TOWARDS A THEORY OF INFORMATION TECHNOLOGY PLATFORM ADOPTION

Research-in-Progress

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Abstract

This research-in-progress paper describes the factors that influence the adoption of IT platforms for application development. The adoption of specific platforms is of tremendous importance in the IT industry; as developers choose particular platforms, they influence the programming languages, applications, and technologies that will become dominant in the future. IT adoption has been a popular area of research for several decades, with a number of theoretical explanations having been developed. IT adoption, however, may differ systematically from IT platform adoption. To investigate the factors that influence IT platform adoption, and whether those factors differ from those that are relevant in IT adoption, we conduct an interpretive field study, analyzing interviews with mobile application developers. After analyzing our results, we discuss the similarities to and differences from extant research on IT adoption.

Keywords: IT adoption, diffusion, IT platforms, mobile applications, software development, interpretive research, theory building, network externalities
Introduction

One of the most remarkable shifts in software development and software-based services is the emergence of development platforms for application software (software commonly referred to as “apps” or add-on “extensions”). Since the launch of the Apple App Store in 2008, Apple has paid out over $6.5 billion in royalties to third-party developers. During 2012, over 275,000 developers paid a $99 annual fee to register with Apple. Apple, Android, Blackberry, and other application platforms have generated – directly and indirectly – over 466,000 jobs in the United States alone (Streitfeld 2012). The proliferation of applications, the amount of revenue generated, and the number of people developing software all indicate the need for both practitioners and researchers to understand why developers choose certain platforms for application development and distribution.

The first research question that we examine in this project is, “What factors influence the adoption of IT platforms?” IT adoption has been a popular area of research for several decades, with numerous well-known theories such as the technology acceptance model (Davis et al. 1989) and the unified theory of technology acceptance and usage (Venkatesh et al. 2003) emerging from such research. This foregoing research has examined how technological characteristics of the IT influence its adoption. Additional factors may be critical, however, when considering IT platform adoption. Unlike IT that is adopted for its own sake, platforms are chosen for the purpose of building end-user applications that may be monetized for profit. Restated, technologies are adopted by technology consumers; platforms are adopted by technology producers. The value of IT platforms accrues in the future, and depends on the expected user base of that platform, its popularity, and other network externality considerations. Furthermore, utilizing IT platforms often requires advanced technological knowledge in areas such as Java or the Android OS. Hence, the adoption of IT platforms may be shaped more by network externality and knowledge barrier considerations than by the technology characteristics identified in IT adoption research. Therefore, our second research question is, “How do the factors that influence IT platform adoption differ from those that influence IT adoption?”

If IT platform adoption differs systematically from IT adoption, then there exists an opportunity to build a theory of IT platform adoption. The identification of the factors that influence IT platform adoption and the observation of any differences when compared to those relevant to IT adoption is the primary intended contribution of this research. To that end, we employ an interpretive approach, interviewing 35 application developers regarding their choice of Apple iOS, Google Android, Blackberry, or Microsoft Windows Phone software development platform to identify a comprehensive set of factors related to IT platform adoption.

Literature Review

**IT Platform Adoption**

An IT platform is the “extensible codebase of a software-based system that provides core functionality shared by the modules that interoperate with it and the interfaces through which they interoperate” (Baldwin et al. 2009; Tiwana et al. 2010, p. 676). Apple’s iOS and the Android operating system are examples of platforms for the development of modules for smartphones and tablets; Mozilla Firefox is an example of a platform for the development of modules for internet browsers. A module is “an add-on software subsystem that connects to the platform to add functionality to the platform” (Tiwana et al. 2010, p. 676). Smartphone apps and browser extensions are examples of modules. The platform, the modules specific to that platform, and the hardware on which the modules run is known as the platform’s ecosystem (Gawer et al. 2002; Tiwana et al. 2010).

IT platform adoption in organizations is a managerial decision that can be explained from technology strategy, organizational learning, technology bandwagon, and adaptation perspectives (Fichman 2004). However, since many mobile applications are built by individual developers in a freelance manner outside of organizational constraints, individual-level factors may be more critical to understanding platform adoption. Individuals are one of the major driving forces behind the “app economy” (Streitfeld 2012). As we have noted in the Introduction, since the Apple AppStore launched, Apple has paid out billions in royalties to hundreds of thousands of freelance coders. Since platform adoption decisions are made by
individuals, we next explore theories of individual adoption to understand this process better.

