

# Entrepreneurship in Mobile Application Development

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## ABSTRACT

The growth of mobile commerce will require development of both demand and supply sides of the market. On the supply side, the development of mobile applications (e.g. games, calendars, search engines) via cellular technologies will occur in a context partially defined by technical development dependencies that arise from the layered nature of mobile hardware and software technologies. This research finds that these technical application development dependencies shape both the strategies employed by entrepreneurs as well as the evolution of the mobile market. In particular, entrepreneurs are faced with technology choices and device uncertainties, while the market experiences fragmentation, intermediation and distribution integration. These results explain, in part, the slow development of mobile commerce in general, provide a basis for understanding future market developments, and are further evidence of the complex interdependency between technological and market evolution.

## Categories and Subject Descriptors

K.1. [The Computer Industry]: *markets, standards, and suppliers.*

## General Terms

Management and Standardization

## Keywords

Entrepreneurship, Mobile Commerce, Application Development, J2ME, BREW, Market Structure

## 1. INTRODUCTION

Mobile Commerce, unlike its cousin electronic commerce, has fallen short of its expectations in multiple ways [6]. Researchers point to several reasons, including consumer trust [18] and indifference [11]; device usability [10, 21] and security [4, 22]; infrastructure dependability [13, 15], and business models [1, 12]. As these challenges indicate, m-commerce faces both demand and supply issues, and here we focus on the latter. In particular, we focus on the supply of mobile applications and services, which,

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given adequate supply, are expected to increase use and chances of user adoption [17].

The supply of innovative mobile applications will be driven partly by entrepreneurship, which has long been seen as a driving force for economic growth [3, 8] and innovation, particularly in developing markets with higher market uncertainty [2, 9]. Research on electronic commerce has also investigated the role of entrepreneurship in spurring innovation and growth. Zhao (2005), for instance, argues that entrepreneurship and innovation are crucial factors for the long-term sustainability of e-commerce [23]. Other researchers have highlighted the entrepreneurial strategic challenges [19, 20] and market structure effects on electronic entrepreneurship [5, 14]. While these studies highlight the importance of entrepreneurial activity in developing electronic markets, it has received comparatively little emphasis in the Mobile Commerce literature.

In order to address this gap we examine entrepreneurship in mobile application development. We focus on the technological issues of mobile application development that influence entrepreneurial firm strategies and evolving market structures. In other words, we attempt to highlight the technological development uncertainties entrepreneurial firms face that both shape their strategies and the structure of the market in which they operate. In particular, we study technical dependencies in application development and deployment on a broad variety of mobile devices, operating systems, and networks.

The findings are based on data gathered from both interviews with entrepreneurial mobile application developers as well as secondary sources. The entrepreneurs had recently started or were active in the mobile applications market in the US for less than a year when the interviews were conducted in the fall of 2005.

In the next section, we present a brief background of the mobile applications market, with particular emphasis on the development issues. This is followed by a discussion of the data and preliminary findings.

## 2. MOBILE APPLICATION DEVELOPMENT: BACKGROUND

Mobile application developers target specialized niche markets that make use of different mobile devices and wireless infrastructures. These wireless infrastructures include, among others, satellite communication networks, Wireless Local Area Networks and cellular communication infrastructure. Here we focus on mobile applications developed for the cellular communications network and cellular mobile devices. We do this

for two reasons – 1) cellular mobile devices (mobile phones) are by far the most widely used mobile devices; and 2) because application development issues are likely to vary across infrastructures it is necessary to narrow the scope of a study of application development issues. In this paper we use mobile application development to refer to mobile phone application development, where mobile application development essentially represents a downstream component of the mobile (cellular) value chain.

## 2.1 Mobile Application Development Dependencies

Developing a mobile application presents numerous technical challenges for the developer. An important source of these challenges is the technical dependencies that exist across the mobile value chain that a functional application must contend with. That is to say that typically a mobile application is restricted to a particular combination of development platform, operating system, device and network, depending upon the functionality-providing resources used at every level [7]. For instance, a GPS application requires location coordinates that can be provided by the device or the cellular network, thereby making the GPS application code dependent on the device/network standard. Similarly, an application attempting to access a mobile device's camera will be dependent on the operating system standard providing access to the device's camera. Hence, an application can potentially have development dependencies at different levels, which depends on the nature of the application. A stacked view of these development dependencies is shown in Figure 1.

