A Comparative Analysis of Digital Innovation Ecosystems

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Abstract--**In this paper, we examine how Apple and Google have used third-party led innovation to create viable digital innovation ecosystems, through the App Store and the Android platform respectively. In many ways, this is similar to the strategy adopted in an earlier decade by NTT DoCoMo in the mobile communications space, through the iMode platform. We compare and contrast alternative approaches to accelerating innovation through such an ecosystem oriented approach, and outline some key lessons for content providers, developers, and other stakeholders. We analyze these developments through the theories of network externalities, social network communication theory, and related frameworks in strategic management**

I. INTRODUCTION

A firm can deploy disparate sources of valuable resources, capabilities and distinctive competencies as it carves out a unique position in an industry. However, even though a firm might have all the prerequisites that favor competitive advantage, there will always be challenges that will impede its ability to develop and sustain dynamic innovation. Two main challenges present themselves in any discussion about sustaining innovation: 1) How to manage for both short-term advantage and long term sustainability, and 2) how to deploy limited resources and capabilities. The first type of concern has been addressed since Schumpeter [63] introduced the concept of creative destruction. This term is related with the process of radical innovation, and subsequent periods of sustained growth. Tushman and Anderson [1] also examined how firms react when there are conflicts in the technological and environmental environments. Christensen [21] advanced these notions in the context of a competitive marketplace, through the notion of the innovators dilemma. Other scholars [61] have also used the term "ambidextrous technology sourcing" to refer to similar situations. This concept is derived from exploration-exploitation framework of organization learning theory. Exploration implies experimentation with new alternatives, while, exploitation refers to a refinement and extension of existing competences of an organization. Successful organizations are the ones that achieve the balance between exploration and exploitation challenges they face. In other words, their sustainability is based on incremental and radical innovation. In order to overcome the second type of concern, managers frequently resort to mergers and acquisitions (M&A) and strategic alliances. Such strategic alliances allow otherwise independent firms "share resources for product design, production, marketing or distribution" [14]. Gradually however, more companies are using another major type of resource, i.e. third-parties sources of innovation.

In recent decades, scholars have started to recognize the key role played by open innovation in different industries. However, the vast literature of open innovation has gained prominence since Chesbrough [20] examined how to firms can create value through open innovation. Open innovation posits that the innovation effort can be actuated by not only the firm itself, but also by different kinds of interrelated parties (universities, other firms, users, etc). This phenomenon has become more important in products and service that are associated with network externalities. Network externalities are used to explain the utility that consumers derive when the consumption of a technology good increases when other customers also consume the good [46]. In other words, every time an innovation occurs, the value is not only in the primary "product" per se, but also in the complementarities or enabling technologies associated with it. There is an active ecosystem involved in the creation and development of an innovation. Customers are also aware of the externalities of an innovation, and understand that the benefits of a product and the value of a network are related to how many other consumers buy and join the network of that good. Another important factor in this process is the interdependence of the demand of complementary goods, and consumers can adopt a "wait and see" attitude when they consider purchasing the primary product or hardware system [39]. In other words, the success of the business ecosystem, which includes the different actors –suppliers, distributors, manufacturers, technology providers, and customers- is highly interrelated with firm performance. These types of innovation approaches are critical in understanding the two main competitive platform providers for information services, Apple and Google.

As described, third-party innovation is an important source of ideas and opportunities. Studies of the machine tool industry and scientific instruments are early illustrations of the role users play in accelerating technological innovation [52]. This type of innovation is a corporate strategy mechanism to engage customers or lead users to be active participants for effective collaboration, and thus in the creation of an innovation. Apple and Google are currently using this corporate strategy to create viable digital innovation ecosystems, through the App Store and the Android platform respectively. In many ways, this is similar to the strategy adopted in an earlier decade by NTT DoCoMo in the mobile communications space, through the iMode platform. Prior studies on Apple and Google have focused only on a "compare and contrast" approach of the companies and their competitors. However, from a review of past studies, we find that little attention has been given the key mechanisms used in corporate strategy to build an innovation ecosystem. In this paper, we are first going to define important grounding concepts such as network externalities,

social network communication theory, and types of open innovation, in the context of emergent information services. In the final section, limitations and further research will be provided.

II. BACKGROUND

In this paper we investigate the phenomena of the rise of the information ecosystem and third-party innovation. There are different multi-platform interfaces that companies are using to lead this type of innovation to occur. The adoption of information and communication technologies has accelerated since the wide adoption of the Internet through multiple platforms, interfaces and end-user devices. This rise has changed how firms do business, innovate, compete, and consequently the boundaries of firms, industries and the broader user ecosystem. Today's mobile phones include features such as games, digital music players, cameras, etc. Increasingly, more handheld manufacturers are moving toward developing smartphones, which could be considered as an ubiquitous or pervasive computing platform [5, 54, 60]. Hence, the boundaries between the mobile industry and other industries that deal with information (such as computer industry, media, etc) are more difficult to define. Another particular aspect of this "new electronic – information-based" industry is the degree of sophistication of products and services that can be delivered. This has made them radically more dependent on an array of applications in order for becoming functional and attractive for the customers. To address consumer needs for multi-functional devices and services, firms need access to a wide set of resources or a variety of partners. This is one of the factors that have made companies to aggressively consider open innovation as an option.