**IT Adoption**

IS researchers have extensively studied factors that influence individual adoption of new IT, using theories such as the Theory of Reasoned Action (TRA) and the Theory of Planned Behavior (TPB) from social psychology literature. These studies led to the development of the Technology Acceptance Model (TAM), and its extensions TAM2, TAM3, and the unified theory of acceptance and use of technology (UTAUT), which have identified perceived usefulness, perceived ease of use, subjective norm, image, job relevance, computer self-efficacy, facilitating conditions, computer anxiety, and perceived enjoyment, among others, as the key drivers of one’s intention to use IT and indirectly, their IT adoption behavior (Davis et al. 1989; Venkatesh et al. 2008; Venkatesh et al. 2000; Venkatesh et al. 2003). Voluntariness and experience are noted as the key moderating factors in many of these models.

Elsewhere, Innovation Diffusion Theory (IDT) describes relative advantage, complexity, image, compatibility, and results demonstrability as important predictors of IT adoption (Moore et al. 1991; Moore et al. 1996; Rogers 1995); and social cognitive theory (SCT) focuses on outcome expectations, self-efficacy, affect, and anxiety (Bandura 1986; Compeau et al. 1995).

Each of the above theories of IT adoption may be relevant for IT platform adoption. However, as noted earlier, end-users adopt technologies for their own sake. In contrast, developers adopt platforms in order to build end-user applications. In this study, adopters are not consumers choosing among various platforms or ecosystems (Xu et al. 2010); instead, here adopters are individual software developers who must decide which platform to adopt. Thus, the software developer adopter of the IT platform is distinct from the end-user adopter of an IT; this is one reason why the factors influencing IT platform adoption may differ from those that influence IT adoption.

The value of IT platforms thus is determined not only by the specific characteristics of those platforms – as identified in TRA, TPB, TAM, UTAUT, IDT, and SCT – but also on the platform’s popularity, network externalities, and potential future value (Eisenmann et al. 2006; Katz et al. 1994; Rochet et al. 2006). Indeed, it has been observed that the software developer’s adoption decision is one fraught with uncertainty about the unknown future benefits of the platform, potential costs of making the wrong decision, and the irreversibility of the decision (Fichman 2004). Additionally, a developer must have a greater level of technical knowledge and programming skills than an end-user in order to utilize a platform properly, which is irrelevant for an individual user. Thus, again, developers have different considerations when adopting an IT platform than end-users do when adopting an IT. We now attempt to uncover the relevant factors for developers using an interpretive study, as described in the next section.

**Methods**

The goal of this study is to generate an explanatory theory of IT platform adoption using an interpretive field study. The interpretive approach to research is one where researchers collect and analyze data (in our case, textual data) to identify concepts and categories evident in the data. These concepts and categories are then connected to develop an explanation for a phenomenon. The process that we follow includes the following steps (Corbin et al. 1990; Crook et al. 1998; Klein et al. 1999; Walsham 1995; Walsham 2006): (1) iterative data collection and analysis, (2) generation of concepts, (3) development of categories and relating these categories to concepts, (4) theoretical sampling, and (5) use of the coding paradigm of conditions, contexts, strategies, and consequences to discuss the phenomenon of interest.

**Data Collection**

Data for this study was collected using semi-structured interviews with 35 developers of mobile applications for the Apple iPhone, Google Android, or the Microsoft Windows Phone platform in South Korea. Interviewees ranged in age from 31 to 42 (mean 36.08), educational experience ranged from bachelor’s degrees to masters’ degrees (most participants held bachelors’ degrees), and full-time professional work experience ranged from 1 to 38 months (mean 18.38 months). Subjects were asked a series of questions related to the motivation behind their IT platform adoption decision, what alternative platforms they considered, their experience with their platform choice, and their future platform usage.
intentions. Interviews were conducted in the Korean language, and translated into English for coding. The interview protocol is available from the authors upon request.

**Data Analysis**

Interview transcripts were analyzed using open, axial, and selective coding as described by Corbin and Strauss (2008). Coding was done by two researchers experienced in qualitative data analysis. During open coding, each coder examined the interview transcripts line by line to uncover concepts that could potentially explain subjects’ IT platform adoption decisions. Each concept was discussed and labeled by consensus. After initial coding, similar concepts were grouped into broad, generalizable, higher order categories, akin to theoretical constructs. Categories helped reduce the large number of concepts to a manageable few and allowed an overview to develop of the pattern of influences shaping IT platform adoption. To avoid a proliferation of constructs, wherever possible, we employed constructs from the existing literature to name our categories. We also identified the characteristics or properties of each category, and the dimension or value of each characteristic along a continuum (high, medium, or low) to identify patterns of covariation among these constructs. Additionally, to understand the relative salience of a concept, we also tabulated the number of respondents mentioning that concept.

Simultaneous with open coding, we conducted axial coding, during which we assembled the categories into casual relationships or hypotheses to tentatively explain the phenomenon of IT platform adoption. We employed a coding scheme to classify categories into causes, effects, and conditions (circumstances in which the phenomenon is embedded), with the adoption decision as the core category. This process led to the emergence of patterns describing the IT platform adoption process, which was graphically documented as a preliminary theory, as shown in Figure 1.

