



# A Proposed Framework for Assessing the Factors Influencing the Adoption of Free and Open Source Application Software in Organizations

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## ABSTRACT

In this paper we propose a framework for assessing the factors influencing the adoption of free and open source application software in business and other organizations. While there have been several interesting examples of free and open source application software adoption by organizations, these have been limited. This research explores factors that potentially influence the adoption of F/OSS in organizations or serve as barriers to such.

## INTRODUCTION

There is widespread interest in the adoption of free and open source software (F/OSS) at individual, organizational, national, and international levels (Al Marzouq, et al., 2005; Fitzgerald & Kenny, 2004; Mrquez, 2004; Weerawarana & Weeratunga, 2004). This, because of the nascent belief that this type of software will be cheaper to develop and own, will increase flexibility and security, while reducing dependence on predatory proprietary software vendors. Interest in F/OSS is not one way. Proprietary software developers and vendors which stand to lose much if F/OSS is adopted by organizations are keen to counter the claims of those advocating its adoption (Al Marzouq, et al., 2005).

According to Al Marzouq, et al., (2005 p. 756) "The terms free and open source refer to software that anyone can freely redistribute, analyze and modify while complying with certain criteria." Free software and open source software, while similar have different genesis, objectives, and licensing regimes (Al Marzouq, et al., 2005). Whatever definition is chosen there are two important features of F/OSS: one is that the source code is made available and can be modified and the other is that the software is redistributed freely (Robson, 2003). The availability of the source code allows the individual or organization that acquires it to make changes and, depending on the licensing regime associated with the software, redistribute it if they, in turn, make the source code available. Although the software is said to be free this does not mean that its adoption will be at zero cost (Towle, McFarland, & Keppler, 2004). Considerable costs may still be incurred, including the cost of software modification and ongoing support. Because of the uncertainties associated with adopting F/OSS, managers are often unclear as to what the total cost of adoption might be.

One of the major potential benefits of the F/OSS option is that it can lower software costs, including licensing fees, which can be quite substantial (Hayes, 2003). Another advantage for organizations is that since the source code is available for modification, the F/OSS can be easily modified to fit specific organizational or process needs. This can

result in higher quality software and greater flexibility. It may also result in software that is more secure, a claim often advanced by F/OSS advocates.

The opportunity to customize software also creates the potential for developing a local IT industry as organizations that acquire open source are unlikely to be interested in tailoring and maintaining it themselves. Local IT companies can seize this opportunity to provide ongoing technical and operational support (Tina, 2005). The continued use of proprietary software is becoming increasingly prohibitive for less developed economies as they seek to apply information technology or participate in the software industry (Dreiling, Klaus, Roseman, & Wyssusek, 2005). F/OSS may be used by countries as an IT strategy to create value in the economy. This translates into new business opportunities in the IT sector for private firms, reduction of IT cost in the economy for both government and private firms, and improvement in effectiveness and efficiency of governance (Weerawarana & Weeratunga, 2004). Local organizations should be able to save as well as generate foreign currency through import substitution. This is especially important for developing countries, as they will not have to pay out large amounts in foreign currency for software acquisition and support services.

The potential benefits to organizations and countries from adopting F/OSS have already caused governments, especially those in developing countries, to encourage its use (Schulz, 2001). Several countries including Brazil, Venezuela, South Africa, Sri Lanka, Peru, and South Korea are actively promoting the adoption of F/OSS in government as well as private sector organizations. There may be other benefits for countries. For example, large proprietary software companies have approached Venezuela with lucrative deals to encourage it to continue to use their software (Sojo, 2004). Having a viable F/OSS strategy gives countries substantial negotiating power.

However, if this move to F/OSS is to be successful, the software will have to be adopted and diffused throughout and among organizations. A key issue therefore facing managers as well as policy makers is to identify the factors that enable or serve as barriers to the widespread adoption of F/OSS applications by organizations.

While there has been a great deal of interest in F/OSS from the supplier side (i.e. the provisioning of F/OSS software) there is limited work that addresses the demand side (Wheeler, 2004). In our exploration of the literature only a limited number of studies have focused substantively and systematically on the adoption of F/OSS in organizations (Fitzgerald and Kenny, 2004; Waring and Maddocks, 2005; Brandon, 2005).

The aim of this research therefore is to identify factors that enable or serve as barriers to the adoption of F/OSS. The salient research questions are as follows: What are the main factors that influence the adoption of F/OSS applications by organizations? What are the inter-relationships among these factors, and what additional factors explain the level of influence of the main factors?