In the following section, we describe how Apple and Google leverage third party- led innovation and their consequent market position mobile application industry

A. Company Backgrounds

1) Apple Inc

Apple Inc. was founded in 1976, as Apple Computers by Steven Wozniak and Steven Jobs. In the early eighties, three personal computers namely Apple I, II, III made their entry in the world market although facing their own share of problems owing to the fact that they all ran on different operating systems, thus limiting interoperability and consequent market position. In order to overcome this challenge, the company managed to combine both the hardware and software capabilities of a computer to create the "Macintosh (Mac) [29].

However, over the next few decades, and through a fortuitous history, Apple went through a radical change in strategy as it ventured into the development of products such as iMac, iPod, iPhone, and iPad. Apple followed a unique retail strategy to introduce these new products. The strategy was to open online and physical stores employed salespersons who were also devout Apple fans, and maintain a high degree of control in all operations [68]. Apple extremely controlled the entire value chain of its products. These traditional propositions (but unconventional by technology industry standards) helped Apple to gain a high market value a strong foothold in the innovation space.

In 2008, the company launched the App Store. This platform allowed the customers to browse, search and acquire third-party applications for their iPhone or iPod touch [26]. In January 2011 there were more than 20 categories of applications, more than 400,000 applications developed by third-parties and more than 9,000,000,000 downloads. In the year 2009 sales of iPhone and iPod represented 60% of Apples' total sales [77]. Nevertheless, the company had faced a continued fierce competition with several companies. However, Apple had become one of the world's most successful companies which progressed mainly owing to adept strategic planning and efficient management of resources.

2) Google Inc.

Google Inc. was incorporated in 1998, by Sergey Brin and Larry Page. The company started by developing a technology for web search. In 1999, AOL/Netscape incorporated Google search technology in their portal. By 2000, more than 60 million searches were answered by the company [27]. Google had worked, since 2001, towards developing mobile applications and platforms for convenient access of websites compatible with mobile phone browsers through WAP (wireless access protocol). The financial success of Google was based on advertising revenues generated primarily from keyword search associations, and other such innovations. Google has relied on M&A to enter new markets, and had acquired assets like YouTube, Double Click, Earth Viewer (now Google Earth), among others [7].

In 2005, Google purchased Android Inc. Android Inc. was a startup that was founded by Andy Rubin. Android itself was a software stack for mobile devices, which included an operation system, middleware and key applications [34]. In 2007, Google announced its entry into the mobile phone industry as an operating system vendor, by entering the Open Handset Alliance (OHA) [32]. OHA was a business consortium, which by February 2011 had 80 members (it started with 34 members). The members of this consortium were technology and mobile firm leaders such as HTC, T-Mobile, NVIDIA, Qualcom, Motorola, LG, Vodafone, etc. In 2008, the Android Platform was used in the first handset by the manufacture HTC and the operator T-Mobile [41]. Android Inc. was originally a small start-up company, which developed software for mobile phones [11]. Android, a free rapidly growing platform, enabled third-parties developers to construct innovative applications with its available Application Programming Interfaces (API). In January 2011, the platform had more than 12 categories of applications, more than 200,000 applications developed by third parties and more than 1,000,000,000 downloads.

We observe that both of these companies were operating in the very dynamic and competitive environment of the mobile industry. Apple essentially started with a handset and then added the applications, while Google entered via Applications, and then added the handset. In addition, they used different models to market their products and services. Apple employed a vertical integration strategy, whereas Google's strategy was based on merger and acquisitions, and alliances. However, it is important to note that both companies depended on third-party innovation to develop their applications. Third-party innovation was an important driver through which these firms created new forms of value for their customers.

B. The Rise of an Information Ecosystem

1) NTT DoCoMo

The rise of what we understand as contemporary information ecosystems can be traced to the late nineties, when telecommunication vendors from Europe, Japan and USA promulgated the ITU standards for enabling the 3G wireless network [6]. The manufacturers, operators and providers of each market needed to decide between leveraging existent technologies or building new solutions. European and U.S. developers put their effort into expanding 3G wireless networks, with Europe being the more successful of the two. However, the Japanese industry did not wait for the 3G to function at a high speed. The Japanese firm, NTT DoCoMo, launched its i-mode system, in spite of its slow data speed [76]. i-mode was a mobile internet service that featured packet-based data service for mobile phones. It incorporated a variety of internet standards, and used a basic version of the HTML for web access [56]. DoCoMo (**Do Co**mmunications over the **Mo**bile Network), was one of the first companies that start using this platform for mobile commerce.