Application development platforms are set of Application Programming Interfaces (APIs) that provide access to certain mobile device and network functionalities that are used by the applications to function on a particular mobile device and/or network. J2ME, BREW, and Flash are primary examples of mobile application development platforms, where J2ME is an open development platform standard and BREW and Flash are proprietary standards. Application development platforms should not be confused with Integrated Development Environments or IDEs (e.g. AppForge, JBuilder, WebSphere, Visual Studio.NET), and the wireless Software Development Kits or SDKs (e.g. Sun wireless toolkit, Openwave). In essence, an application development platform is a technological solution to avoid development dependencies. However, different application development platforms bring their own issues to the mix of development dependencies.

First, different development platforms are supported by different mobile device manufacturers and network operators. For instance, BREW is supported by Verizon Wireless and various vendors offer different BREW-enabled devices. Second, due to the rapid technological advances in device features, additional versions of an application development platform are created and different versions are used for different devices. To circumvent such issues developers use the base version of a development platform and access different device, OS, and Network APIs for developing their applications (see Figure 1), thereby creating the very dependencies that application development platforms were attempting to reduce. Further, device manufacturers realizing this dependency have provided device-specific integrated development platforms like the Nokia Series 60 (Nokia, 2005). RIM's Blackberry is another example of an integrated API

package that integrates the development dependencies around Blackberry devices.

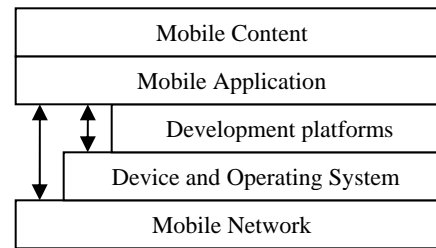


Figure 1. Mobile Content and Application Development Dependencies

## 3. ENTREPRENEURSHIP IN MOBILE APPLICATION DEVELOPMENT

In order to understand the criticality of mobile application development issues in the supply of new mobile applications, we studied entrepreneurial activity in mobile application market. As mentioned above, we investigated the influence of development dependencies on – a) entrepreneurial strategies; and b) the market structure that affects future entrepreneurial strategies.

We conducted a total of eighteen interviews in fall 2005. Twelve interviewees were involved in the startup of their firms and were currently active in the mobile applications market. The other six interviewees were senior managers of firms at different levels of mobile value chain – network operators, application distributors, operation support system providers for network operators (billing, content management system and the like). These six managers were interviewed to capture their expectations of the market structure changes that affect mobile application developers.

The interviews were open-ended in nature and ranged from 60 to 90 minutes in length. The open-ended interviews were transcribed and categorized to extract technological, entrant-specific and structural constraints on entrepreneurial efforts. The categorization was validated by cross transcript comparison. Further, emerging themes were weighted on the background of the interviewee (professional, market experience) and on the number of interviewees raising a particular issue.

The preliminary findings are organized in two sections. The first section highlights the strategic challenges entrepreneurs faced that stemmed from development dependencies. The second section attempts to describe the evolving market structure of mobile application development and its implications for entrepreneurship.

### 3.1 Entrepreneurial Strategies and Development Dependencies

The nascent nature of mobile applications market provides ample opportunities for entrepreneurial activity. To exploit these opportunities mobile application developers must generate successful market entry strategies, and among them a niche market strategy is considered the first step towards financial gain. Almost all the entrants pointed to the unique space, market position, and requirement they had carved out for engaging in business. In addition to delineating the market niche in general, entrepreneurial strategies must also address niche-specific issues

of production and distribution. For mobile applications our interviews suggest that niche-specific production and distribution are shaped by development dependencies.