In the following sections we will review the existing literature to identify and explain the factors that could influence the adoption of F/OSS. We then propose a model for the adoption of F/OSS, which we will use to derive a set of propositions that serve as the basis for future research. While studies of individual adoption of IT predominate the IS literature, the work in this paper focuses on the organizational adoption of IT (King and Gribbins, 2002).

**RELEVANT LITERATURE**

A growing body of research on F/OSS exist. However, the focus of much of this research is on the supply side of F/OSS. Research focusing on F/OSS development approaches, methods, communities, and the like are becoming more substantive (O'Reilly, 1999; von Hippel and von Krogh, 2003; Crowston and Howison, 2005; Jin, et al., 2005). However, although there has been much debate in the media lately about the benefits of and barriers to the adoption of F/OSS, generating a number of articles and news reports about its adoption both at the country level and organizational level (Economist, 2003; Fredrick, 2003; Karp, 2003; Mrquez, 2004; Sojo, 2004; Weerawarana & Weeratunga, 2004), few studies provide in-depth insights into the phenomena. Only a limited number of published research exist that focus on the demand side of F/OSS (Fitzgerald and Kenny, 2004; Waring and Maddocks, 2005). This dearth of empirical research limits the amount accumulated knowledge on the subject on which we can draw.

The interest in the perceived barriers to the adoption of F/OSS (Farber, 2004) has mainly come about because of the need to understand the relatively low diffusion rate and usage of F/OSS applications in organizations. Some of the views as to why this is so are: a lack of formal support; the velocity of change brought about by developers continually modifying the software makes it difficult for organizations to maintain it; the lack of a roadmap makes it more difficult for the chief information officer (CIO) to plan; licensing issues; and issues related to accountability (Farber, 2004). Also there is uncertainty about the cost of switching and the total cost of ownership associated with F/OSS.

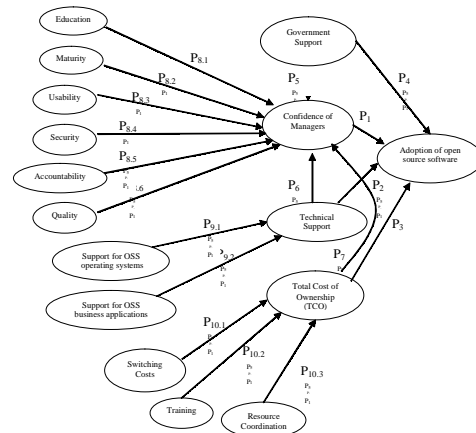
**FORMULATING A MODEL FOR THE ADOPTION OF F/OSS**

Several IT adoption and diffusion frameworks have been used for IT generally and could be considered for this study (Agarwal, 2000; Hall & Khan, 2003; Moore & Benbasat, 2001; Rogers, 2003). These models, as well as several others, focus on individual adoption behaviors and decisions. They do not necessarily lend themselves to studying organizational adoption of technology (King and Gribbins, 2002). Other models such as the McFarlan and McKenney (1982) model, concerned with the assimilation of new technology into organizations, emphasize the actual process of technology adoption rather than the factors influencing organizational adoption. In addressing the factors influencing F/OSS adoption in organizations we see the need for a framework that specifically highlights these issues.

**PROPOSED FRAMEWORK**

Our review of the existing literature supplemented by the views of several scholars and practitioners, reveal four factors that seem to affect the adoption of F/OSS. They are the confidence of IT and business managers in F/OSS, the uncertainty of the TCO of F/OSS, the availability of technical support for F/OSS, and the level of government support for F/OSS. We have further decomposed the four specific factors, identified earlier, into a set of propositions ( $P_N$ ) and associated these with a set of possible explanatory variables. These factors and their associated

Figure 1. Open Source Software Adoption Framework



variables that are believed to influence F/OSS adoption are depicted in the open source adoption framework presented in Figure 1.

**FACTORS AND THEIR CHARACTERISTICS**

**Confidence of IT and Business Managers**

The lack of confidence of IT and business managers in F/OSS seems to be one of the main barriers to the adoption of F/OSS. While this lack of confidence is not universal it is persistent and often characterized by a number of misconceptions (Al Marzouq, et al., 2005). If managers are not confident in the suitability and efficacy of F/OSS then they would view its adoption as an increased and unwarranted risk. A number of issues are relevant when considering confidence: education, F/OSS maturity, usability, quality, security and accountability. There seems to be a lack of education/knowledge about F/OSS, especially at the managerial level, and the benefits that can be gained from its use.