DoCoMo was a traditional corporation, which attained competitive advantage by creating new service markets and they established a unique position in the mobile internet business in Japan [50]. This company employed alliances with Nokia, Motorola, Siemens, Ericson, etc, to establish technical standards. The firm also possessed multiple alliances with companies inside and outside the mobile business, such as Coca-Cola Japan, Denstu, Itochu, Microsoft, SEGA Corp., Sony, Sun Microsystems, 3Com, and Walt Disney [3]. Furthermore, the company used an open architecture WCDMA-based third generation [30]. A key move for the company was to establish a gateway business department (GBD). This department was created to address general users, by developing non-voice communication services over the mobile phone [49]. In order to create enough content to maintain a successful i-mode service, the company gave positive feedback to information providers (IPs). DoCoMo provided a platform to the IPs in order for them to create their own content. This platform also allowed end-users to be IPs. The earned profits were distributed 91% to the IPs and 9% to DoCoMo. In essence the three lessons for DoCoMo were: 1) the importance of strategic alliances, 2) the consequence of 1st mover advantage for the creation of a new (shared) service model, and 3) how the involvement of the customer helped the creation of a new content with the aid of a common platform. The DoCoMo case illustrates how the corporate strategy used by the firm helped them to become a dominant player in the mobile industry in Japan.

The following section will introduce the entrance of Apple and Google in the broaden mobile information ecosystem.

2) Apple Inc and Google Inc.

Both Apple and Google were late entrants in the Smartphone – OS market. The first entrants in the Smartphone-OS industry were Symbian-Nokia, RIM - BlackBerry, Microsoft –Windows Mobile. In the case of Apple, the design, integrity of the system, reputation and innovative applications enabled the iPhone OS to catch up and surpass some of its competitors. This entry strategy allowed Apple to persuade its loyal customer base to switch to the iPhone-OS. It quickly became the second most adopted Smartphone-OS in the US market in the third quarter of 2008. In the third quarter of 2010, Apple controlled the smartphone market in the US with a 26% share [13]. In the case of Google, the main motivation to be part of the emerging mobile internet market was to own a platform where they could extend their business model based on advertisinh [33]. However, they did not succeed immediately, in spite of the strategic alliances, the wide variety of handsets and that fact that it was open source OS. 2009 was a very challenging year for Android- OS, however by Q4 of 2010, this OS became the world's leading smartphone platform [12].

III. ECOSYSTEMS APPROACH

To analyze these competitors, we develop a framework based on an ecosystem approach. A business ecosystem is a term introduced by Moore [55], in which he made an correspondence between biological ecosystems and the economic environment. A business ecosystem was defined as "an economic community supported by a foundation of interacting organization and individuals- the organism of the business world". This term had evolved, and ideas such as dependence among the participants for mutual effectiveness and survival, integrated electronic business, role of the internet for networked information economy, digital business ecosystem, and network of companies, had been added over time. In sum, an ecosystem approach was a community of different actors, which had relations between them. These relationships needed to be dynamic and self-organizing in order to acquire adaptability (success) [57]. In a sense, innovation from an ecosystem based approach could be explained by the network externalities, and by understanding the mechanism that were used for relating the different actors. In order to consider the ecosystem approach, we needed to include the role of social network in our model. A social

network is identified by the actors and the relationships (ties) among them [38]. The main purpose of the proposed model is to provide a framework that depicts what triggers third-parties innovation in order for customers to continue using the main product.

Fig. 1 shows in general what the relationship between the customers and the firms were when there was no need for complementarities in technology.

Here, the innovation mainly took place at the boundaries of the firm. Usually the link between the firm and the customers were the suppliers. However, these types of products are currently minimal or non-existent.

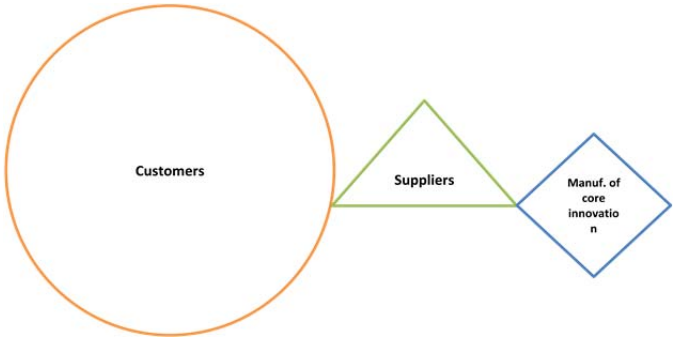

Fig. 1

Fig. 2 shows how the ecosystem changes with the emerging of the indirect effects of network externalities.

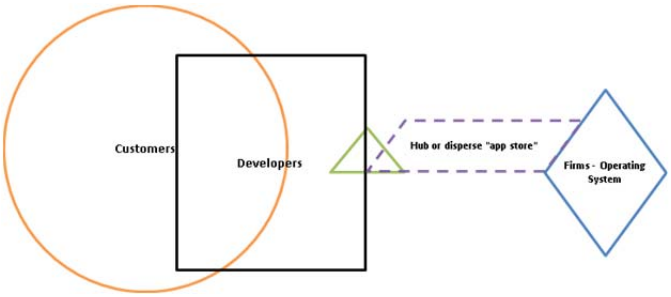

Fig. 2

It is important to note that customers were more involved in the development of complementarities technology/ applications. Even suppliers could be part of the developers group. The hub or dispersed mode of coordination was what made the ecosystem closed or open. The user toolkits could be one or many depending on the type of ecosystem. The interaction of the firm with the customers was much more complex. It is important to understand the interaction between customers-developers-firms, given that it was what triggers the complementary technology.

In the following sections, the phenomena background will be explained, and specific illustrations for Google and Apple will be constructed.

