer group. Some applications are free and users do not have to buy a license for them, which makes this more viable and it can make it fairly easy for the industry to work on and adopt this. With different groups of developers coming together, open source platforms can provide the best cutting edge technology in terms of features and applications. With the help of the developer community, code can be of superior quality and can also be delivered much faster than any other development projects. One of the advantages of using an open source software is that one can ask for the source code directly from the person developing it, and can add/modify it according to his/her requirements provided he/she meets the license obligations for the supply.

An open source platform enables developers to implement their ideas easily and also allows them to extend it in the future. An open source platform like Linux is one such example of this revolution.

2.4.3 Limitations of Open Source Platform

Sometimes the access to platform source code is not valued by code users, and also the code change suggestions are not appreciated by developers who are very close to or attached to the applications they have developed. In case of an

issue, some developers may not provide immediate support to the open source package. The tendency towards fragmentation in open source platforms may create interoperability issues with other platforms which may lead to cost increase and additional overhead.

2.5 Introduction of Smartphone

2.5.1 Worldwide Smartphone Adoption

In 1973, Motorola introduced a first cellular telephone, and then no one had imagined that this would ignite a whole new technological change: “The Mobile Revolution.” Typical “cell phones” were used only for voice calling and later for text messaging, but with growth in mobile phone adoption, “cell phones” are now available with a number of different features like e-mail, video and audio facilities, internet access, etc. Thus, a whole new change in this mobile sector happened and the smartphone race began. This race also created competition between operators and handset manufacturers in getting more returns from mobile phone equipment and services. The rise in the smartphone segment accompanies the mobile internet revolution. However, the main reasons are better margins for Original Equipment Manufactures (OEMs) and higher Average revenue per user (ARPU) for operators. The smartphone is basically a combination of operating system, application, and handset manufacturers. In addition, due to the increase in the application market of the smartphone and the growing popularity of OS used for mobile systems, it can be said that the near future will witness the most power-full application running on phones with high powered operating systems. Considering current growth in the smartphone sector, it is estimated to grow by at

least 18-20% by 2011 according to iSuppli. Following table shows sales of smartphones during year 2008 and 2009.

Table 1: Worldwide Smartphone Sales

Worldwide Smartphone Sales to End Users in 2009 (Thousands of Units)				
Company	**2009 Sales**	**Market Share (%)**	**2008 Sales**	**Share (%)**
Nokia	440,881.6	36.4	472,314.9	38.9
Samsung	235,772.0	19.5	199,324.3	16.3
LG	122,055.3	10.1	102,789.1	8.4
Motorola	58,475.2	4.8	106,522.4	8.7
Sony Ericsson	54,873.4	4.5	93,106.1	7.6
Others	299,179.2	24.7	248,196.1	20.3
Total	**1,211,236.6**	**100.0**	**1,222,252.9**	**100.0**

(Source: *Worldwide Smartphone Sales.* (2010, February). Retrieved October 5, 2009, from Gartner web site: http://www.gartner.com/it/page.jsp?id=1306513.)

2.5.2 Overview of Different Smartphone Operating Systems

Before moving to Android and iPhone, it is necessary to understand existing smartphone operating systems in the market. Here is the list of mobile operating systems: (1) Symbian OS (2) WebOS (3) RIM OS for Blackberry (4) iPhone OS (5) Windows Mobile (6) Android (7) Others. The table below shows these operating systems market share and their respective deployments during year 2008 and 2009.

Table 2: Worldwide Smartphone Sales to End Users by Operating System in 2009 (Thousands of Units)

Company	2009 Units	2009 Market Share (%)	2008 Units	2008 Market Share (%)
Symbian	80,878.6	46.9	72,933.5	52.4
Research In Motion	34,346,6	19.9	23,149.0	16.6
Windows Mobile	15,027.6	8.7	16,498.1	11.8
iPhone OS	24,889.8	14.4	11,417.5	8.2
Android	6,798.4	3.9	640.5	0.5
Linux	8,126.5	4.7	10,622.4	7.6
WebOS	1,193.2	0.7	NA	NA
Other OSs	1,112.4	0.6	4,026.9	2.9
Total	**172,373.1**	**100.0**	**139,287.9**	**100.0**

(Source: *Worldwide Smartphone Sales with Operating System Market Share.* (2010, February). Retrieved April 15, 2010, from Gartner web site: http://www.gartner.com/it/page.jsp?id=1306513.)

An operating system is the core software which manages hardware and software resources in any smartphone. Complete platforms have an operating system, middleware and applications while the others only include lower levels and need other platforms help to provide a complete structure. Below is a brief introduction of all operating systems.

1. Symbian OS:

Symbian OS is the dominant platform in the market, available in around more than 120 different models of phones. This platform covers only two lower levels software stacks - kernel and middleware and application platforms like UIQ (User Interface Quartz), MOAP, and Series 60 provide the upper layers for Symbian.

2. WebOS:

WebOS runs on Linux kernel with the proprietary components developed by Palm. The Palm Pre is a first device with WebOS and both were released in June, 2009. There is also a WebOS software development kit available called Mojo. This OS has a built-in application catalog, and APIs for extending JavaScript in order to access hardware features of the device. (Kairer, 2009)

3. RIM OS for Blackberry:

RIM (Research in Motion) owns and provides the entire software stack including kernel, middleware and many applications. This platform offers different development tools for writing Java ME applications for Blackberry smartphone. RIM platform supports multiple third-party applications operation by using Blackberry API (Application Program Interface) classes.

4. iPhone OS:

Apple iPhone and iPod touch are developed by using iPhone OS based on Mac OS X (itself built on the Darwin project for Berkeley UNIX). The programming languages used for iPhone OS are Objective-C and Xcode. All iPhone and iPod touch applications are offered only via the Apple app store.

5. Windows Mobile:

The Windows Mobile OS includes the entire software stack – an operating system, middleware, and applications. Windows Mobile 6 is the latest version of this platform. It is compatible with the Microsoft Office suite of programs.

6. Android:

Android is a Linux-based open source platform. It is backed by Google with the foundation of Open Handset Alliance includes 65 technical leader companies like HTC, Intel, Qualcomm, NVIDIA, T-Mobile, etc. The G1 the first Android-based phone was launched in 2008 by HTC. The Android Development Kit is available for Windows, Linux and Mac OS. Applications are developed in Android using a version of the Java programming language running on the Dalvik virtual machine.

7. Others:

- **Linux operating system:** Linux is used as a basis for a number of different mobile platforms developed by OSVs (ACCESS, Azingo, et al.), by community projects (e.g., OpenMoko) and through consortia like the LiMo Foundation. Many handset OEMs deploy Linux-based hardware, including Motorola, NEC, NTT DoCoMo, Panasonic, Samsung and Vodafone.
- **MeeGo:** It is a new Linux-based mobile operating system combining the best of existing Moblin and Maemo platforms and targets both ARM and Intel Atom-based devices. Its UI merges APIs for GTK+, Qt and Clutter. It was unveiled by Nokia and Intel at the 2010 Mobile World Congress in Barcelona.
- **Bada:** It is a mobile operating system which is still in development from Samsung Electronics. The handsets using this OS will be available in the second half of 2010.

- **LiMo:** It is a software platform for mobile phones and other handheld devices developed by LiMo Foundation. (a group of cellular handset makers and network operators) It uses Linux as its operating system.

2.6 Summary of Literature Review

This literature survey gave us a good background of many new topics which was helpful in implementing our project. The mobile phone ecosystem helped in understanding how companies implement their own ecosystem strategy to gain market advantage, the categories of the mobile/wireless ecosystem, and their tradeoffs. Next, it gave a brief understanding about open source software; how the concept of open source platform came into existence, the various advantages of the implementing an open source platform, how it could help make a company successful by using various tools and cool applications developed using open source code, and limitations of using open source platforms. Additionally, this literature review helped in understanding platform leadership concepts that could help any company to gain competitive advantage over its rivals. Reading through lots of articles helped learn about smartphone adoption and a brief overview of different smartphone operating systems. Also, we understood many concepts of the mobile industry which helped us implement our project and conduct interviews with “third-party developers” who build an application for Android and iPhone.

3.0 APPLE iPhone AND APPLICATION STORE

3.1 Introduction to Apple iPhone

One ongoing issue for mobile internet arises from expectations for a wired internet user experience. The desktop browsing experience, in particular, was built for large screens and keyboards, and is not suitable for mobile phones with small screens. To overcome this issue and to create a better end-user experience, Apple introduced iPhone with single OEM and operator rather than multiple vendors and operators in the mobile market by focusing on re-creating the mobile phone from already existing wired web mature ecosystem rather than recreating new Internet ecosystem. The iPhone 3G was launched on July 11, 2008 and came pre-loaded with iPhone OS 2.0 with App store support. It gained rapid success in the United States and Europe. Apple has already developed market position with iPod music player and iPhone is an integrated device of existing value systems – iTune music and video service. Apple further extended its iPhone strategy by providing updated models and operating system software which brought a better web browsing, application development platform, improved phone hardware, and improved delivery channel for third-party software and services (Joel West & Michael Mace, 2009).

The Apple iPhone operating system follows a complete closed system by including operating system, hardware, built-applications, and online services. It is based on a variant of the same Darwin operating system core that is found in Mac OS X. It is therefore a Unix-like operating system by nature. iPhone OS has four layers: the Core OS layer, the Core Services layer, the Media layer, and the Cocoa Touch layer. This operating system is developed by Apple and used by Apple only. Smartphones that are

compatible with this OS are also made by Apple. To be more specific, iPhone OS can not be used by any other handset manufacturer company and is not compatible with other available smartphones.

Being a closed system, Apple has big advantages with its smartphones. One is that Apple's engineers know exactly what the hardware is being used to run their OS and how they can make OS most efficient on that hardware. In addition, this operating system and related software are developed by only one company which helps fulfill company's goals for its own products. The developers who develop codes for closed system operating system do not have to worry about meeting the needs of various companies. However, even though iPhone got a rapid success; there are some limitations in using iPhone for example; it works only with limited devices with limited input; it has a built-in memory but no external memory slots, so one can not add additional memory.

3.2 Apple iPhone Application Store

On July 10, 2008 via an update to iTunes, Apple released an online market place for applications, called "App Store." It is a service for the iPhone, iPod touch, and now the iPad. By using this app store, iPhone users can download any apps they want through iTunes or directly from their phones to take advantage of all available iPhone features. As of May 4, 2010, iPhone App Store has more than 195,000 third-party applications with over 4 billion total downloads. The Application Store is basically a centralized collection of all different applications. Currently, it has around 20 different categories which help users select and download the exact application they are looking for. The price of these applications, free or paid, is decided by the developer of a particular

application. The figure below shows a third-party development model for any online application marketplace.

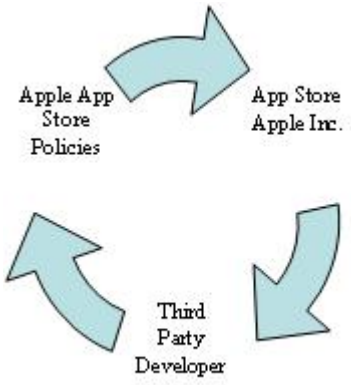

Figure 2: App Store (Third Party Development Model)

Once the developer decides to build an application for the iPhone, he/she must consider and follow something called the iPhone Developers Program. This program has 3 main contents namely: (1) Develop, (2) Test, and (3) Distribute ("iPhone Developer Program," n.d.)

1. **Develop:** This includes all the development tools and resources needed for building an application using the iPhone's SDK. (Software Development Kit) Basically, the development tools include: Xcode, iPhone Simulator, Instruments, and Interface Builder. The development resources provide developers an access to the Apple developer forums, getting started videos & documents, iPhone reference library, and coding resources.
2. **Test:** This allows developers to test their applications to see how they will perform in the real environment. This program also includes two technical support incidents: (I) Apple engineers provide the developers with code-level assistance and helpful guidance which would help the developers (II) Directions for the

issues that developers are facing. This includes test in real-time; test over-the-air; and technical Support.

3. **Distribute:** Apple has two distribution channels: App Store Distribution and Ad Hoc Distribution. These are the only way users can get access to the applications. Users can download their applications using an iPad, iPhone, or iPod touch via the iTunes store. With App Store Distribution, any app developed and published on the app store can reach millions of customers. While with the Ad Hoc Distribution, the application can install on up to 100 devices without going through the App Store. Developers are forced to use 'Ad Hoc' distribution so that apps can be tested prior to submission to the iTunes App store (Ben, 2008). The Apple method requires pre-registration of beta testers. In order to register them, developers need to know Unique Device Identifier (UDID) for their devices and then create a mobile provisioning file - a security certificate that authorizes that unique device to run the app being tested. (Ben, 2008)

Apple uses the 70/30 model for splitting the revenue generated from the App Store, between the developer and itself. The App Store has helped 3rd party developers to solely focus on developing creative and innovative applications and not worry about its distribution process. The marketing of the applications is handled by the App Store which serves as the distribution channel for these apps. Thus, Apple has created a huge demand for the platform as well as the App Store (Bill, 2007).