Development dependencies are technological in nature and depend on the choice of technologies at multiple levels. First, the development language and platform chosen was driven by the developer's background and experience in similar technologies. Developers with Java experience chose J2ME as the development technology, whereas developers with C++ background chose to use visual studio development environment for designing their application, which was a requirement for the BREW development platform. Second and more importantly, choice of technology is not limited to development languages, IDEs, and platforms, but also includes selections of various device, operating system, and network operator development standards or Application Programming Interfaces (API's). These choices had to closely map with the targeted market and distribution opportunities. At the device level, for instance, a developer used 'Palm Treo'-specific APIs for developing a J2ME-based application to get access to the device-specific special keys. The choice of this device was based on the demand that was projected for the application – that is to say that Palm Treo owners were expected to be more receptive and willing to buy the customized application. At the network level, the choice of technology, took the form of adopting special requirements of mobile operators. Nextel (now Sprint-Nextel), for instance, provided a limited set of GPS capable handsets. In building a GPS application the developer limits the application to GPS- capable-Nextel Handsets as GPS API implementation differ across mobile operators. This development dependency is not just evident in the GPS applications, as one developer pointed out – “mostly if you make a program in J2ME it should run on every java enabled phone...but it doesn't...operators have specific, what they call 'API extensions' that work on their own phones...these extensions include location APIs, multimedia APIs and many more”. In other words, the technology a developer chooses is a complex mix of different APIs at multiple levels that are dictated by application niche requirements, which in turn influences their distribution strategy.

Another issue that emerged from development dependencies was the certification process. Due to problems with interoperability of applications across a variety of devices, networks and operating systems, upstream firms in the mobile value chain impose certification requirements for applications. Otherwise they are unwilling to offer the application to their customers. The upstream firms defend the certification process as necessary due to – a) the security of the mobile network and devices; and b) to ensure proper functionality of the application that depended on APIs used from platforms and different devices and networks. The certification process includes the cost of testing the mobile application, digitally certifying the authenticity of the application for download, and even digitally signing the application to be able to access certain restricted network APIs (for instance, access to GPS-derived location information). Since applications must be tested for performance and functionality on a variety of platforms, devices, and networks, the certification costs are considered high compared to the revenue a typical application generates. Hence, the developers consider certification an important investment as well as a potential market entry barrier.

Furthermore, due to development dependencies the entrepreneur has to be aware of the consumer market for the applications. This is a difficult endeavor, particularly at the device level. Although, devices with improved performance, usability and features are becoming available in the market, the devices in the mass consumer market are typically on average a year old compared to the latest available mobile devices. This is due to the subsidized provisioning of mobile devices by network operators to contractually lock-in the end-user. This trend is more disconcerting for the application developer in the prepaid user market. Though the prepaid market is increasing in the US, the phones that are subsidized by the mobile operators are even older and cheaper, further diminishing the potential returns that improved device features might present to application developers.

## 3.2 Emerging Mobile Market Structure and Development Dependencies

In addition to development dependencies' direct strategic implications for entrepreneurs, the interviews also highlighted its influences on mobile market structure that indirectly impact entrepreneurial opportunities and activity. Three main themes in development dependencies induced market structure changes emerged – Fragmentation, Intermediation, and Distribution Integration.

### 3.2.1 Fragmentation

Two mechanisms of market fragmentation due to development dependencies were observed. First, due to rapid changes in mobile device features and non-standardized device architectures, an application can be developed for specific combinations of device, operating system and networks. The mobile industry is still in an embryonic stage and hence higher degrees of harmonization and interoperability are expected. However, this harmonization is expected to be slow as it feeds on the strategic negotiations and positioning of various upstream firms. Second, application development platforms were seen as a solution to this slow harmonization of incompatible standards. However, almost all interviewees had issues with open (versus proprietary) application development platform standardization efforts in mobile application market. J2ME, for instance, attempts to provide compatibility across devices, operating systems and networks. However, the diffusion of different versions and uncertain adoption of different API sets of J2ME by device manufacturers falls short of achieving interoperability. Although J2ME has the potential to provide economies of scale for development (partly due to the familiarity and success of Java in the desktop market), the lack of control in the diffusion of J2ME to device manufacturers cancels out the intended effect. Proprietary development platform standards such as BREW and Flash, on the other hand, provide the necessary control for diffusion, but are limited in their market reach as a de-facto development standard has not yet emerged.