IV. PHENOMENA BACKGROUND

A. Open Innovation

Since the term open innovation was coined in 2003 by Chesbrough, researchers and practitioners have considered the following questions: 1) is there a specific business strategy to pursue innovation, 2) is open better than closed innovation, and 3) what are the managerial challenges for open innovation [18]? Chesbrough acknowledged that "we are witnessing a paradigm shift in how companies are generating and commercializing new ideas" [17]. Gradually, more companies were changing the way they used to produce innovation, from closed to open innovation. In the closed model, the lemma was "successful innovation requires control" [19]. In this approach, companies produced their own ideas, which they then developed, manufactured, marketed, distributed and serviced. The closed or traditional model of innovation examined the generation and commercialization of ideas as a process that happens within the boundaries of a firm. Heavy investment in R&D labs was the critical source of competitive advantage of many companies. During the past century, many remarkable innovations were obtained through internal efforts. The focus was on locking up the "best and the brightest", to come up with new innovations. Vertical Integration was one of the main strategies used by the companies to take advantage of the scale and scope for internal R&D [15, 67]. However, the closed model paradigm was on a path of gradual decline, and more companies were embracing the open innovation model.

Factors such as the extent and mobility of knowledge workers, and the availability of private venture capital were starting to make unsustainable a tightly control approach for innovation [36]. Increasingly, firms were explicitly collaborating with different parties to create new innovation. This phenomenon of using ideas that were generated not only from within, but outside the boundaries of the firm, and then bringing to commercialization is what we call open innovation. With open innovation, the sources for innovation opportunities were explored through internal and external sources. It is important to note, that even though the firm could acquire many ideas from outside of its own boundaries, it had to invest in its absorptive capacity. This was done by integrating firm capabilities and resources, and those opportunities were investigated through different pathways [24, 74]. The collaboration for open innovation could come from customers, academia, firms from unrelated industries, and even with competitors. Furthermore, the open innovation paradigm was tightly associated with the open source phenomenon, in which open innovation also implied a new way to research, manage and change the use of [24, 74]. In order to produce a shared technology, open source software included collaboration between firms, suppliers, customers or developers. However, it is important to recognize that not all open software projects were example of open innovation, or vice versa. Open source was considered open innovation only if it had a business model [75].

In the case of Google and Apple, both companies used open innovation in different forms, given that they needed a variety number of partners for the innovation of applications. In order for these applications to reach the consumers, portals or transaction platforms needed to be created. These portals were the key part of the value chain of each company, given that they trigger dynamism and can attract large number of development [10]. Even though Google and Apple, used the portal mechanism, they differed in the way they managed these portals. In the case of Apple, they had a centralized portal called Apple Apps Store. The App store, which was the online market place for applications developed by Apple, was launched in July 2008 as an update to the iTunes store[1]. The App store served the iPod touch, iPhone and iPad. In order for the developers to sell any of their applications, they had to be publish on the Apps Store. As a part of the Apple Apps Store policies, the company had the right to approve or reject any application, after they screened them for a basic reliability testing and other analysis. Hence customers using this OS only relied on an exclusive point for sale that distributes the different applications. In the case of Google, they also developed an online store, the Android Market, for their devices. The majority of the Android devices came with this preinstalled "Market" application, which allowed the users to search, buy and download the apps. However, Google did not have restricted policies for users and developers to acquire the apps from Android Market. The apps could also be published at any portal, including the developer's own website. Google did not have the control of all the portals, hence they were not planning to review the application prior to publication [43]. Even though Google had a main online store, they also did not restrict other points of sale. Therefore, it was a more decentralized ecosystem.

Previous research in open innovation had primarily addressed the difference between open and closed innovation. According to [59], there are four types of collaborations. These modes differed in the degree of openness (open vs. closed) and in the type of hierarchy (hierarchical vs. flat). Their definition for openness was based on who can participate. By hierarchy, the authors referred to who makes the key decision. In the open hierarchical mode any participant could provide ideas, however only the company defined the problem and chooses the solution. In the open flat mode, the ideas were offered by any participants and anybody could decide what innovation was valid. In the closed hierarchical mode, the company selects who were the participants or alliances that would collaborate in a project, and then decided what ideas were going to be developed. Finally in the closed flat mode, only a selected group would be invited to offer ideas. The participants would share information and make key decisions together. Other authors, such as West, Gassmann, Jeppesen, focused on understanding what type of open innovations exist. Overall types of collaboration for innovation had been classified depending on the partner variety, the degree of openness in the innovation funnel [51], the direction of the innovation (inbound, outbound or coupled) [36], the decision makers [59], the financial terms [25], and different open source strategies [75], among others.

From the above discussion, we can conclude that innovation was not longer a phenomenon that took place within the boundaries of the firm. Alliances were common place with other firms and institutes, such as universities, but with individual developers that could be end-users. None of these classifications took into account an ecosystem approach, where not only the firm perspective was addressed, but also the views of customers and the developers. However, innovation is a multilevel phenomenon [16], requiring different contributors to interact. Furthermore, many of the current products/service depended not only on the main "product", but on the complementarities or enabled technologies (also referred to as network externalities of a product).