4.0 GOOGLE ANDROD AND ANDROID MARKET

4.1 Google Android

To create a mobile phone OS, Google acquired Android Inc. in July, 2005 and appointed Andy Rubin as their Director of the mobile platforms group. After that Google entered into the mobile market not as a handset manufacturer, but by launching a new OS called as “Android” on November 5, 2007.

The main reason why Goggle entered this market is to sell more ads in the emerging mobile form factor and also with the dream that its OS could run any device manufactured by different handset vendors like Samsung, LG, Motorola, HTC, etc. The customers can buy Android powered phones from any carrier operators like T-mobile, Verizon Wireless, Sprint, etc.

Goggle introduced Android as an OS which runs the powerful applications and gives the users a choice to select their applications and their carriers. The Android platform is made by keeping in mind various sets of users who can use the available capacity within Android at different levels; like basic users who demand only calling option, going one step higher, users who use many of the available applications up to a certain extent, and going even higher, the ones who use all of the available applications and also want to develop or suggest their own multipurpose applications or tools which can be useful not only to them, but also to their peers. The Android source code is available to all the software developers for future upgrades and addition to the existing platform or code.

Goggle has a vision that Android based cell phone will have all the functions available in the latest PC. In order to make this effort possible, Goggle launched the Open

Handset Alliance. Today, the open handset alliance is a group of around 65 technological companies coming together to promote open source software, which is powered by Google. These 65 companies are split into different groups: 1) Handset Manufacturers like HTC, Motorola, and Samsung etc., 2) Software Developers like eBay, Goggle, livewire etc., 3) Mobile Operators like T-mobile, Sprint, Do Co Mo, etc., and 4) Chip manufacturers like Broadcom, QUALCOMM, Marvell, Intel, etc. These companies have come together with common goal which is to make the platform viable for mobile and also to publish the code as an open source.

The Android platform consists of several layers which provide a complete software stack. The extreme bottom layer is the Linux Kernel, then the system libraries, Dalvik which is a virtual machine, the application framework, and all the applications on top of that. The Android platform use a lot of open source libraries like the Webkit, and harmony, Open SSL, Apache http components, etc. In the libraries they have 2D and 3D graphics for the mobile systems. The most powerful part in the platform is the Dalvik virtual machine, which interprets and executes portable Java-style byte code which is optimized to operate on the mobile platform. As most of the applications these days are related to the web, the first two layers are written in Java. With all these functionalities, Android is complemented by the application layer which includes a web browser, touch screen, GPS, instant messaging, camera for the phone, etc. One of the best features of this platform is that they have put in hooks, which the developers can extend in ways which nobody has even thought of yet. Thus, it can be said that it is a complete feature or a stack for mobile system.

4.2 Android Market

The Android Market, an online software store, is developed by Google for Android devices. It was announced on August 28, 2008 and was made available to users on October 22, 2008. Most of the Android devices come with preinstalled “Market” application which allows users to browse, buy, download, and rate different available applications and other content for mobile phones equipped with the open-source operating system.

Unlike with the iPhone App Store, there is no requirement that Android apps should be acquired from Android Market. Android apps may be obtained from any source including a developer's own website. Also, Android developers can create their own application market. Google does not have a strict requirement for the application to show up on the Android Market compared to the “Ad Hoc” process used by Apple. This process is much more open then Apple’s App Store. Lastly, the Android Market follows a 70/30 revenue-sharing model for applications developed by developers. The developers of priced applications receive 70% of the application price and remaining 30% distributes between carriers (if authorized to receive a fee for applications purchased through their network) and payment processors. Developers get the earned revenue from the Android Market via Google Checkout merchant accounts. Moreover, priced application support for Android Market was made available in mid-February 2009 for US users and UK users got a facility to purchase priced application on 13 March 2009(“Android Market,” n.d.).

After launching, there were about 2,300 applications available in the Android Market in March 2009. As of May 04, 2010, Android apps hit around 49,000 applications which were around 12,500 in August 2009 and 20,000 in December 2009. The growth

rate of new applications in the Android Market have shown in the below figure. Recent months in 2010 have shown a growth rate of approximately 8,000 additional applications per month.

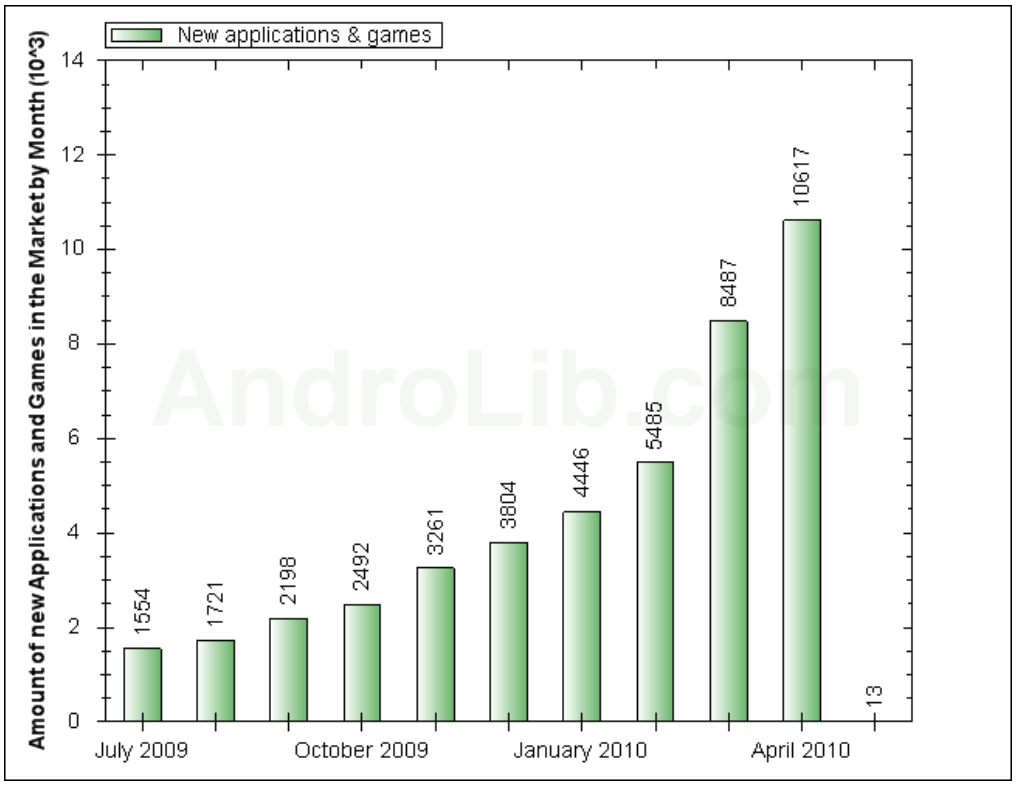

Figure 3: Amount of new applications by month

(Source: *Application Statistics*. (n.d.). Retrieved April 30, 2010, from AndroLib web site: http://www.androlib.com/appstats.aspx.)

5.0 APPLICATION DATABASE

5.1 Introduction to Application Data

As a part of the research, this project compiled an applications database, i.e. a collection of applications from the iPhone and Android online applications marketplace using semi-automated and manual data collection techniques.

The iPhone applications data has been collected from the iTunes App Store and iPhoneapplicationlist.com. This data has been collected using WinHTTrack Website Copier, free and easy-to-use offline browser utility software, which allows downloading a World Wide Web site from the internet into the local directory of a computer. After downloading web pages using this software, these files have been imported into Excel with the help of Software Developer.

Android apps, paid or free, from Android Market have been collected using an Android phone, Google online marketplace or from the website androlib.com. The reason for using two websites (iPhoneapplicationlist.com and androlib.com) is that the applications showcased here are identical with the iPhone App store and Android Market, respectively. Also, the information on this website is up-to-date.

The application database contains the application name, ranking, # of downloads, the developer name, etc. as shown in the table below. (Also see Appendix VII)

Table 3: Application Database

Application Name	Ranking	Released Date	Free/Paid cost	# of Downloads	Ratings	Version	Developer Name	Other apps developed	Star	Description	Website

It includes the name of a developer along with his ranking because “most users discover apps by browsing the Top 25 or Most Popular Apps by category from their

iPhone's, and the app store rankings are based on the total number of downloads over a short period of time. (~24hrs)" (Mario, 2010)

5.2 Importance of Application Database

This database would help understand the number of new applications developed on both the platforms and also compare the growth of number of applications on individual platforms in the near future. Apart from knowing application growth, it will also help understand which developers are common or different for both the platforms. The information on application developers also helped get more responses for a survey.

From the available 20 different categories and more than hundreds of applications in each category on iPhone and Android platforms, the application information under "Travel" category has been gathered because of the following reasons:

- Some applications have an identical name on the both platforms.
- It has an identical concept along with some of the same name applications on the both platforms.
- It has seen upward trends with the introduction of big giants like Google with Google-Maps app.

5.3 iPhone and Android Applications Volume per Category

5.3.1 iPhone Application Volume

The figure below shows the number of application in each category by month. In January of 2010 there were around 23,000 applications in the Games category and reached around 34,000 by April of 2010, i.e., over 11,000 new applications were added within a period of 4 months. The book category, which was earlier at around 26,000 in January 2010, reached to around 34,000 plus

applications by May 2010. Considering the current growth in the new applications, we can say that there would be an increase of 8-10% growth in the App Store.

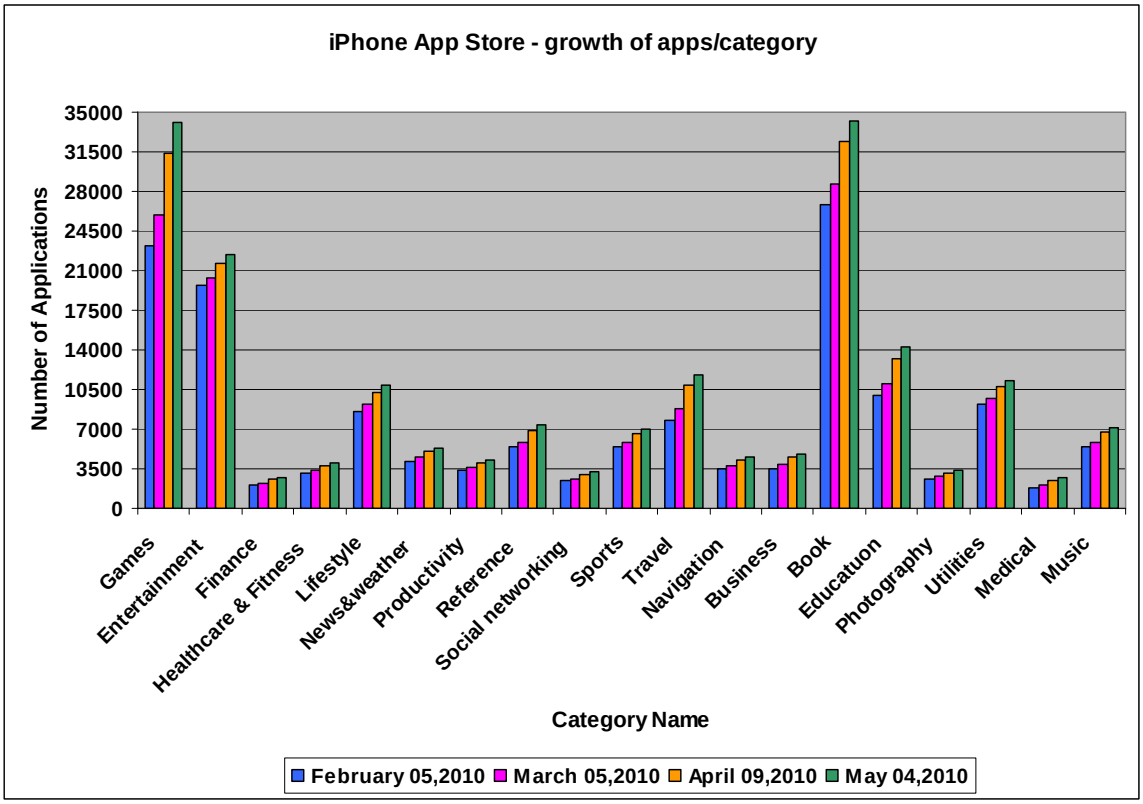

Figure 4: iPhone App Store – Number of Applications/category/month

5.3.2 Android Application Volume

The figure below shows the number of application in each category by month. In January of 2010 there were around 3,800 applications in the Games category and reached around 6,300 by April of 2010, i.e., over 2,600 new applications were added in this category within a period of 4 months. The Entertainment category which was earlier at around 4,400 in January 2010, reached to around 9,500 plus applications by April 2010. Considering the current growth in the new applications, we can say that there would be an increase of 18-

20% growth in the App Store. We can see that some of the categories like comics, entertainment, travel, tools, themes, etc. are also increasing at an exponential rate.