![Figure 1. Theoretical Model of IT Platform Adoption](image)

The third phase of our coding was selective coding, during which we selectively coded the rest of the data set using our preliminary categories and patterns to support, refute, or extend our preliminary theory. Descriptions of each of the constructs and categories in our proposed theory are described in the subsequent section.

**Research Findings**

Our open coding process identified 62 concepts that were grouped into 27 categories. To focus on the more salient predictors and to ensure parsimony, we decided to only consider those categories that were mentioned by five or more respondents. This resulted in the selection of 18 categories that were codified as constructs of interest.

Our axial coding identified two effects of adoption, namely satisfaction and IT platform loyalty; one contingent factor for loyalty, which we have labeled as competitive option; and 14 predictors of adoption. One of these 14 predictors was forced choice, where company directives mandated developers to use a specific platform. Since such circumstances do not reflect a free adoption choice, it was dropped from further analysis. The remaining 13 predictors were further classified into four broad sets: perceived platform characteristics, perceived network externalities, individual characteristics, and social interaction. These sets of predictors are listed below, and the number of respondents that mentioned that predictor is
noted in parentheses.

Perceived platform characteristics refers to salient technological attributes that influenced adopters' choice of that platform. In our sample of application developers, these characteristics included:

- **Relative advantage**: the perceived strength of an IT platform relative to competing platforms; this included IT platforms' performance, debugging capability, convenience of use, and ease of development. (mentioned in 27 interviews)
- **Platforms' innovativeness**: the perceived novelty of the platform, containing useful functions, innovative image, and benefits. (7)
- **Technical compatibility**: the extent to which a platform was compatible with or could be integrated with other programming technologies. (6)
- **Platform openness**: the extent to which a platform used open source software. Bourdreau (2010) stated that “openness relates to the easing of restrictions on the use, development, and commercialization of a technology.” (6)
- **IT security**: the ability of the platform to protect itself against malicious attack, from either external or internal sources, such as viruses or denial of service incidents (Edmiston 2007). (5)

Second, perceived network externalities refer to direct or indirect value expected from a large network of adopters for a given IT platform. For network-hosted applications, network externalities are presumably a key driver of adoption that is often overlooked in technology acceptance research. Three network externality factors emerged from our analysis as salient to IT platform adoption:

- **Market potential**: the expected size or growth of the future market for the platform. More platform users translate into greater revenue opportunities for application developers. (21)
- **Marketability**: the existence of a current market or app ecosystem based on the IT platform where developers are willing to pay to enter in order to obtain the desired good or service (Mundt et al. 2010). (16)
- **Developer tools**: the availability of tools to support application development and implementation. A large network size motivates vendors to supply tools that can boost developers' presence and participation in the network. (25)

Third, individual characteristics are personal characteristics that explain differential patterns of adoption across the developer population. In this category, two motivational forces and two individual differences emerged from our analysis:

- **Personal benefit**: the potential of earning revenue through application deployment on a platform (an extrinsic motivation). (15)
- **Enjoyment**: personal expectations of fun or goal achievement from developing applications (an intrinsic motivation). Prior research suggests that both extrinsic and intrinsic motivations are key drivers of IT adoption (Davis et al. 1992), and that the same appears to hold true for IT platform adoption. (5)
- **Related knowledge**: developers' prior knowledge of web services, Java, and related tools which are needed to build and deploy applications on their intended platform. (20)
- **Personal innovativeness**: developers’ propensity to experiment with and try out a new platform. This construct is also known to influence IT adoption (Agarwal et al. 1999). (6)

Fourth, social interaction is a link or complex interaction established via reciprocity behavior between two actors who perceive themselves to be interdependent (Thompson et al. 1999; Wang et al. 2009). From our analysis, this interaction refers to social influence, which can be defined as “the degree to which an individual perceives that important others believe he or she should use the new system” (Venkatesh et al. 2003). From our analysis, social influence (mentioned in 9 interviews) influences IT platform adoption, because developers typically get new information regarding platforms and application markets from their professional peers and colleagues.

An examination of the frequency counts suggests that network externalities (availability of tools, market potential, and marketability) are the dominant drivers of mobile platform adoption, followed by relative advantage and related knowledge, while other constructs played a less significant role.

**Discussion**

Extant IS research reveals factors that influence individuals’ adoption of new IT. As we noted in the
Literature Review of this paper, TRA, TPB, TAM, TAM2, TAM3, and UTAUT identify perceived usefulness, perceived ease of use, and job relevance among their list of influences on technology adoption. In our study, various aspects of these factors are captured in the predictors that we have grouped as *perceived platform characteristics*. Additionally, personal benefit, enjoyment, related knowledge, and personal innovativeness have been identified in prior literature as well. We group these factors together into the *individual characteristics* category. Thus, our research confirms that many of the factors that are relevant in IT adoption are also relevant in IT platform adoption.