B. Network Externalities

The concept of networks externalities was developed by Katz & Shapiro [47, 48], in which the value of a good or service increased when more consumers were using compatible technology. Network externalities could have direct and indirect effects. Direct network externalities effects occurred when the customer benefits directly from the number of consumers that joined the network of that technology. In other words, the value of the product increased with the installed base of customers. For instance, this was the case for fax machines. The product would have value for the customers if other customers were using it. In the case of indirect network effects, the benefits for the consumers did not depend on the extent of people that joined the network [23]. Rather, consumers derived benefits when the use of a technology depended on a complementary or compatible technology [22, 62]. The greater the variety of complementary technologies, the higher the value of the hardware product. An issue with this was that the variety of software or applications relied on the extent of customers that acquire the compatible hardware. This hardware-software paradigm was applicable to many markets, and could cause the chicken-egg paradox or the wait and see phenomenon that would make the potential customers delay the acquisition of the hardware part of the system [39, 66]. The hardware – software system was useful if the core innovation (hardware) had the adequate investment of the complementary goods (software) [67]. Examples of the products with indirect network externalities were personal computers, DVD players, audio technologies, etc [65]. Furthermore, markets that were not associated with electronics could also have hardware/software system, such as electric cars (hardware) and charger and battery swap stations (software), ATM cards (hardware) and compatible teller machines (software), etc [23].

[1] The iTunes store allowed the customers to download music in a reliable way, and without the infringement of any property rights

From the discussion above, it is clear that there were many challenges for products/service with network externalities. The complexity of the challenges arises when the effects were indirect, given that many "applications or software" needed to be produced to sustain and increment the value of the product. In addition, the complexity of these types of products could be increased when the designers on the software side of the system were not only companies or strategic alliances, but also participants. Thus, it is important to consider the different actors involved in products with network externalities. For instance, in the case of smartphones there were four main actors: the firm (or alliances firms) producing the phone, the network operator, the end user, and the user-developers[2] that were making the applications. Hence, the strategy of a firm that manufactured products which were greatly influenced by network externalities, should consider the whole ecosystem of its product space.

In the case of Apple and Google, even though they both had the same actors for their ecosystem, the interactions among each other were different. In the next figures, we will illustrate these interactions.

Apple Inc.

Fig. 3 illustrates the key actors in the Apple System and relationships between them. The blue arrows show how the consumers could acquire the core technology. Apple customers could purchase the device either from Apple Stores or authorized carriers. For an extended period the only carrier authorized to serve and sell the equipments was AT&T. In early 2011, Verizon became another authorized network operator to serve Apple products. The purple arrow shows the relationship between the network operators and Apple. AT&T had an exclusive agreement with Apple. The red and green arrows are the ones used to depict the network externalities effects (the software part) for this product. In both cases (Apple and Google), the complementary technology were the applications. The red arrow shows that there was only one way that the customers could acquire these applications, which was through the Apps Store. The green arrow represents the way the developers could make available their applications, which was the Apps Store. Hence, the Apps Store represented the digital hub where all the innovations for the complementary technologies were available for purchase and sale. Even though, that there were many developers that could participate in the development of the software, Apple followed a completely closed ecosystem process.

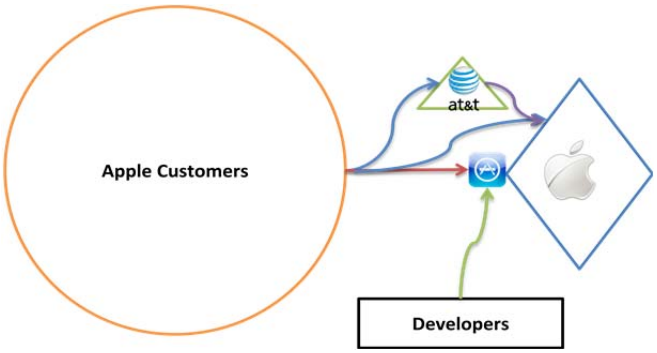

Fig. 3

Google –Android

Fig. 4 depicts the actors and their relationships in the case of Google Android. In this figure, we observe that customers had more alternatives to acquire the core technology. Fig. 4 only shows a few examples of network carriers that sell Android's handsets. It is interesting to see that Google as a company did not sell the handsets; however these were marketed through companies that were part of the OHA, and other independent companies. In the case of applications, the consumers could use different channels to buy them. Google owned one of these channels, which was the Android Market. However, consumers could also acquire them from third party sites. In the case of the developers, they could get involved with Android by participating in the innovation of the applications. They could post them through the Android Market or through other sites, even their own sites. Furthermore, the developers could also contribute to the code of Android. Therefore, we can see that even though the categories for the actors were the same for Apple and Google, Google had a more complex and open process than Apple.

1) Challenges for open innovation for products with Network Externalities

There were many challenges caused by open innovation with network externalities and many external participants involved in the process. However, the main ones were coordination/collaboration of the new ideas [18, 59] and motivation for the developers to continue developing their applications [45, 73]. There were different approaches that organizations had used to deal with the challenges of coordination. One method consisted of having a controlled system, like a digital hub, where the developers could post their new applications. In addition, some key aspects of the innovation process could be standardized to couple the coordination-cooperation process. Previous literature had looked at innovation toolkits, in which the company set up a framework to empower the user to create their own products/application for addressing their own requirements [8, 42, 44, 58]. In the case of motivation/collaboration, this was a key aspect that needs to be emphasized to enable the innovation from the developers' point of view. Depending on openness it innovation, in some cases there was an absence of financial return for the developers [74].