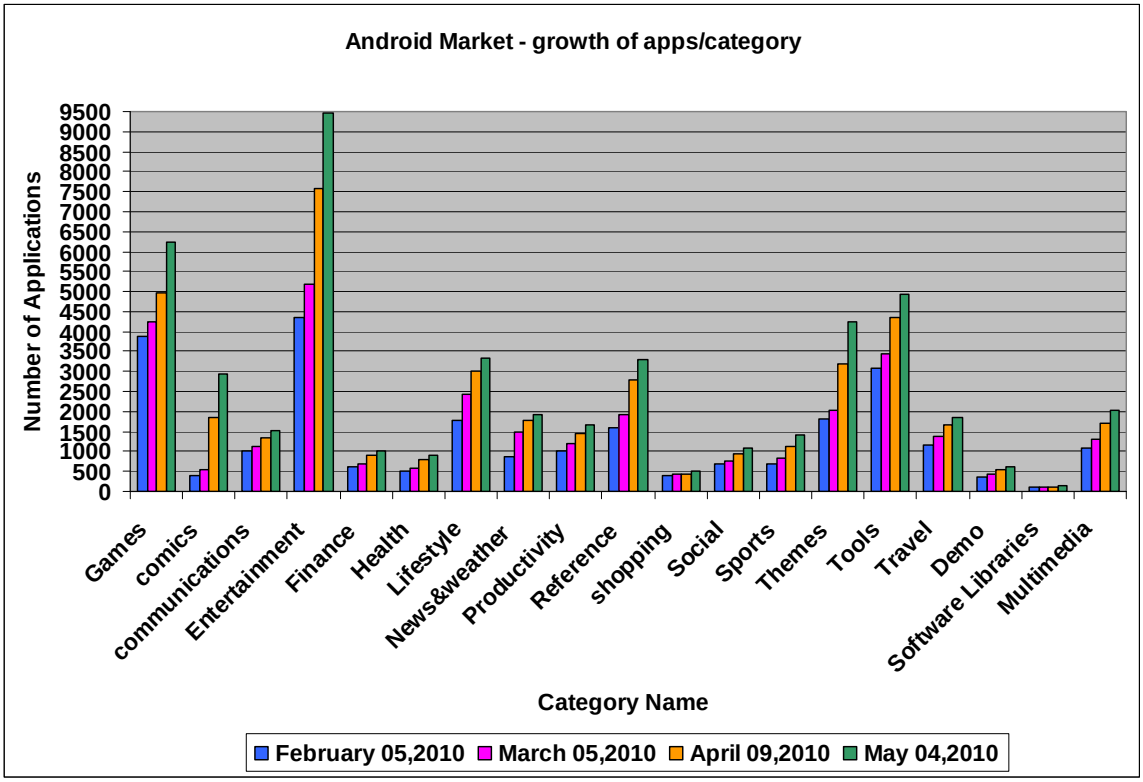

Figure 5: Android Market – Number of Applications/category/month

5.3.3 Comparision of iPhone and Android Application Volume

The figure below shows the common categories by month on both iPhone and Android. The total 12 categories are common on both the application stores. As shown below under game category, there were around 23,000 applications on iPhone App Store compared to 4,000 applications on Android Market in January 2010.

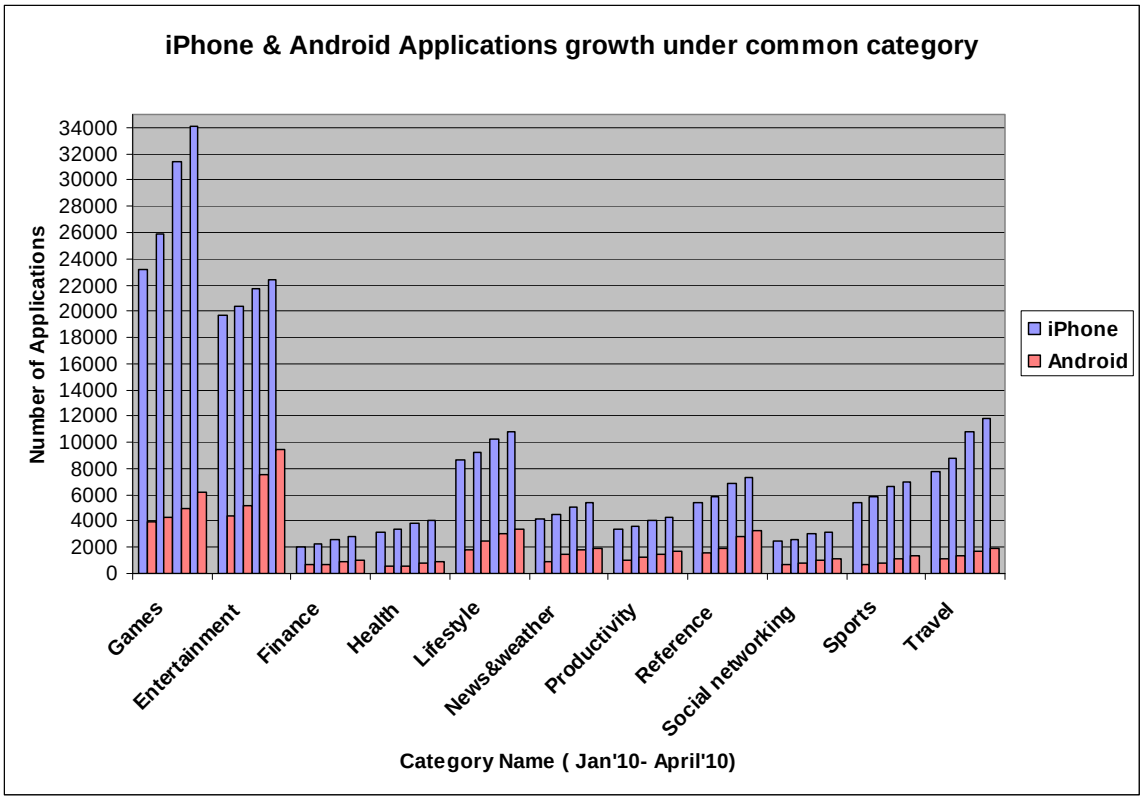

Figure 6: Number of Applications/common category/month on iPhone App Store & Android Market

5.4 Observations from Collected Application Data

From the application data collected for Jan, Feb, March, and April of 2010, we saw an increase of approximately 15-20% growth in the Android Market. On the other hand, for iPhone we saw around 8-10% growth in the App Store.

(See the Appendix IV &V)

6.0 MOBILE APPLICATION DEVELOPERS INTERVIEW

6.1 Attending Mobile Industry Conferences

Basic information on the different mobile platforms and their application developers are collected by attending different events like the Mobile Monday Silicon Valley (MoMo), Meetup group events organized by sfandroid group and IEEE Computer Society. Mobile Monday (MoMo) is a Silicon Valley based group and their mission is "to help tech professionals based in the San Francisco Bay Area learn more about mobile industry through monthly presentations and networking events." (MobileMonday, 2010) The San Francisco Android User group is an interactive group about Android mobile platform focusing on latest developments in this space. Their discussion is focused on the trends in technology, business, and job outlook. ("San Francisco Android User Group, 2009)

These events helped in gaining an insight and an understanding of how the new mobile applications are more customer-centric, and how the developers find the ways to promote their applications in the global market. Moreover, a conversation with different industry folks and developers gave an insight on mobile application marketplace and why the developers build applications for more platforms (cross-functional platforms) to gain market leadership.

One of the attended events was about "Looking at different trends in check-in apps, their social impacts and monetization opportunities." t was focused on how cool applications like cause world are; by not just creating new check-ins for customers but also helping donate to charities by having tie ups with big brands like Procter & Gamble, Citi, and Kraft. One of the panelists, Cyriac Roeding, Co-founder and CEO of Shop Kick

Inc. at the conference spoke about how these big brands are turning their marketing dollars into charitable donations. Reno Marioni, Nokia Strategic Internet Partnerships promoted the apps store concept and also made an announcement that Nokia was open for partnerships for such cools applications. The other attended event, organized by the Santa Clara Valley Chapter of the IEEE Computer Society at Microsoft Research, was about an overview on Android business ecosystem by Mike Demler and Android technical lecture by Marko Gargenta. The summary of the attended conferences is also shown in the below table.

Table 4: List of Attended Conferences

Date	**Sponsor**	**Topic**
03/08/2010	Mobile Monday	Check-in Apps/Social Location - Social Impacts and Monetization Opportunities
04/13/2010	IEEE Computer Society of Silicon Valley	Android: A 9,000-ft Overview

Additionally, we got an opportunity to showcase this research paper towards the end of the first event with a 2 minute long speech. Thus, by attending these events we met and shared our reseach idea with professionals working in mobile industry.

6.2 Summary of One-on-One or Phone Interview

For this research, 9 interviews were conducted with mobile application developers, product managers, and business developers to know their views on various mobile platforms and understand the ecosystems of the iPhone as well as the Android. These interviews have served as a preliminary set of information for the research. Most of the interviews were either telephonic or one-on-one discussions. Sections below

summarize the developers' opinions on various aspects of application development for iPhone/Android platforms.

6.2.1 Factors for selecting iPhone/Android Platform

When asked about the factors that facilitate to work on iPhone/Android platforms, most of iPhone developers answered that the iPhone is much more mature market and platform compared to other mobile platforms for application development. Other facilitating factor for iPhone is its complete available SDK package including user interface, architecture framework, APIs, development tool, libraries, etc. Also, the iPhone development community is very large to bring the products to market easily. The number of customers, applications and number of revisions facilitate the developers to build an application on this platform much easily.

Discussing about Android development, most of the developers said that Android is growing at a faster rate compared to iPhone and they would like to switch to Android in near future. As per their views, Android being open source also offers a complete SDK package with architectures, APIs, libraries etc., but its development tools are not well advanced and are required to add more enhanced features in near future to increase more application development.

6.2.2 Negative Factors on iPhone/Android Platform

When asked about how these platforms do not meet one's needs as a developer, most of the interviewees said that Apple has lack of transparency with application developers in terms of the store policies. Sometimes Apple does not share clear rules with developers and changes its store policies very often without

notifying the developers. Another negative factor is the application approval process of the iPhone App Store. Other dissatisfying issue is that Apple does not give any clear indication of application acceptance or rejection. Apart from this, according to the developers, there are no particular software related issues for developing an application other than an approval process.

For Android, one of the main shortfalls is development tools for building an application. Android Market is still in the development phase so there are no other negative factors as of now.

6.2.3 Developer and Application Approval Process on iPhone/Android Platform

Asking few developers about the iPhone App Store approval process, they said that the first step is to enroll in the Apple Developer Programs and register as a developer, then select the programs based on the platform an individual wishes to develop on, and complete the purchase by receiving an e-mail from the Apple developers support team which has all the information about how to access the program. One can enroll as an individual or as a company. As an individual developer, he/she is a sole developer and his/her name appears as the seller. On the other hand, if one enrolls as a company, he/she can add additional developers to form a team and the company's name appears as the seller. On the other side, there is no such type of approval process for those who want to develop an application on the Android platform.

In response to the question asked about the App Store's application approval process, most of the interviewees said that though the first step is to

submit an app to Apple store by following their policies, Apple sometimes does not share the changes of its rules/policies, if any, with the developers and the application approval process has no clear rules. Another issue is the lack of proper guidelines given about procedures to be followed in order to know applications acceptance and rejection on the application marketplace. They also mentioned that earlier the whole approval process was used to take 3-4 weeks but from last few months it took only 1-2 weeks. Though Apple has very strict rules and policies for an application to get approved on the App Store, at the end of the day these rules help the developers build better applications and gain huge profits via the sales of these applications and benefit the end user by making the user experience better.

While asking the same question about Android, most of the interviewees answered that Google has not yet created any typical approval process or policies to get an application on the online marketplace. To sell an Android application, there are multiple markets available other than Android Market and developers can also create an application market with a whole bunch of their own apps. For this, they do not require permission from Google or anyone. Thus, the application approval process for the Android is not as strict as compared to the iPhone App Store "Ad Hoc Distribution." It currently helps developers develop and show up their apps on the Android Market within a day or two.

6.2.4 Product Price Decision

When asked about how the companies generate revenue or how they arrive at the product pricing for the iPhone applications, most of the

companies/developers said that they first understand the business model and their target customers by conducting market analysis. After that they follow standard norms to decide the product/application price i.e., they build products/applications which have bigger audience and then decide the price by comparing them with competing applications. Many interviewees mentioned an exciting strategy for arriving at their product price. It is like this: first, introduce an application as a free application from the app store, then monitor the number of downloads for the same application. 1) if the numbers are staggeringly high, introduce a premium version of that application for a few dollars. 2) if the numbers are significantly low, update or modify the look-and-feel of the application to gain more downloads. According to them, the free applications also contain explicit advertising information of the paid premium version of the application that eventually bring in more sales/revenue. There are various business models for advertising the applications like:

I. Freemium: It offers minimum charges for the premium version of application; most of interviewees were using this business model
II. Ad-supported (like Google Radio): It advertises the applications developed by the developers who want to earn higher revenue for their developed apps using ads; very few of the interviewees were using this business model
III. Paid Applications: It charges money for downloading the apps; many interviewees were using this business model.

Talking about the Android, they mentioned that there is no such price deciding method on Android Market. Most of them decide the product price after market analysis of a similar kind of product on same or other platforms.

6.2.5 Future Development

According to most of the application developers, considering the current market, iPhone is much more mature compared to other platforms but Android would definitely be a lot more mature market in the future with lots of more features. They also mentioned that after the launch of windows mobile 7, the whole mobile application market, competition would change between these 3 platforms.