### 3.2.2 Intermediation

The increasing fragmentation of the mobile applications market has opened up multiple intermediation opportunities. Intermediation opportunities such as testing, certification, and cross-platform application porting have emerged from development dependencies. Further, we observed that this

intermediation was shaped and encouraged by the network operators. The network operators in the early 2000s were looking to get as many mobile applications as possible on their application portals to drive up their average revenue per user (ARPU). In order to do this they opened up multiple developer programs and workshops to support the developers. However, the network operators faced multiple challenges. Of particular concern for the carriers were the possibilities that a badly designed application might affect their networks or that an application might cause an end-user's device to crash and possibly lose critical data. Furthermore, the challenges of testing, certification and integration were mounting – not to mention the administrative challenges of managing and interfacing with the increasing number of developers. This led the mobile operators to outsource the management of these issues to technology enablers, testing agencies and certification bodies. More so, their relations matured with selective aggregators/publishers of applications. Although, intermediation can be beneficial for a growing industry, in mobile application market the entrepreneurs noted that the money that trickles down to them was just “too little”.

### 3.2.3 Distribution Integration

In addition to the development dependencies-induced intermediation, the mobile value chain is also witnessing the consolidation of distribution channels around application aggregators/publishers. The rise of BREW and its distribution system (BDS) is particularly noteworthy here. In addition to providing APIs for application development, BREW incorporates a Distribution System (BDS) that provides the framework for network operators and the end users' to shop, purchase, download, and install software over the operators' network. This constitutes a vertically integrated distribution control system for the network operator. Further, Qualcomm through its BDS facilitates a process to manage certification and testing of applications on different BREW-enabled devices (see [16] for details). Although there is a cost associated with this package, the process is streamlined and can be repeatedly used by the entrant in the long run. Currently, BDS is not an option for J2ME developers, but with newer BREW versions that incorporate the J2ME platform, this is expected to change.

As the three different market structure effects (fragmentation, intermediation, and distribution integration) indicate, all the levels in the mobile value chain are knit into a complex system. Innovation will come from multiple levels of this complex and continuously evolving structure. New innovative mobile applications hence will depend heavily on the slow evolution of the mobile value chain. Expectations for the speed of this evolution are exemplified by the comment of one entrepreneur – “I think its naïve on my part to hope that I would be able to write an application and be able to run [it] on different devices.” These expectations are likely to hold true for some time to come.

## 4. CONCLUSION

The idea of a “killer app” driving the ongoing “mobile revolution”, derived from the Internet revolution, is often discussed in trade press articles. However, the development of this “killer app” requires navigation through a variety of technical dependencies and market uncertainties. The complexities

stemming from such issues hamper the economic viability of entrepreneurial efforts, which might otherwise serve as the engine for the “mobile revolution”.

Our research shows that in the particular case of mobile phone application development, in order to be able to reap the benefits of economies of scale application deployment has to cater to a broad variety of devices, operating systems, and networks. Based on the interviews with entrepreneurial mobile application developers, we assessed the impact of technological challenges in mobile application development on entrepreneurship. The preliminary findings highlight the role of technical development dependencies in – a) creating strategic uncertainties that entrepreneurial application developers face; and b) shaping mobile value chain evolution.

In addition, the paper highlights the potential benefits and shortfalls of application development platforms. That is to say that although multiple open and proprietary application development platforms have been designed to address technological dependencies (like J2ME, BREW, Nokia Series 60), two important implications stand out – 1) development platforms are unable to completely integrate technological dependencies; and 2) the mobile applications market has fragmented along the development platforms. These two issues combine to further exacerbate problems that development platforms were introduced to resolve. We also note that these issues are more prominent in the case of an open development platform (J2ME) as opposed to a proprietary development platform (BREW), due to the lack of control in adoption and versioning.

The study's strengths lie in its identification of issues facing entrepreneurs in mobile application development, but is currently limited by the small number of interviews conducted. Future studies should look at entrepreneurial activity in mobile application development more rigorously by either focusing on a specific domain of applications or comparing different domains of applications.

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