[2] The term user-developer implies that the developer can also be an end-user.

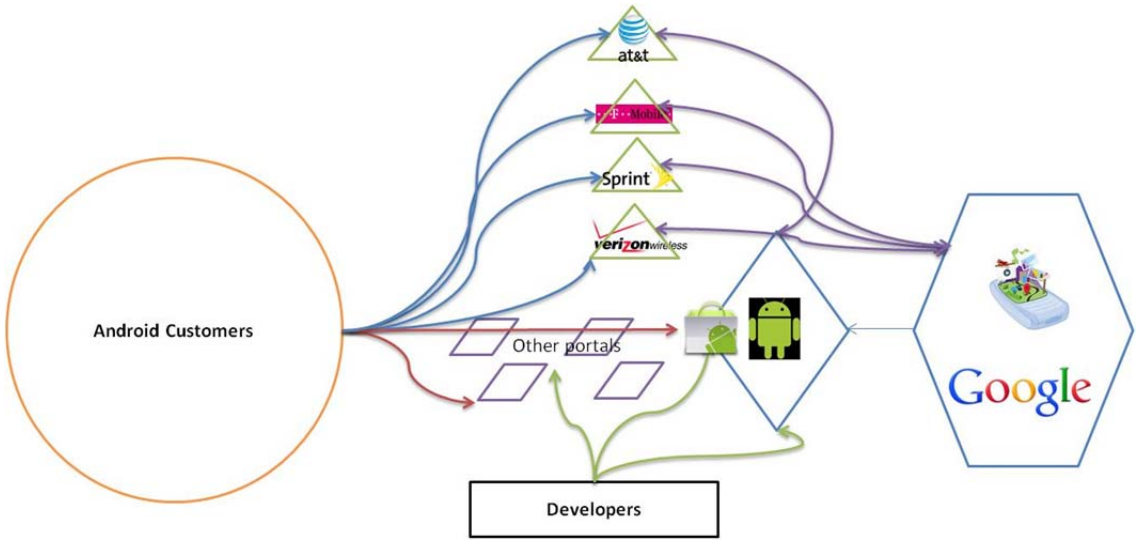

Fig. 4

2) Coordination/Cooperation

To ensure success with an open innovation model, managers had to be able to integrate the variety and extent of user-developers and other external groups, in order for them to cooperate constructively to a project [40]. Typical mechanisms that have been developed in the strategy literature include standardization and user innovation toolkits. In the following section we will discuss both mechanisms.

3) Motivation/Collaboration

Effective collaboration is defined as "a collaboration that leverages the differences among participants to produce innovative, synergistic solution and balances divergent stakeholders' concerns" [53]. Collaboration is affected by knowledge sharing, knowledge learning and knowledge created [9]. Collaboration and motivation are related, in a sense that in order for collaboration to exist the individuals needed to have stimulus to do it. The literature about motivating individuals has observed the underlying reasons, in user-developers to invest their time in knowledge contribution into complementarities' innovation. Theories such as expectancy theory, sociological theories, social capital and capital and collective actions, have attempted to explain what were the factors where firm and user communities intersect [45, 72, 75]. The factors that have been studied included reputation, peer recognition, firm recognition attractiveness of a reward, instrumentality, and reciprocity, among others. Even though it is important to understand the intrinsic/ extrinsic aspect why people contribute, this area of research is outside the scope of this study. The focus here is on the type of mechanism that could contribute to empower and motivate the user-developers to collaborate. Scholars have found that innovation equipments such as user toolkits could enhance the participation for innovation [69-71]. Furthermore, the user toolkits could also be an approach that companies have to coordinate the complimentary goods developed by users.

4) Mechanism used for overcome open innovation challenges

User Toolkits.-

User toolkits can facilitate firms to overcome the motivational aspect for user-developers to transfer their innovative ideas. User toolkits are a viable solution for manufacturers to understand the heterogeneous needs of the users [31]. User toolkits enable users to be part of the innovation process through the transferring of their needs in the products or the complementarities [36, 42]. The toolkits addressed the design side of mass customization process. Nevertheless, if a company provided third parties great involvement for the innovation process, it also has to provide more support for the customers [44]. There are different types of toolkits. The first ones enable access to information, and the second type emphasizes on getting access to more generic innovative ideas in the user domain. The first type of toolkits motivated the developers by giving them the R&D capability to offer individual solution for the manufacture. In the second case, the motivations were given by empowering the developers to provide their innovative ideas, for process improvement [58].