In summary, the iPhone developers would like to continue working on the iPhone platform, but are also willing to shift on Android if it gains a larger market share with the implementation of new development tools. The most important factors taken into account when selecting a platform for developing a new application are money, market share, market size, number of customers, development tools, and ease of publishing.

7.0 SURVEY DATA AND ANALYSIS

7.1 Introduction

Preliminary interview helped gain some understanding regarding the iPhone/Android app stores; the factors most important for development on these platforms are approval process, channel distribution process, etc. After completing the preliminary interviews, the survey was developed based on the information from the application data and interviews. It was required to bring a clear understanding about the 3rd party application development. The survey was posted on SurveyMonkey, an online tool to create and publish custom survey, which was ideal for this research project.

The conferences we attended and contacts with developers during the preliminary interview helped reach a bigger and targeted audience. Our advisors also gave us the right directions in finding appropriate audience. The survey was shared amongst friends, colleague and posted on groups such as online Yahoo-groups for Mobile Monday (MoMo), Google-groups for Android, San Francisco Developers Meetup group, various LinkedIn developers' groups. This survey was filled out by different professionals like developers, product manager, engineers, etc., who work on iPhone/Android platform and has a deep understanding about the trends and future of these platforms. At the end, we got 63 responses which is a significant sample size for this project. The results from the survey are explained below.

7.2 Summary of the Average Responses (Descriptive Statistics)

A summary of the average of the questions which give general information about the responders has shown below.

Question 1:

From the below table, it shows that the Android is the most important mobile platform than the iPhone for most of the respondents. For respondents working on iPhone, it is the most important platform, and Android is the next important platform for them and vice versa.

Table 5: Most Important Mobile Platforms

Which mobile platforms are most important to your company?(Rank them: Being 1 - Least important and Being 6 - Most important)		
Answer Options	**Most important**	**Rating Average**
Android	35	5.37
iPhone OS	19	4.68
Blackberry OS	4	3.27
Windows Phone	1	2.57
Web OS	1	2.56
Symbian/Series 60	3	2.56

Question 2:

From the below table and graph, we can say that most of the respondents are working on Android.

Table 6: Mobile Platforms

What mobile platforms do you work on?		
Answer Options	**Response Percent**	**Response Count**
Android	90.5%	57
iPhone OS	44.4%	28
Blackberry OS	23.8%	15
Symbian / Series 60	14.3%	9
Windows Phone	11.1%	7
Web OS	7.9%	5

Question 3:

The below table says as per most of the respondents, market size and potential revenue are the most important factors for developing an application. In addition, other respondents also mentioned that development time, cost vs. return and security model are the considerable factors for developing an application, In particular, for Android, being an open source provides stable and flexible architecture and design for development. Also, Google's flexibility for approval process for Android Developers to try out an app in their own phones before pushing in the Android Market attracts them to choose Android over iPhone.

Table 7: Important Factors for Application Development

For developing an application, which factors do you consider most?		
Answer Options	**Response Percent**	**Response Count**
Market Size	61.9%	39
Potential Revenue	60.3%	38
SDK	55.6%	35
Cost of Development	55.6%	35
Channel Approval Process	47.6%	30
Distribution Channel	46.0%	29
Developer community	38.1%	24

Question 4:

Here, we can conclude that according to most of the respondents software issues are the biggest problem for mobile development. Some of the respondents also mentioned that as Android is available on different devices with different versions creates interoperability, platform fragmentation, and replication user issues and these issues increase the development time.

Table 8: Biggest Problem in Developing Application

Which is/are the biggest problems you have experienced for mobile development?		
Answer Options	**Response Percent**	**Response Count**
Software issues	61.4%	35
Hardware issues	31.6%	18
Support from Platform Developers	29.8%	17
Channel Approval Process	21.1%	12

Question 5:

From the table, we can say that online discussion forums are the most useful resources as seen from the table and graph below. Also other respondents feel that manual is one of the useful resources.

Table 9: Useful Resources for Making Development Decisions

For making development decisions, what are the most useful resources from the following?		
Answer Options	**Response Percent**	**Response Count**
Online Discussion Forums	74.6%	47
Personnel Friends	34.9%	22
Conferences	27.0%	17
E-mail list	22.2%	14

Question 6:

On asking about level of expertise in Android, we can conclude that here most of the respondents fall under the scale of 3 & 4.

Table 10: Level of Knowledge about Android

How knowledgeable are you about Android on the scale of 1 to 5?		
Answer Options	**Response Percent**	**Response Count**
1-Novice	4.8%	3
2	12.7%	8
3	33.3%	21
4	31.7%	20
5-Expert	17.5%	11

Question 7:

Here, from the table we can say that APIs are the most important feature to respondents developing on any platform. Other respondents also consider open source, open platform and support from platform vendors as important factors for Android.

Table 11: Android Features

Which are the most important Android features to you?		
Answer Options	**Response Percent**	**Response Count**
APIs	77.8%	49
Development Tools	58.7%	37
Platform Architecture	55.6%	35
Developer Community	44.4%	28
Access to Hardware Features	42.9%	27
Too complicated to learn/use	6.3%	4
Poor Enterprise Integration	3.2%	2

Question 8:

The table below shows that application development is the prime focus for the respondents. Few respondents also mentioned that their company's focus is more on the devices running Android.

Table 12: Type of the Company

What is the focus of your company?		
Answer Options	**Response Percent**	**Response Count**
Application Development	71.4%	45
Software	22.2%	14
Hardware	6.3%	4
Distribution	0.0%	0

Question 9:

From the below table, we can conclude that half of the companies spend less than $1K in marketing on the smartphone-related business.

Table 13: Annual Marketing Expenditure

How much is your company's annual marketing expenditure for smartphone-related business?		
Answer Options	**Response Percent**	**Response Count**
$0	25.4%	16
$1-1000	22.2%	14
$1000-100K	42.9%	27
$100K above	9.5%	6

Question 10:

The below result says that most of the respondents participated in this survey are Software Developers. There are also few respondents who are sole traders, CEOs, Business Analysts.

Table 14: Respondents' Job Title

What is your job title?		
Answer Options	**Response Percent**	**Response Count**
Software Developer	49.2%	31
Other	19.0%	12
Technical Manager/Engineering Manager	15.9%	10
Product Manager	12.7%	8
Marketing Manager	3.2%	2
Hardware Developer	0.0%	0
Quality Assurance	0.0%	0

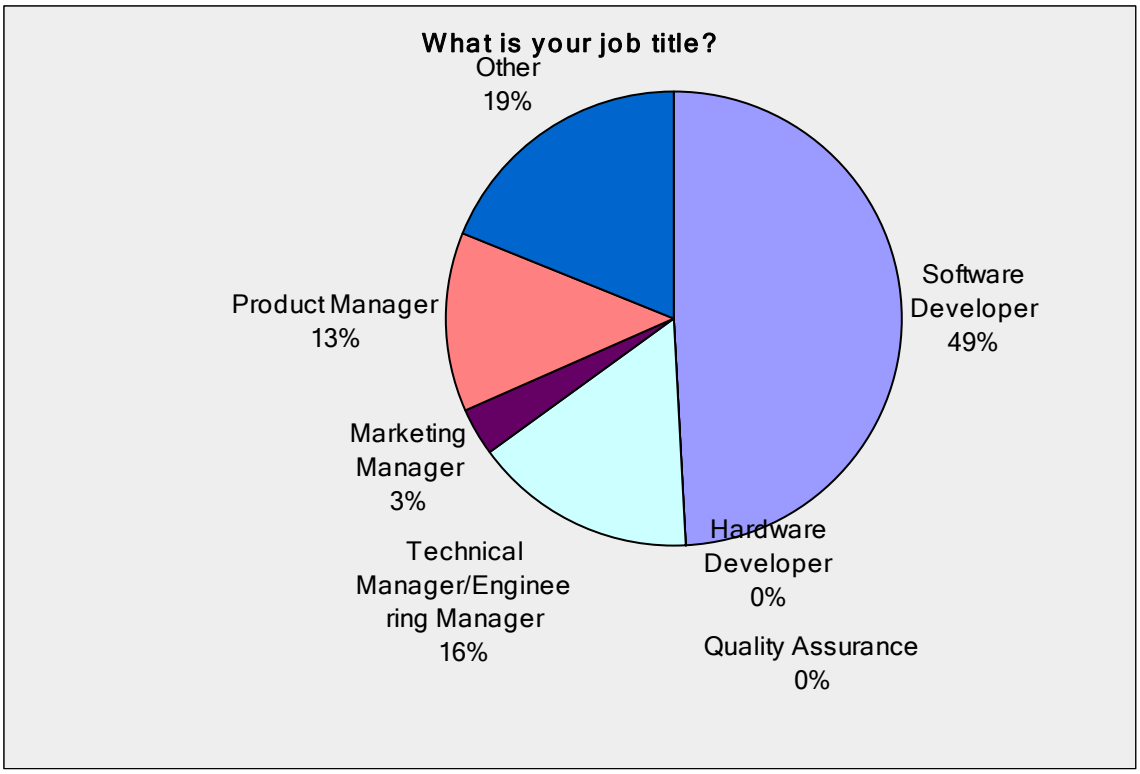

Figure 7: Job Title Response Count

Question 11:

Below result shows that most of the professional developers who filled out this survey have more than 10 years of experience.

Table 15: Years of Experience as Developer

How long have you been professional developer?		
Answer Options	**Response Percent**	**Response Count**
0-6 Months	6.3%	4
1-5 Years	17.5%	11
5-10 Years	11.1%	7
10 Years or more	52.4%	33
N/A	12.7%	8

Figure 8: Response Counts for Years of Experience

Question 12:

From the below table & graph, we can conclude that majority of the respondents work in a company/group of developer having the size of 1-9 employees.

Table 16: Size of the Company/Developer Group

What is the size of the developer group for mobile product of your company?		
Answer Options	**Response Percent**	**Response Count**
1-9	81.0%	51
10-99	15.9%	10
100-999	1.6%	1
1000-above	1.6%	1

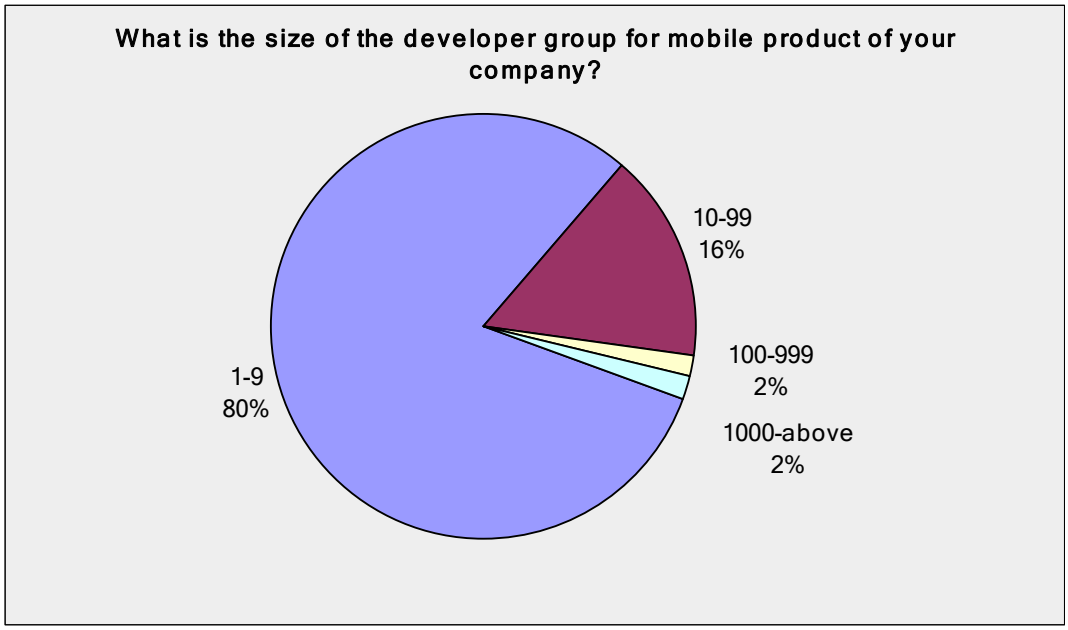

Figure 9: Size of the Company/Developer Group

Question 13:

The below results shows that majority of the people participated in this survey were from North American companies.

Table 17: Location of the Company's Headquarter

Where is your company's headquarters located?		
Answer Options	**Response Percent**	**Response Count**
North America	66.7%	42
Europe	22.2%	14
Asia	9.5%	6
Other	1.6%	1

7.3 Correlations between Questions (Crosstab Results)

To prove the hypothesis, it is also needed to know interrelation between the development trends on the platforms like Android and iPhone. To understand this, we used the tool available with the premium addition/version of the SurveyMonkey, called "Crosstab Responses." This tool helps to show a side by side comparison of two or more survey questions to determine how they are correlated.

In this case the variables are: iPhone and Android and the emphasis was on developers, who choose the platform for development based on the development tools, market size, revenue potential, etc. For this project, the questions 3, 4, 5, and 7 from the survey (as mentioned below) are very important. To understand the results from these questions, few variables are selected from question 1, 2, 8, 9, 10, 11, and 12. The results after correlating the different questions from the survey are explained below.