One of the key differences that we have observed between IT adoption and IT platform adoption, however, is the importance of network externalities. As we have noted, platforms are adopted not by end-users, but by developers to create applications for end-users. Platforms are thus adopted by technology producers, not technology consumers. One of the key considerations for these developers is the size of the market for which they are writing, which is a direct network effect. The related products and services that assist them in development such as books, training seminars, and developer networks, are indirect network effects. Both types of network effects are important and relate to the costs of development and the potential (usually monetary) benefits of development. Developers must conduct some assessment, at least an informal one, of the network externalities offered by each platform.

From a theoretical perspective, neither the TRA/TPB/TAM/UTAUT family of models, nor the IDT models, nor SCT models can account for network externalities in the adoption decision. While some might attempt to force network externalities to fit into the perceived usefulness construct of TAM, the relative advantage construct of IDT, or the outcome expectations construct of SCT, such attempts would fail to take into consideration the original thrust of these constructs’ definitions. Indeed, previous studies explicitly excluded individuals’ profitability in IT adoption decisions, because researchers regarded those concepts as issues related to the organization level (Moore, et al., 1991).

A possible unifying theoretical background for our research and the foregoing research on IT adoption would be the theory of bounded rationality (Simon 1979). This is a theory that acknowledges the rational choices made by individuals in terms of search and satisficing. In the context of our research, search refers to how thoroughly a developer searches for information about various potential platforms to adopt. Satisficing refers to a solution choice, a platform, that the developer perceives as being acceptable (though not necessarily optimal) for development (Tiwana et al. 2010). Bounded rationality is a high-level theory that would serve as an overarching framework for IT platform adoption that subsumes many of the extant models of IT adoption mentioned in the previous paragraph by assuming that the factors in those models are a part of the search and satisficing process. Bounded rationality also allows for the addition of network externalities to an explanation of search and satisficing. Markets that are “large enough” and development platforms with adequate design and distribution features would factor into the boundedly-rational decision-making process of adoption.

Potential adopters actively evaluate factors such as marketability, market potential, and related knowledge and calculate the perceived value of adopting the platform. In most cases, potential adopters have alternatives and they choose one, two, or all according to their perceived value. They might choose not to adopt any platform at all when there is a negative perceived value. The overarching point is that potential adopters tend to maximize their profit from adoption, and that bounded rationality is a framework that can explain this perspective.

**Future Research**

As we move this project forward, we plan to take a mixed-methodology approach. First, we plan to conduct additional interviews to identify any possible additional factors. In the additional interviews, we plan to specifically focus on developers who are users in multiple ecosystems, such as those who use an iPhone as well as a Blackberry, but choose to develop within one ecosystem or the other. We will also seek information about developers who choose to simultaneously develop for multiple platforms, a phenomenon known as multi-homing (Armstrong et al. 2007; Caillaud et al. 2003). While this was not seen in our interviews for this paper, it seems plausible that multiple-platform adoption will be driven by factors similar to the ones we have identified for single-platform adoption. In addition, when platforms allow for apps to be easily ported from one platform to another, we surmise that this technological characteristic of the platform will facilitate multi-homing. Second, we will seek information about any...
potential differences in the drivers of platform adoption between professional developers, part-time commercial developers, and hobbyists or open-source idealists who have no expectation of remuneration. Third, while the model described in this paper was developed using an interpretive approach to analyze interview data, we plan to collect survey data to test the model that we have proposed. The survey data will be collected from a sample of 150-200 developers, and will include subsamples from multiple national/cultural contexts. Survey data will be analyzed and hypotheses will be tested using PLS analysis.

Limitations

Like most empirical studies, our research is not without limitation. Our first limitation is our small sample size of 35 developers. A larger number of developers, perhaps from the aforementioned categories of professional developers, part-time commercial developers, and hobbyists, and perhaps from different national cultural contexts would provide more comprehensive information. Second, we acknowledge that our study focuses only on application development for smartphones, and that our findings may not hold for the development of software modules for other types of platforms (such as the development of extensions for web browsers).

Conclusion

The purpose of this study was to begin to develop a theory of IT platform adoption through a qualitative analysis of interview data from adopters of application developers using the Apple iPhone, Google Android, or Microsoft Windows Phone platforms. The adoption of platforms is of tremendous importance in the IT industry, as applications are designed to work with specific platforms and the choice of the wrong platform may result in significant competitive disadvantage for an application developer. If researchers can understand the reasons why certain platforms are adopted (or not), they may be able to identify emerging trends in IT at an early stage. Our proposed theory supports some of the tenets of IT adoption, while also presenting new theoretical issues to address. We hope that our effort will motivate further research on IT platform adoption and help contribute to the construction of a comprehensive theory of this phenomenon.

References