In the case of Google and Apple, they both provided user toolkits for their developers, which were the software development kits (SDK). In the case of Apple, the SDK for third parties development was not available from the beginning of the introduction of the product. The only available applications were the ones pre-installed by Apple. The first official SDK - iOS 1.2b1 Beta 1- was released on March 2008. The release of the first SDK was at the same time as the App Store was launched. Since, its release there had been four series, and more than 30 different versions,

including beta and final versions. The SDK was available on the Apple Developer website. The annual registration fee was USD 99. The model revenue split between the developer and Apple was 70/30. This site had a support center, with extensive documentation about the SDK. In February 2011, the SDK - iOS 4.3 Golden Master- included a complete "set of development tools for creating apps for iPad, iPhone, and iPod touch. The SDK incorporated the Xcode IDE, iOS Simulator, Instruments, Interface Builder, and more" [4] . On the other hand, Android –OS also offered a SDK for the developers. The first beta version was released in August 2008. Since this release, there had been more than six subsequent releases, which had lead to the issue of the platform fragmentation. The SDK was available online, on the Android Developers website. The SDK was free to download, however developers had to pay a one-time fee of $25 if they wanted to post their applications in the Android Market. The revenue between the developers and Google was also 70/30. Extensive supporting documentation was also provided in the site. The SDK included a comprehensive set of development tools, such as the Android System files, packaged APIs, and the Google API's add-ons. The tool included a debugger, a handset emulator, libraries, sample codes, tutorials, among others [2]. The SDK enabled the developers to write the applications using the Java programming language. In addition, Android offers the Native Development Kit. This kit allowed the developers to write on C or C++, which could be compiled into native byte code.

Standardization.-

Standardization is an approach used to formalize the process of open innovation. Standards have a key role for maintaining service quality, when there are a great variety of suppliers. Standards are defined as "a set of technical specifications that could be aggregated to a producer tacitly, by a formal agreement or by explicit regulatory authority" [28]. Compatible standards can guarantee that the components or subsystem will be incorporated and there will be interoperability. These types of standards can facilitate the coordination in products with network externalities, as a way to match between the demand-supply. Furthermore, standards reduces transaction costs; hence they prevent duplication of investment and waste of resources [37]. In the case of network goods, standards and networks are a mutually reinforcing process. There are closed standards (proprietary) and open standards (free for everybody to adopt). Open standards are pro-competitive, and the goal of them is to increase the set of choices for the end users and the developers. Open standards can make the consumer less concerned about lock-in. In the case of the closed standards, these are anti-competitive, and they are the result of one firm (or alliances) that encompassed a major market share. Joint development of commonly accepted (open) standards is needed, given the pervasiveness of the IT for innovation [30]. Furthermore, standards have revolutionized the focus of competition from systems to components [64]. Standards can make the platform more open and attractive for developers [35]. In the case of Android, the company was based on more open standards, with JAVA as a programming language. As for Apple, they had more proprietary standards in their system.

In a sense, users' toolkits and technical standards are related, given that they provide a way for the firm to communicate with the user-developers. These mechanisms can be used to overcome communication and coordination challenges. In the case of the user-toolkits, previous literature has analyzed them as the link that connected motivation and collaboration among the companies and user-developers.

V. OPEN INNOVATION MODEL WITH AN ECOSYSTEM APPROACH LENS

From the above discussion, it is important to observe that previous models for open innovation had focused on the role of the firm for open innovation. Little attention has been given to the ecosystem approach for open innovation. Therefore, the framework proposed in this paper is built upon previous literature of open innovation, network externalities and their underlying mechanism. Furthermore, it is important to note the role of network externalities in user adoption for the current innovation. The major role for network externalities' product is directly related to the availability of the complementary technologies and the installed base [62]. This means that adoption of new technologies depend increasingly on thirds-parties innovation. Hence, firms need to enable a platform that integrates the efforts of different third-parties' innovation. These third-parties can be developers or customers that addressed their different needs through the applications. The proposed framework tackles the different strategies that can enable diversity varieties of developers to collaborate with the firm.

A. Open vs. Closed Ecosystem

The following checklist is constructed using the type of ecosystem portrayed by Apple and Google. This list also includes the success factors on the strategy used by each company.

Table 1 depicts that there are many factors that should be considered in any digital ecosystem. Each ecosystem has advantages and disadvantages in respect to each other. For instance, a closed ecosystem such as Apple can offer good coordination and control of the other actors in the system. This could bring outstanding organization and groundbreaking innovation. Hence, the customers would have more reliable, quality tested and safe applications. Furthermore, the usability and product integration would be consistent and slick. However, the cost of a closed ecosystem could be shifted to the developers, which could see the process of submitting an application too rigid and burocratic. On the other hand, a more open system such as Google has a distributed approach to coordinate and control the ecosystem.