Question 3: For developing an application, which factors do you consider most? (Overall result: Market Size)

- Cross tabulating with the mobile platforms (iPhone or Android) (Q2)
    - Of iPhone developers, 85.7% consider "Market Size" as most important
    - Of Android developers, 59.6% consider "Potential Revenue" as most important
- Cross tabulating with the type of company (Q8)
    - Of Application Development, 64.4% consider "Potential Revenue" as most important *(Significant different)*
    - Of Software company, 71.4% consider "Cost of Development" as most important *(Significant different)*

- Cross tabulating with company's annual marketing expenditure on smartphone-related business (Q9)
    - Of spending $0, 62.5% consider "SDK" as most important *(Significant different)*
    - Of spending $1-1000, 78.6% consider "Cost of Development" as most important *(Significant different)*
    - Of spending $1K-100K, 66.7% consider "Market Size" and other 66.7% consider "Potential Revenue" as most important *(Significant different)*
- Cross tabulating with the job title (Q10)
    - Of Software Developers, 64.5% consider "Cost of Development" as most important *(Significant Different)*
    - Of Technical/Engineering Manager, 60% consider "Potential Revenue," other 60% consider "Market Size," and other 60% consider "SDK" as most important *(Significant Different)*
    - Of Product Manager, 87.5% consider "Market Size," and other 87.5% consider "Potential Revenue" as most important *(Significant Different)*
- Cross tabulating with the size of developer's group/company (Q12)
    - Of the size of 1-9, 58.8% consider "SDK" as most important *(Significant different)*
    - Of the size of 10-99, 90% consider "Market Size" as most important *(Significant different)*
- Cross tabulating with the developer's region (Q13)

- Of the North American companies, 69% consider “Market Size” as most important
- Of the European companies, 57.1% consider “Potential Revenue” and other 57.1% consider “SDK” as most important *(Significant Different)*
- Of the Asian companies, 66.7% consider “Market Size,” other 66.7% consider “Potential Revenue,” other 66.7% consider “Developer Community,” other 66.7% consider “SDK,” and other 66.7% consider “Distribution Channel” as most important *(Significant Different)*

Question 4: Which is/are the biggest problems you have experienced for mobile development? (Overall Result: Software Issues)

- Cross tabulating with the mobile platforms (iPhone and Android) (Q2)
  - Of iPhone developers, 56% consider “Software Issues” as most important
  - Of Android developers, 60.4% consider “Software Issues” as most important
- Cross tabulating with the type of company (Q8)
  - Of Application Development, 57.1% consider “Software Issues” as most important
  - Of Software company, 66.7% consider “Software Issues” as most important
- Cross tabulating with the job title (Q10)
  - Of Software Developers, 60.7% consider “Software Issues” as most important

    - Of Technical/Engineering Manager, 60% consider “Software Issues” as most important
    - Of Product Manager, 57.1% consider “Channel Approval Process” as most important *(Significant Different)*
- Cross tabulating with the size of developer’s group/company (Q12)
    - Of the size of 1-9, 69.6% consider “Software Issues” as most important
    - Of the size of 10-99, 44.4% consider “Support from Platform Developers” and other 44.4% consider “Channel Approval Process” as most important *(Significant different)*
- Cross tabulating with developer’s region (Q13)
    - Of the North American companies, 58.3% consider “Software Issues” as most important
    - Of the European companies, 71.4% consider “Software Issues” as most important
    - Of the Asian companies, 66.7% consider “Support from Platform Developers” as most important *(Significant Different)*

Question 5: For making development decisions, what are the most useful resources from the following? (Overall Result: Online Discussion Forums)

- Cross tabulating with the mobile platforms (iPhone and Android) (Q2)
    - Of iPhone developers, 78.6% consider “Online Discussion Forums” as most important
    - Of Android developers, 75.4% consider “Online Discussion Forums” as most important

- Cross tabulating with the type of company (Q8)
    - Of Application Development, 73.3% consider “Online Discussion Forums” as most important
    - Of Software company, 85.7% consider “Online Discussion Forums” as most important
- Cross tabulating with the size of developer’s group/company (Q12)
    - Of the size of 1-9, 74.5% consider “Online Discussion Forums” as most important
    - Of the size of 10-99, 70% consider “Online Discussion Forums” as most important
- Cross tabulating with developer’s region (Q13)
    - Of the North American companies, 78.6% consider “Online Discussion Forums” as most important
    - Of the European companies, 64.3% consider “Online Discussion Forums” as most important
    - Of the Asian companies, 66.7% consider “Online Discussion Forums” as most important

Question 7: Which are the most important Android features to you?

(Overall Result: APIs)

- Cross tabulating with the mobile platforms (iPhone and Android) (Q2)
    - Of iPhone developers, 82.1% consider “APIs” as most important
    - Of Android developers, 78.9% consider “APIs” as most important
- Cross tabulating with the type of company (Q8)

    - Of Application Development, 84.1% consider “APIs” as most important
    - Of Software company, 71.4% consider “Platform Architecture” as most important *(Significant different)*
- Cross tabulating with company’s annual marketing expenditure on smartphone-related business (Q9)
    - Of spending $0, 75% consider “APIs” as most important
    - Of spending $1-1000, 64.3% consider “Developer Community” as most important *(Significant different)*
    - Of spending $1K-100K, 88.9% consider “APIs” as most important
- Cross tabulating with the size of developer’s group/company (Q12)
    - Of the size of 1-9, 76.5% consider “APIs” as most important
    - Of the size of 10-99, 80% consider “APIs” as most important
- Cross tabulating with developer’s region (Q13)
    - Of the North American companies, 76.2% consider “APIs” as most important
    - Of the European companies, 78.6% consider “Development Tools” as most important *(Significant different)*
    - Of the Asian companies, 100% consider “Platform Architecture,” 100% consider “APIs,” and 100% consider “Developer Community” as most important *(Significant different)*

Question 9: How much is your company’s annual marketing expenditure for smartphone-related business? (Overall Result: $1K-$100K)

- Cross tabulating with the type of company (Q8)

- Of Application Development companies, 48.9% spend “$1K-$100K” on marketing for smartphone-related business
- Of Software companies, 35.7% spend “$0” and other 35.7% spend “$1K-$100K” on marketing for smartphone-related business
- Of Hardware companies, 50% spend “$1-$1K” on marketing for smartphone-related business

7.4 Summary from Survey Results

Though the overall result of the survey shows that “Market Size” is the important factor and “Software Issues” is the biggest problem in developing an application and also most of the respondents consider “APIs” as one of the attractive feature on Android. Some of the survey results are different from the overall expected results when they are cross-tabulated. The below content explains these results.

- For respondents working on iPhone, it is the most important platform and Android is the next important platform and vice versa.
- As per most of the Product Manager, iPhone is the most important platform.
- Although overall result shows “Market Size” as the most important factor, for Software Developers “Cost of Development” is the first important factor and “Channel Approval Process” is the second important factor for developing an application.
- On the other hand, according to the most of Products Managers “Channel Approval Process” is the biggest problem for application development. The “Software Issues” which is the overall result, is the least big problem for them.

- For the Software companies, “Cost of Development” instead of “Market Size” or “Potential Revenue” is the most important factor for developing an application.
- “Platform Architecture” is the highest important Android feature for Software companies while “Development Tools” and “APIs” are second equal important features.
- “APIs” is more important Android feature for Application Development companies than Software companies.
- For developing an application, “Potential Revenue” and “SDK” are more important for European companies while “Market Size” (Overall result) is more important for North American companies.
- We can also conclude that “Market Size” is more important for Application development and Hardware companies whose headquarter is located in North America.
- The Asian companies involved in mobile application development, “Support for Platform developers” is more important than “Software Issues.”
- The first Android feature that attracts the European companies is “Development Tools” and the second important feature is “APIs.” On the other hand, for North American companies “APIs” is the more important Android features and “Development Tools” is the second important feature.
- Most of the North American and European companies who participated in this survey are with the size of 1-9 as a company or developer group for mobile product.

- “Potential Revenue” is more important for them who are working on Android and “Market Size” is the second important factor in developing an application while “ Market Size” is more important for them working on iPhone OS.
- From the overall result of the survey, we can also say that half of the companies spend less than $1K on marketing for smartphone-related business.
- The companies spending annual $1K-$100K on marketing for smartphone-related business, “iPhone OS” is more important than “Android” for them. On the other side, the companies spending annual $0-$1K, “Android” is more important than “iPhone OS.”
- The companies spending annual zero dollar on marketing for smartphone related business, “SDK” is more important to them than “Market Size” or “Potential Revenue” which are more important to companies spending $1K-$100K, for developing an application. While “Cost of Development” is more important for companies spending $1-$1K.

Apart from these results, the survey also says that platform fragmentation o\in Android, documentation, and development time are also the important factors in developing an application.

8.0 ECONOMIC JUSTIFICATION

8.1 Executive Summary

What is the product?

The research paper, “Analysis of Emerging Android Market” will provide a service to all the developers developing applications for platforms like Android, iPhone, etc. This paper will help understand the role of application developers in the mobile ecosystem and how Android is gaining success, and the number of applications on this is increasing by a significant amount.

What is the market size?

There are around 195,000 plus apps on iPhone App Store and 49,000 plus apps on Android Market. If the market continues to grow at a steady rate, there would be an ever increasing demand in the trends for application development. At an approximate price of $1000 per article, we estimate the market for our research paper to be $850K. We anticipate developer communities and different Independent Software Vendors (ISVs) like individual developers, small ISVs, large ISVs, enterprise developers, etc. as the target market.

What is the startup cost?

We would require approximately $40,000 to start a small mobile research foundation.

What is the payoff?

We anticipate break-even when 65 copies been sold. In addition, we anticipate working with the developer communities and small and big ISVs to reach a bigger audience.

Management Team?

The team itself was multidisciplinary and multi-cultural consisting of two San Jose State University Engineering Managers.

8.2 Problem Statement

Recently, the battle of mobile OS is spreading beyond the smart-phone arena and entering into other mobile and consumer devices. This battle has created the challenges for application developers to offer attractive & creative applications that are convincing on multiple platforms. Today, most of the major OS vendors are working to create an effective ecosystem of application developers to build different attractive applications for their OS platforms. It is a fascinating area to research and figure out the application developments trends across these platforms.

As stated earlier, this project addresses the Android ecosystem and their third-party application developers. This project is triggered in indentifying and understanding the views of application developers about the mobile platform and the ecosystem by comparing Android and iPhone platforms.

8.3 Solution or Value Proposition

The main purpose of this project is to provide solution/service for understanding the role of application developers in the mobile ecosystem and developers' motivational facts for building an application for hand-held devices e.g., iPhone, Android.

By going through many articles and research papers, we found that a lot of research has been done on iPhone and Android online application marketplaces. This study mainly includes investigating the growth of these two app stores i.e., which applications are developed & become popular, what is the average cost of each

application, how developers are making the iPhone or Android platform so popular among customers, etc. Where, this research paper specifically focuses on investigating third-party application developers' views about the wireless mobile ecosystem or their motivations for building an application on iPhone/Android mobile platforms. Thus, this study will provide significant information on iPhone/Android application developers to individual developers, small ISVs, large ISVs, enterprise developers and different developer communities.

8.4 Market Size

Benefit of our service to our potential customers is to get market research paper at very low price to $1000. According to market analysis, the potential customers who want the similar type of research regularly pay up to $3000.

8.5 Competitors

Through research, we found few competitors like marketing research companies, research consultants and independent market researchers world-wide that provide similar solutions only related to the wireless mobile ecosystem or online application markets. But there is no directly competition to our market research and analysis.

Our service provides research of the third-party application developers, build cool applications for different app stores. Apart from the main focus, this project also contains the analysis of iPhone and Android application market.

8.6 Customers

This project focuses on industry wide solution. The target audience for this project includes different developers' communities and Independent Software Vendors (ISVs) that include individual developers, small ISVs, large, ISVs, enterprise developers,

etc. It would be sold to senior level management. In addition, it could be also useful to our competitors, want to conduct a research study of third-party Software/Application developers.

8.7 Cost Summary

For this research related project, the cost is associated as implementation (in terms of time) and survey cost.

8.7.1 Development and Implementation Costs

The first step, for conducting a comparison between iPhone and Android developers, is to study and understand their individual online application stores. These application stores have around 20 different applications categories and each category contains more than hundreds of applications. The following figure shows the distribution as percentage of apps in different categories for both application stores.

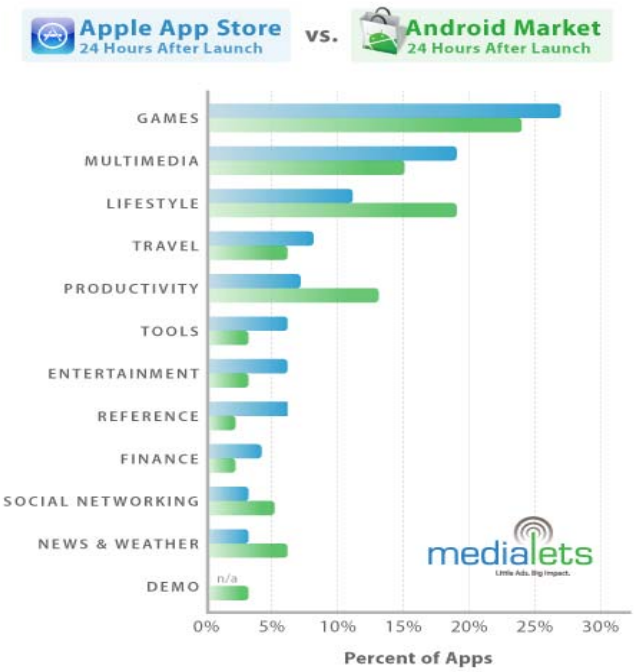

Figure 10: Percentage of applications in different categories

(Source: *Android Market and iPhone app store*, Retrieved on October 18, 2009, from Androidcentral web site: http://www.Androidcentral.com/Android-market-iPhone-app-store-compared.)

Under these categories, hundreds of new applications are being developed and come into the market every month. So, collecting the information for each application and its developer is going to be very tricky and time consuming effort. Here, we have estimated the cost of this time consuming effort as below:

- Android Market has 1,960 (4% of 49,000) applications and each application would take around 30 seconds to get the information. (1,960 apps * 30 seconds)/ 60 seconds = 980 minutes (16.3 hours)
- iPhone App Store has 4,875 (2.5% of 195,000) applications and each application would take around 30 seconds to get the information. (4,875 apps * 30 seconds)/ 60 seconds = 2,438 minutes (40.6 hours)

- Total time for collecting data = 16.3 hours + 40.6 hours = 56.9 hours ~ 57 hours

The cost of each application varies from price of free to approximately $20.

Apart from these application data, to get the information of iPhone/Android application developers, we have attended many mobile industry conferences conducted in Silicon Valley. To know developers' views, we have interviewed 9 iPhone/Android application developers. Thus, collecting mobile applications and developers' related data would be a big cost in terms of time and effort.

8.7.2 Survey Cost

As we mentioned above, there are more than 38,000 applications and around 20 different categories in the Android Market. In order to collect the Android application data for market analyzing, we used a manual method. (Importing HTML into Excel) The iPhone application data has downloaded with the help of a software developer. (Team resource)

The cost incurred by us can be categorized as follows:

- Sample the collected data as per requirements
- Develop and post the survey on online survey website: surveymonkey.com. The subscription cost = $20/month
- Overhead costs: $200/month
- The labor cost for creating the survey and analyzing the results
- Fixed labor cost = 28 days * 8 hours * $40/hour = $8,960/person

- Total Survey Cost = Labor Cost + Survey Development Cost + Overhead Costs (internet, electricity etc.)
- Total Survey Cost = $8,960 + $20 + $200 = $9,180

8.7.3 Total Project Cost

For calculating the overall project cost, we have assumed following:

- Project duration: 6 months = around 25 weeks = 125 days (5days/week)
- Total Survey Cost: $9,180
- Operating Cost**:** Electricity + Internet + Other Cost = $1.5/day**,**
- Other Expenses = $500 over total project duration
- Overall Project Cost = $9,180 + (125 days*8 hours*$30/hour) + (125 days * $1.5) + $500 = $9,180 + $30,000 + $187.5 + $500

  Overall Project Cost = **$40,000 (Approximately)**

8.8 Price Point

Above calculations shows that if any market research company or individual wants to conduct this kind of study, it would cost them around 3-6 months depending on the number of persons involved plus approximately $40,000. On other hand, our research paper is around $1,000-$1,100. It is determined by market research of similar kind of available articles and our expenses and time that are spent on this individual project. This paper would be useful for people who want to conduct the further research in this type of area. With the help of this paper, they can save their investment in terms of time and money.

8.9 SWOT Analysis

It is an essential planning tool to evaluate Strengths, Weaknesses, Opportunities, and Threats involved in a project. Below is the SWOT analysis for this paper.

STRENGTHS	***WEAKNESSES***
No similar research has yet conducted Helps to minimize time & cost for conducting similar research Effective price	Highly dependent on survey data for market analysis Less access to distribution channels Few Contacts
OPPORTUNITIES	***THREATS***
Growing popularity of iPhone App Store and Android Market Research on understanding views about application developers	Future competition

Figure 11: SWOT Assessment

8.10 Investment Capital Requirements

Being a research project, there is no need to invest a huge amount of money except time commitment. The initial amount invested is divided equally among two investors Bimal Gadhavi and Khushbu Shah. This fund will help in the expenses (i.e., software person wage, survey cost, marketing & advertising cost, internet & electricity bill, etc.) required before reaching at breakeven point. The breakeven point where the total revenue would cover our paper cost is shown in the below diagram.

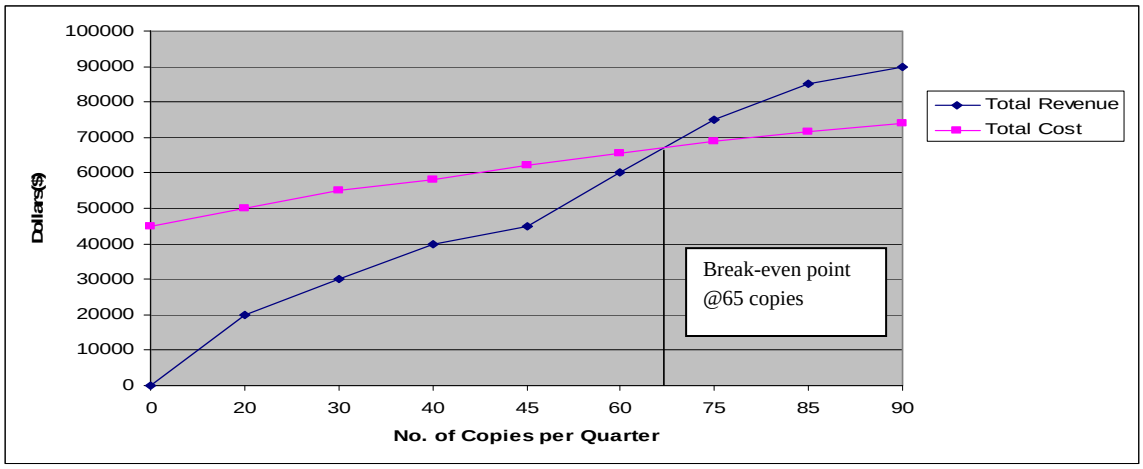

Figure 12: **Break-even Analysis**

As per breakeven graph, if 65 copies of our report were sold we will start to make money.

8.11 Personnel

Most of the research work has been carried out by a team of two individual, Bimal Gadhavi and Khushbu Shah, under the guidance of experienced professionals working closely to mobile industry. However, a Software Engineer is needed for gathering application data from online websites. Bimal Gadhavi is financial and marketing manager. He is responsible for finding and talking with the clients by market research. He also works to gather data for this study. Khushbu Shah is a project developer and she works on collecting all necessary data required for the project. Overall, both members work together to achieve a success through this research paper.

8.12 Business and Revenue Model

A business model describes the method for customer selection, pricing, competitive strategy, position in value chain of doing business. We have estimated to sell this case study (research paper) at a price of $1,000.

In order to how we actually sell this paper, we have planned to advertise it via social networking websites and events like online discussion forums, online technical

groups, technical conferences, and blogs. Moreover, we will publish our paper on the different websites dedicated for the developers' community.

8.13 Strategic Alliance/Partners

Our team of 2 people will work together as a whole to develop and sell a service. We do not intend to have partnership with others.

8.14 Profit & Loss

8.14.1 Profit and Loss Calculation for 1 year

Estimated expenses and sales are evaluated in profit & loss statement for Q3' 2010 to Q2' 2011. (1 Year)

Table 18: Profit & Loss Statement

	No. of Copies per Quarter	Cost/copy	Total Revenue	Total Expenses	Profit/Loss
Q3' 2010	0	$1,000	0	$45,000	($45,000)
Q4' 2010	20	$1,000	$20,000	$50,000	($30,000)
Q1' 2011	30	$1,000	$30,000	$55,000	($25,000)
Q2' 2011	40	$1,000	$40,000	$58,000	($18,000)

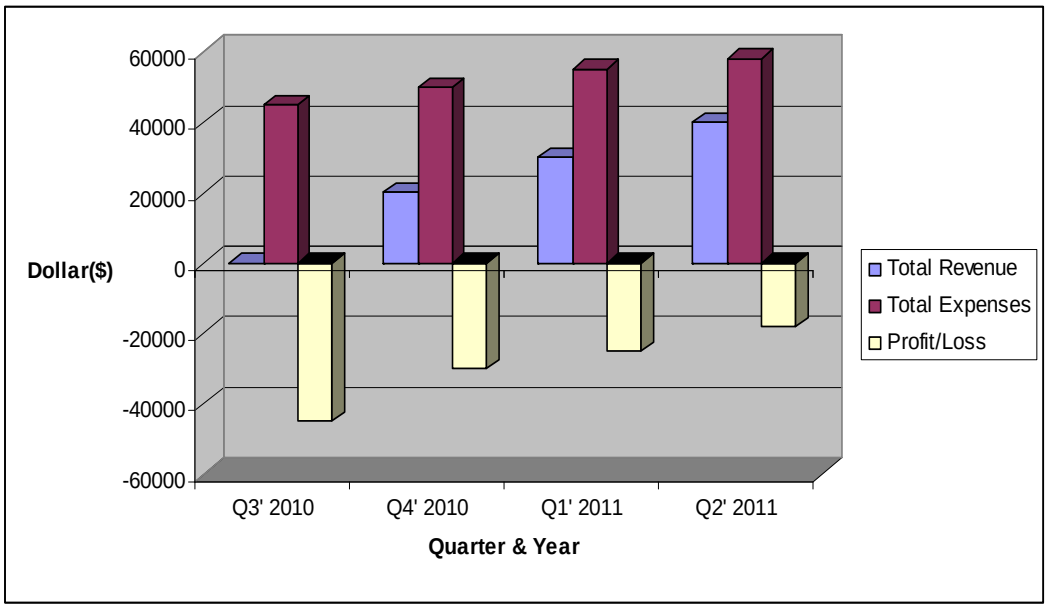

Figure 13: Profit & Lost Graph for 1 year

8.14.2 Norden-Rayleigh

The Norden-Rayleigh Graph helps to know the expenditures over the time for this project. It is calculated by using probability density function formula:

V(t) = 2adte^(-at^2)

The cumulative distribution function for the Rayleigh:

V(t) = d (1- e^(-at^2))

where v(t) = Total cost expended, a = financial cost drivers, d = estimated total budget, t = time

Table 19: Norden-Rayleigh Financial Profile

t	a	d	(-at^2)	e^(-at^2)	V(t) = 2adte^ (-at^2)	1-e^ (-at^2)	V(t) = d(1-e^(-at^2))
0	0.1	$45,000	0	1	0	0	$0
1	0.1	$49,500	-0.1	0.9037292	8946.91905	0.0962708	$4,765
2	0.1	$53,500	-0.4	0.66704211	14274.70122	0.3329579	$17,813
3	0.1	$56,500	-0.9	0.40210995	13631.52733	0.59789	$33,781
4	0.1	$60,500	-1.6	0.19797621	9582.048738	0.8020238	$48,522
5	0.1	$64,000	-2.5	0.07960821	5094.925151	0.9203918	$58,905
6	0.1	$67,500	-3.6	0.02614444	2117.699334	0.9738556	$65,735
7	0.1	$70,000	-4.9	0.00701257	687.2320904	0.9929874	$69,509
8	0.1	$72,500	-6.4	0.00153622	178.2009622	0.9984638	$72,389
9	0.1	$74,000	-8.1	0.00027485	36.61066417	0.9997251	$73,980
10	0.1	$74,000	-10	4.0163E-05	5.944195057	0.9999598	$73,997