TABLE 1.- CLOSED VS. OPEN ECOSYSTEM

	Closed – Apple Inc.	Open - Android	Success Factor
Company			
Innovation Model	Open Hierarchical	Open Flat	**General:** Open approach attracts a wide range of possible ideas Both companies have strong images **Apple:** The company can easily coordinate other players work **Google:** The innovation model allows Google to share the burden of innovation with the other players.
Reputation	Strong brand image – High-end brand with strong aesthetic	Strong brand image – Can build on the success of Google	
Coordination and Control	Centralized	Distributed	
Company – Other firms			
Corporate strategy	Vertical Integration – Operating System software, and Hardware	Alliances, Mergers & Acquisitions (focus on small venture capital companies)	**Apple**: Vertical integration allow the company to coordinate all the process for the product/software development **Google**: Alliances, M&A enhance the cooperation with more players and more collaboration
Institutional Environment	Strong	Weak	
Coordination and Control	Centralized	Distributed	
Company – Developers			
Software Development Toolkits (User Toolkit)	One Annual-payment fee of $99	Two: SDK and the Native Toolkit One-payment fee of 25 to post at Google Market Free SDK	**General**: Both approaches enhance the collaboration of user-developers by providing tools like the SDK and online discussion forum **Apple**: The use of a more controlling environment makes a more reliable and slick ecosystem. **Google**: There is more interaction along the innovation funnel. This allows the players to have more flexibility and customization in the process and applications.
User interaction with the value chain	Limited	More interactive along the innovation funnel	
Point of Sale/Distribution	Only on Apple Apps Store	Android Market + other websites	
Number of Applications	+400,000	+ 200,000	
Architecture/ Standards	Closed	Open	
Incentive for developers	Firm/customers	Peer/customer	
Equipment needed for development	Required an Apple Mac for development	Can build it in Windows XP or superior, and in Mac	
Approval process	Strict, long and burocratic	Flexible	
Resources	Online Discussion Forum	Online Discussion Forum	
Disadvantage/ Challenges	Control	User Interface can be non consistent from one phone to the next	
	Limited feed back	Limited feedback	
	Rigidity of the process	Coordination	
	Software related issues	Software related issues	
Advantage	Reliable and slick ecosystem	Flexibility and Customizable	
View of the company	Business oriented	Morally satisfying	
Company – customer			
Payment	Cash	Eyeball – Advertisement	**Apple:** A regulated and quality control environment allows a a high degree of product integration. This also makes the applications to be safe for the end user. **Google:** The M&A and partner alliance strategy used by Google, allows the end users to have different brands and models of handsets.
Third Party Access	Regulated and quality controlled	unrestricted	
Usability and product integration	Consistent	User Interface can be non consistent from one phone to the next	
	highly useable	Lack of product integration	
Safety	Safe applications	Hacking and related security issues	
Customer relationship	Direct	anonymous	
Handsets	iPhones	Different brands and models	

The corporate strategy used was strategic alliances and merger and acquisitions. By using this corporate strategy, Google could build more hardware models per year than Apple. Given the openness of the process, the interaction for innovations was higher with the customers/developers. Google provided a flexible and customizable hardware/software for the developers and the customers. However, the flexibility and openness also came with a cost of difficult coordination, security issues, and lack of product integration, and inconsistency.

This table also displays the success factor for each strategy used by each company. It is interesting to note that there are success factors that are shared by both of the companies, such as open innovation model or the type of reputation they have. Furthermore, as seen in the previous table, each strategy used by each company has a balance of positive aspects (such as a reliable and slick ecosystem, or

more handsets available to the clients) with negative or restrictive factors (such as a controlling environment or lack of product integration). Hence, in order for any company to select the strategy that they will used to develop their product/service, they need to understand what how it will affect the rest of the ecosystem where they want to play. If they want to attract more collaboration and share the burden of innovation, they can have coordination/ control issue. Still, this approach provides more flexibility could offer more products and services to the end users. On the other hand, if they want to have extended collaboration but control the direction of the innovation, they might be seeing as to controlling for the collaborators. This could be burdensome for the developers. And could also limited the amount of products offered. However, this could grant a slick integration for the products and service to the end users.

VI.CONCLUSIONS

In the last years, there has been a paradigm shift for the type of innovation, gradually moving from a closed to open innovation process. Even firms that traditionally have been very closed in the new product development process had opened their innovation funnel in some degree. Open innovation sometimes is confused with open source, however open innovation depends on many factors, such as partner variety, degree of openness, decision maker, among others. Furthermore, in order for a product/process/service to be considered open innovation it has to have business value.

A main reason for the shift to open innovation is that current products/services have network externalities effect. The complex and dynamic current market has caused that many products/services have direct and indirect effects of network externalities. This implies that the key for the success of a company relies on the installed base of customers and on the complementary technology. Hence, the customers requireds a variety and extensive software/applications for a core technology to operate. Consequently, companies have shifted from thinking about consumers to thinking about co-creators of value. This shift has also included a change from the value chain to a value of networks. Overall, the strategy used by any company needs to include all the relationships that existed in the whole ecosystem [8].

However, even though there are many benefits for open innovation in terms of new and diversity of innovation. There are also many challenges, which could be different depending on how closed or open is the ecosystem. For instance, a company that has a better coordination process could be seen as too controlling. Another company that is more flexible could possess issues with consistency among the different versions and developers. Motivation is also seen as a general challenge independent of the type of innovation. The tool used for collaboration (the SDK in this paper) is critical for any type of innovation. Standardization could also be a critical mechanism to manage open innovation.

In this paper, we have chosen Google and Apple to offer what are the lessons from the rise of the information ecosystem and open innovation. These two companies are selected given that they were successful firms with very different corporate strategies to manage innovation. Apple strategy was focused on vertical integration. They only used open innovation to gather a variety of partners at one point of the innovation funnel. Whereas, the corporate strategy used by Google was based on alliances and M&A. In addition, Google had a wider set of technological relationships and involvement of different partners through the whole innovation funnel. However, each of these corporate strategies ensue benefits and drawbacks that the organizations needs to manage.

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