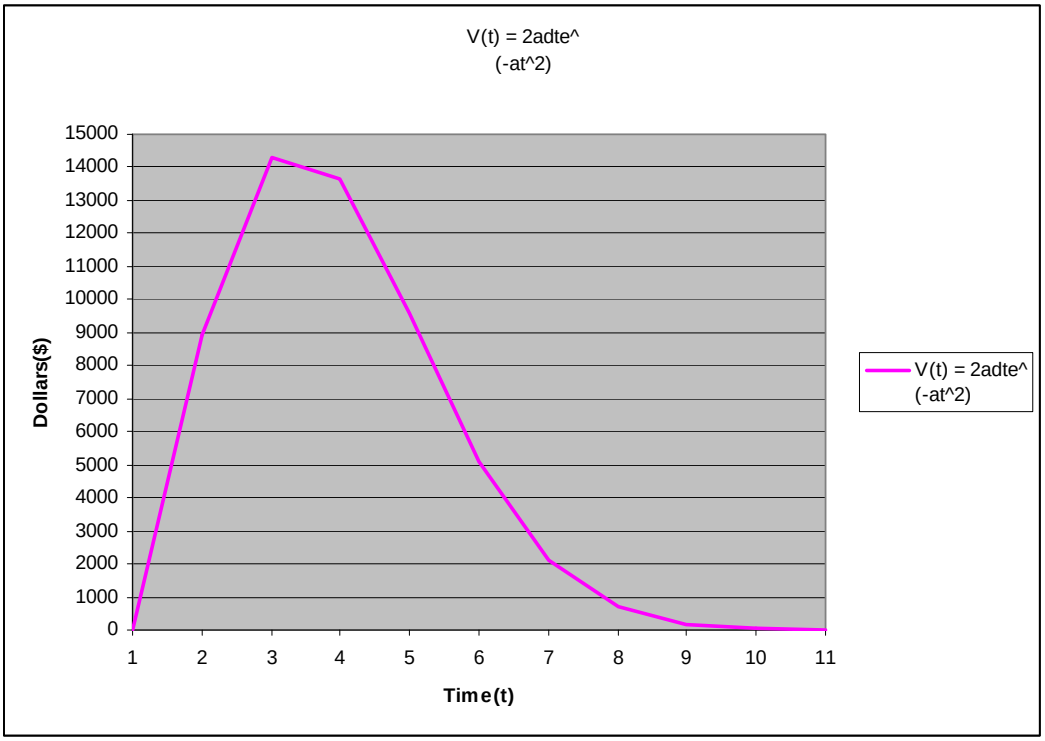

Figure 14: Funding profile over time

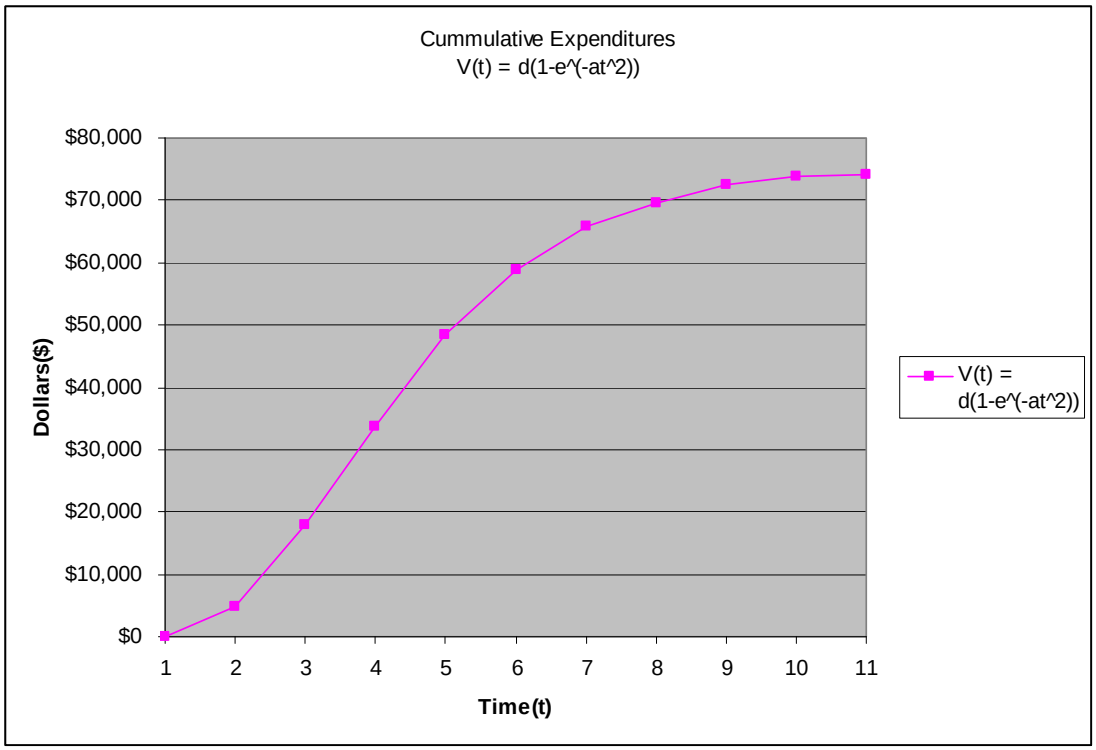

Figure 15: Cumulative funding over time

8.15 Exit Strategy

Currently, the smartphone industry is booming. Our goal is to continuously provide the similar kind of service to our customers in the future for different mobile platforms depending market condition. The exit strategy is to sell our copyrights to an established rival if they offer a good price after 3 years.

9.0 CONCLUSION

From reading articles, attending conferences, talking with developers, and gathering application data, and survey shows that there is a real demand for the application stores and 3rd party development for all the OS vendors.

The application data collected for Jan, Feb, March, and April of 2010, shows an increase of approximately 15-20% growth for the Android Market. On the other hand, iPhone sees a growth of around 8-10% in the App Store in the same period (see Appendices). From this data, we can conclude that the number of applications for Android is increasing exponentially. It can be said that the developers are switching to Android or developing their application on both iPhone and Android platforms.

Developers select Android for developing applications, based on Development Tools, APIs, Potential Revenue, and Approval Process/distribution channel. More developers will be choosing Android over iPhone in the near future for development; considering the market size and the growth in the application market.

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APPENDIX I – Team and Committee Information

Detail of committee members

William Weinberg is an industrial advisor for our master's project. He works as a Principal Analyst and Consultant at Linuxpundit.com and as Mobile Practice Partner at the Olliance Group. He has over 20 years of experience in open source, embedded and open systems, telecommunications, and other technologies. Linuxpundit.com helps clients on how to meet business strategy, technology and communications challenges in a rapidly growing marketplace. Mr. Weinberg has provided technical and economic advice and support throughout the project.

Dr. Joel West is a faculty reader for our master's project. Currently, he is working as a professor of innovation and entrepreneurship at the Department of Organization and Management in the College of Business, SJSU. Dr. West has earned a Ph.D. in management from the University of California, Irvine. He has provided us the necessary guidance for achieving each necessary milestone during project implementation by monitoring the project progress and would also provide technical advice if necessary.

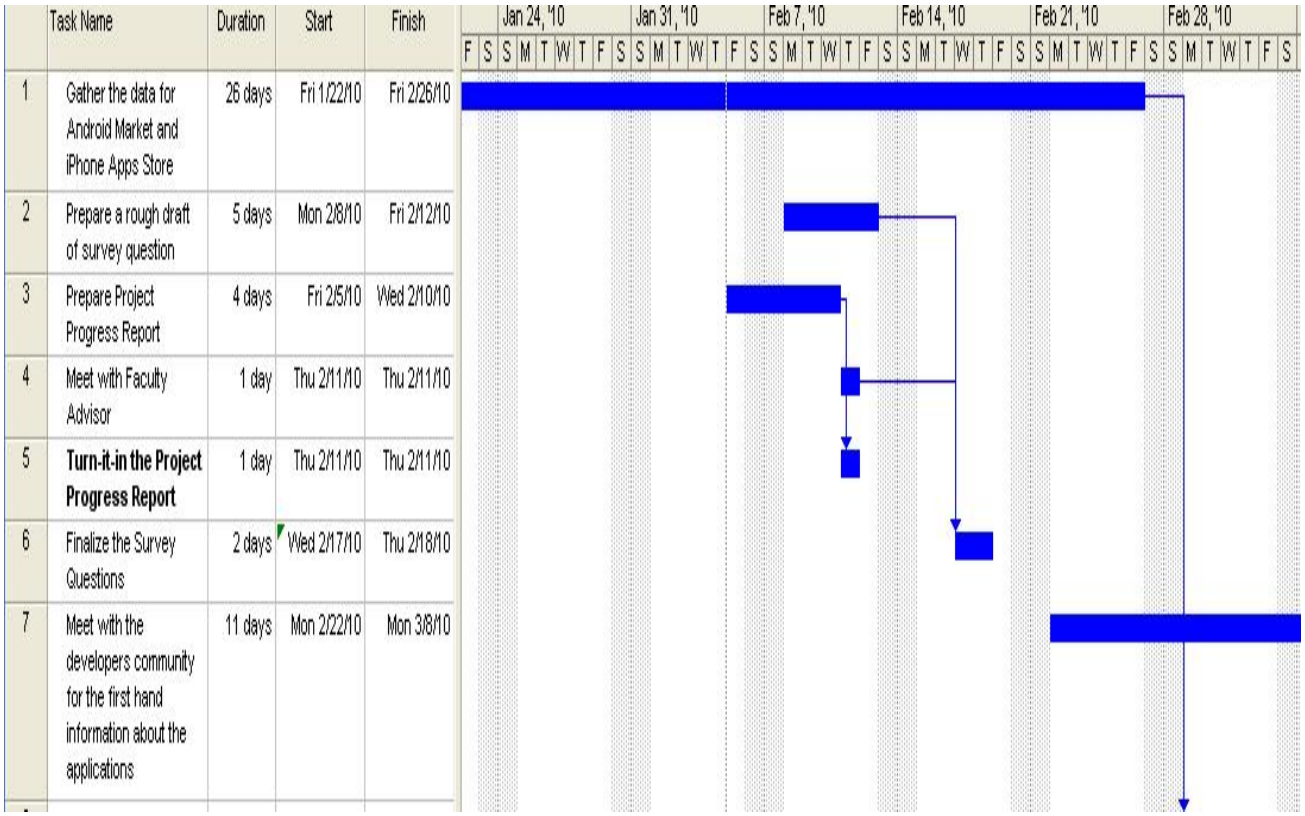
Details of Team Members

This project will be carried out by team of 2 members, Khushbu Shah and Bimal Gadhavi. Both team members are from the General Engineering department, with concentration in Engineering Management. Bimal Gadhavi is the project leader and coordinator. He will mainly work on organizing meetings with committee members. Khushbu Shah is a project developer and she will collect all necessary data required for the project. Both team members will work together on achieving major milestones of the project.

APPENDIX II – Project Schedule

Project Schedule

Following is the project schedule for ENGR 298.



	Task Name	Duration	Start	Finish
1	Gather the data for Android Market and iPhone Apps Store	26 days	Fri 1/22/10	Fri 2/26/10
2	Prepare a rough draft of survey question	5 days	Mon 2/8/10	Fri 2/12/10
3	Prepare Project Progress Report	4 days	Fri 2/5/10	Wed 2/10/10
4	Meet with Faculty Advisor	1 day	Thu 2/11/10	Thu 2/11/10
5	**Turn-it-in the Project Progress Report**	1 day	Thu 2/11/10	Thu 2/11/10
6	Finalize the Survey Questions	2 days	Wed 2/17/10	Thu 2/18/10
7	Meet with the developers community for the first hand information about the applications	11 days	Mon 2/22/10	Mon 3/8/10

Figure 1: Gantt chart – 1 for ENGR 298

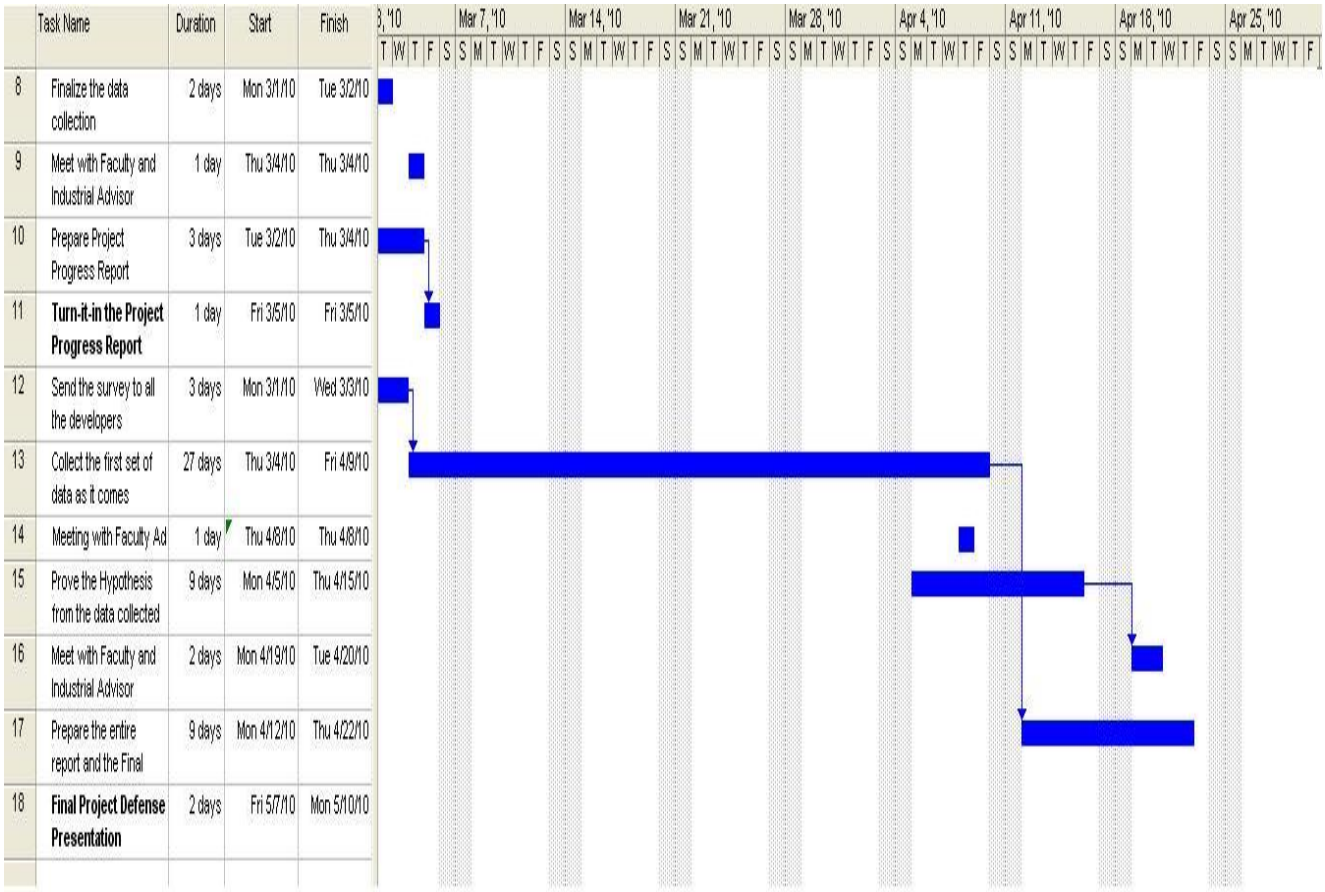


Figure 2: Gantt chart -2 for ENGR 298

APPENDIX III – Android Device Analyses

The following table shows the list of mobile devices those are/would be in the market with Android open source mobile operating system.

1. The Motorola Droid smart-phone actual material and manufacturing costs are shown in the table below. A major difference between the Droid and the iPhone is the addition of a microSD slot for storing data or content.

Table 1: Major Cost Drivers in Motorola Droid

Major Cost Drivers in the Motorola Droid
(Pricing in U.S. Dollars)

Component	Manufacturer	Cost
microSD Memory Card - 16GB		$35.00
Display Module		$17.75
Touchscreen Overlay		$17.50
Camera Module		$14.25
Baseband Processor/ Radio Frequency Transceiver	Qualcomm	$14.04
Applications Processor	Texas Instruments	$12.90
Multichip Module: 4Gbit NAND Flash, Plus 2Gbit Mobile DDR	Toshiba	$9.20
Bluetooth/WLAN/FM Transmitter/Receiver	Texas Instruments	$6.50
Multichip Module: 1Gbit NAND Flash Plus 512Mbit Mobile	Numonyx	$4.90
Lithium Ion Battery	Motorola	$4.25
Other Costs		$42.82
	Total Materials Cost	$179.11
	Manufacturing Cost	$8.64
	Grand Total	$187.75

(Source: *Major cost drivers in Motorola Droid*. (n.d.). Retrieved on April 20, 2010, from isuppli website: http://www.isuppli.com/News/Pages/iSuppli-Does-Droid-Teardown-Finds-$18775-Bill-of-Materials-and-Manufacturing-Cost.aspx.)

2. **Google Nexus One:** Though sold with the Google brand name, Nexus One is actually manufactured by HTC Corporation. It was released in January 2010. The price of unlocked phone is $529 or $179 with a two-year contract from T-mobile. The actual Bill-of-Material cost is as below:

Table 2: Hardware Information for Google Nexus One

Preliminary Bill-of-Materials Summary for Google Nexus One Smart Phone*

Component	Manufacturer	Description	Price
Baseband Processor	Qualcomm	Quad-Band GSM/GPRS/EDGE, UMTS HSPA, 1GHz CPU, 600MHz Digital Signal Processor	$30.50
Memory	Samsung Semiconductor	Multichip Package (4Gbit NAND Flash + 4Gbit Mobile Double Data Rate (DDR) DRAM	$20.40
Bluetooth/WLAN	Broadcom	Bluetooth / WLAN / FM Transmitter/Receiver (802.11a/b/g/n, Bluetooth V2.1+EDR, 65nm)	$8.20
Power Management	Qualcomm	Power Management IC (w/ Integrated USB Transceiver)	$2.50
Radio Frequency Transceiver	Qualcomm	RF Transceiver (ZIF, Quad-Band GSM/EDGE, Tri-Band WCDMA/HSDPA)	$2.50
Power Amplifier	Skyworks & Others	4 Power Amplifier Modules (Skyworks & Other)	$2.20
Power Management	Texas Instruments	Power Management & Li-Ion Charger	$1.20
Display	Samsung Mobile Display	Display (3.7" AM-OLED)	$23.50
Touchscreen	Synaptics	Touchscreen Assembly (Capacitive Multitouch)	$17.50
Electrical		Misc. Electronic Components (Small IC's, Discrete Semiconductors, Passives, etc.)	$16.30
Camera		Camera (5.0 MP Auto Focus)	$12.50
MicroSD Card		MicroSD Card (4GB)	$8.50
Electro-Mechanical		Misc. Electromechanical Components (Connectors, Acoustics, Antennas, etc.)	$7.50
Electro-Mechanical		PCB's	$6.60
Mechanical		Misc. Mechanical Components (Plastics, Metals, Hardware, Shielding, Insulation, etc.)	$6.20
Battery		Battery (1400mAh, 3.7V)	$5.25
Mechanical		Main Enclosure Housing (Machined Aluminum Unibody)	$2.80
		Total BOM (Materials Only)	**$174.15**

*Teardown analysis accounts only for hardware costs and does not take into consideration other expenses such as manufacurintg, software, box contents, accessoories and royalties.

(Source: *Major cost drivers in Nexus One*. (n.d.). Retrieved on April 20, 2010, from isuppli website: http://www.isuppli.com/News/Pages/Google-Nexus-One-Carries-$17415-Materials-Cost-iSuppli-Teardown-Reveals.aspx?PR.)

APPENDIX IV – iPhone Application Volume

Table 3: iPhone Application Volume from January 2010 to April 2010

Application Category	**February 05,2010**	**March 05,2010**	**April 09,2010**	**May 04,2010**
Games	23160	25,898	31373	34110
Entertainment	19700	20,371	21712	22383
Finance	2040	2,225	2596	2781
Healthcare & Fitness	3120	3,353	3818	4050
Lifestyle	8620	9,173	10278	10830
News&weather	4200	4,489	5066	5355
Productivity	3360	3,583	4028	4251
Reference	5400	5,885	6854	7339
Social networking	2440	2,627	3000	3186
Sports	5440	5,822	6585	6966
Travel	7780	8,799	10836	11854
Navigation	3540	3,796	4309	4565
Business	3500	3,839	4517	4856
Book	26800	28,661	32382	34243
Educatuon	10000	11,055	13165	14220
Photography	2640	2,816	3167	3342
Utilities	9200	9,705	10715	11220
Medical	1800	2,020	2460	2680
Music	5400	5,846	6737	7183
Total	**148140**	**159,959**	**183596**	**195414**

APPENDIX V – Android Application Volume

Table 4: Android Application Volume from January 2010 to April 2010

Application Category	**February 05,2010**	**March 05,2010**	**April 09,2010**	**May 04,2010**
Games	3890	4250	4980	6221
comics	388	533	1847	2924
communications	1021	1125	1352	1507
Entertainment	4351	5181	7563	9480
Finance	628	694	919	1021
Health	519	586	781	901
Lifestyle	1773	2423	3013	3331
News & Weather	882	1470	1781	1907
Productivity	1017	1196	1454	1677
Reference	1603	1930	2788	3286
shopping	403	425	453	495
Social	682	766	959	1085
Sports	678	825	1142	1404
Themes	1829	2042	3204	4242
Tools	3096	3437	4354	4926
Travel	1156	1362	1668	1861
Demo	377	444	551	610
Software Libraries	108	112	124	139
Multimedia	1073	1299	1712	2020
Total Applications	**25474**	**30100**	**40645**	**49037**

APPENDIX VI – Platform Application Categories and Volumes

Table 5: iPhone and Android Application Volume for common category from January 2010 to April 2010

Application Category	February 05,2010		March 05,2010		April 09,2010		May 04,2010	
	iPhone	Android	iPhone	Android	iPhone	Android	iPhone	Android
Games	23160	3890	25,898	4250	31373	4980	34110	6221
Entertainment	19700	4351	20,371	5181	21712	7563	22383	9480
Finance	2040	628	2,225	694	2596	919	2781	1021
Health	3120	519	3,353	586	3818	781	4050	901
Lifestyle	8620	1773	9,173	2423	10278	3013	10830	3331
News&weather	4200	882	4,489	1470	5066	1781	5355	1907
Productivity	3360	1017	3,583	1196	4028	1454	4251	1677
Reference	5400	1603	5,885	1930	6854	2788	7339	3286
Social networking	2440	682	2,627	766	3000	959	3186	1085
Sports	5440	678	5,822	825	6585	1142	6966	1404
Travel	7780	1156	8,799	1362	10836	1668	11854	1861

APPENDIX VII – iPhone and Android Application Database

Table 6: iPhone Application Database

Application Name	Rank	Paid/Free	Developer's Name	Website
SodaSnap Postcards	46	FREE	F2M2, Inc	http://www.sodasnap.com/
Currency	6	FREE	Jeffrey Grossman	http://www.currencyapp.com/
BigTipper (Tip Calculator with History)	150	$1.99	PureBlend Software	http://www.pureblendsoftware.com
Urbanspoon	2	FREE	Wanderspot LLC	http://www.urbanspoon.com/
BA Flights	87	FREE	British Airways Plc	http://www.britishairways.com
Travelocity	11	FREE	travelocity	http://travelocity.com/mobile
Lonely Planet Mandarin Phrasebook	36	$9.99	Lonely Planet Publications Pvt Ltd	http://lonelyplanet.com/
Local Picks by TripAdvisor	21	FREE	TripAdvisor LLC	http://www.tripadvisor.com/
Yelp	3	FREE	Yelp Inc.	http://www.yelp.com/
TravelTracker with TripIt	155	$7.99	Silverware	http://www.silverwaresoftware.com
Tipulator	18	$1.99	Sophia Teutschler	http://www.sophiestication.com/
Babelingo Translated Phrases	194	$1.99	Alta Vida LLC	http://www.ibabelingo.com/
iTimeZone - World Clock Where You Control Time	137	$1.99	Dave Murdock	http://www.tangerineelement.com/
ACT Currency	63	$0.99	Houdah Software	http://www.houdah.com/iPhone
Fahrplan	187	FREE	Frank Vercruesse	http://www.vercruesse.de/
Hotels.com	27	FREE	Hotels.com L.P.	http://www.hotels.com/
MagicHour - formerly VelaClock	159	$3.99	Vela Design Group	http://www.veladg.com/
BlackBook Guides	39	FREE	BlackBook Media Corp.	http://www.blackbookmag.com
MoMPF CurrencyConverter	196	$0.99	Sascha Lange	http://www.mobilemultiplayerfun.de/
Lingolook JAPAN	170	$4.99	Lingolook Publishing LLC	http://www.lingolook.net/
LocalEats	26	$0.99	Magellan Press Inc.	http://www.wherethelocalseat.com/
London Tube Status	144	FREE	Malcolm Barclay	http://mbarclay.net/
DC Going Out Guide	65	FREE	Washingtonpost.Newsweek Interactive	http://www.washingtonpost.com

Table 7: Android Application Database

Applications	Free/Paid	# of Downloads	Developers	Website	Star
Places Directory	Free	>250K	Google Places Directory Team	www.google.com	4.5/5
NYC Bus & Subway Map	Free	>250K	episode 6	www.episode6.com	4.5/5
Where	Free	>250K	where	www.where.com	4.5/5
GPS Status	Free	>250K	EclipSim	www.m.eclipsim.com/ gpsstatus	4.5/5
Kayak Flight and Hotels Search	Free	50K-250K	Kayak	www.kayak.com	4.0/5
English Spanish Dictionary	Free	50K-250K	Baris Efe	www.langtolang.com	4.0/5
Country Music RADIO	Free	50K-250K	BluMedialab.com B.V.	www.blumedialab.com	4.0/5
Trapster	Free	>250K	Trapster.com, Inc.	www.trapster.com	4.0/5
iTranslate	Free	50K-250K	Sonico Mobile	www.soniccomobile.com	4.0/5
MetroMap Paris	Free	10K-50K	Cyril Mottler	www.cyrilmottier.com	4.0/5
XE Currency	Free	10K-50K	XE.com Inc.	www.xe.com	4.5/5
Nav4All navigation /track&trace	Free	>250K	Nav4All	www.nav4all.com	3.5/5
FlightStats Lite for Android	Free	10K-50K	FlightStats	www.flightstats.com	3.5/5
Star Translate	Free	50K-250K	StarObject	www.moblie.starobject.com	4.5/5
Wikitude World Browser	Free	>250K	Mobillizy	www.mobillizy.com	4.5/5
Houston Traffic	Free	10K-50K	Aristo Setlawan	www.aristo.name	4.5/5

APPENDIX VIII – Relevance of ENGR 201, ENGR 203, and ENGR 200W

The topics we learned in ENGR 201 such as normal distribution, probability density functions, etc. helped us to calculate the financial cost over time for this project. Also, break-even analysis, forecasting, system engineer aspects, etc. we learned in ENGR 202 & 203 were very useful during the financial implementation for this project. ENGR 200W topics like how to start with literature review, how to write a report in APA format, etc. helped us very much in preparing and writing this project.