There is a perception that F/OSS is not as mature as proprietary software. This perception may be compounded by the fact that the source code is available and can easily be modified, creating challenges in maintaining version integrity. Because this makes the velocity of change much higher, managers feel that planning is more difficult (Farber, 2004). Further, managers often perceive that open source software is not as usable as proprietary software (Nichols & Twidale, 2002). One of the reasons for this may be that F/OSS developers initially focused on the back end processes, creating high barriers to entry for non-technical end-users (Al Marzouq, et al., 2005). Proprietary software developers, on the other hand, have more products targeting the front end (i.e. the user interface) making them more accessible to non-technical users.

Some also perceive the quality of F/OSS as not as high as proprietary software even though research has shown that the quality of F/OSS is comparable with or in some instances even higher than that of proprietary software (Birendra, Ashutosh, & Srinivasan, 2002; Verma, 2005). This may reflect the feeling that it lacks maturity and usability. The view that security may be compromised in F/OSS is held by some (Fisher, 2002). However, advocates of F/OSS argue that access to the source code makes it possible and easier to address security issues more immediately, thus increasing security. Another element affecting managers' perceptions of F/OSS relates to accountability for potential problems with implementation and ongoing support. Managers need someone or organization that can be held accountable when things do not work out as expected. It is often felt that F/OSS arrangements do not provide this level of accountability.

Based on the above we propose the following:

*P<sub>7</sub>: The lack of confidence of IT and business managers negatively affects the adoption of F/OSS.*

We further propose that perceptions concerning:

*P<sub>8</sub>: The lack of education (P<sub>8.1</sub>), maturity (P<sub>8.2</sub>), usability (P<sub>8.3</sub>), security (P<sub>8.4</sub>), accountability (P<sub>8.5</sub>) and quality (P<sub>8.6</sub>) negatively affects the confidence of IT managers.*

## TECHNICAL SUPPORT

Technical support for F/OSS can vary widely, from immediate and abundant to non-existent (Al Marzouq, et al., 2005). Many organisations that are willing to acquire open source solutions do not necessarily want to have to customize and maintain the software. They have to be confident that there is vendor support for this. F/OSS software covers a wide range of applications whether on the server side or on the business application side (Al Marzouq, et al., 2005). While there is growing and substantive support for server side applications such as operating systems software, database systems, and web and email servers by companies such as IBM, Redhat, SuSE/Novell, the third party support for business application software is not as visible (Rapoza, 2004, Waring & Maddocks, 2005).

Based on the above we propose the following:

*P<sub>2</sub>: The perception that there is a lack of technical support for F/OSS negatively affects its adoption.*

We further propose that:

*P<sub>9</sub>: The availability of support vendors for operating systems (P<sub>9.1</sub>) and business applications (P<sub>9.2</sub>) affect the availability of technical support for F/OSS.*

## TOTAL COST OF OWNERSHIP (TCO)

Fitzgerald et al. (2004) report significant cost reduction by converting information systems infrastructure to F/OSS. Nevertheless, there is still some reluctance to switch due to the uncertainty about the true cost of such a move. F/OSS, although often described as “free”, has costs associated with it such as the costs of switching and training (Wang & Wang, 2001). High short-term switching costs are usually expected when transitioning to F/OSS (Waring and Maddocks, 2005). There may also be substantial costs associated with F/OSS resource coordination and delivery (such as having to develop further expertise in-house). These costs may not be clearly defined when considering F/OSS and may cause some uncertainty as to the true cost of its adoption. The TCO is a key consideration when evaluating the cost of F/OSS (Al Marzouq, et al., 2005).

Based on the above we propose the following:

*P<sub>3</sub>: The uncertainty of the total cost of ownership of F/OSS negatively affects the adoption of F/OSS.*

We further propose that:

*P<sub>10</sub>: The switching (P<sub>10.1</sub>), training (P<sub>10.2</sub>), and resource coordination (P<sub>10.3</sub>), costs affect the TCO of F/OSS.*

## GOVERNMENT SUPPORT

In many countries the government has become involved in the promotion of F/OSS. For example, in Brazil and Venezuela, the government

sought to compel its agencies to migrate to F/OSS (Mrquez, 2004; Sojo, 2004). In other countries, while F/OSS adoption is allowed and encouraged it is not specifically promoted (Waring & Maddocks, 2005). Government initiatives, pro or con, will directly influence the adoption of F/OSS.

Based on the above we propose the following:

*P<sub>4</sub>: The lack of government support negatively affects the adoption of F/OSS.*

## INTER FACTOR INFLUENCES

In addition to the factors themselves and their proposed causal variables, there are influential relationships that exist between these four main factors. Three inter-factor influences that affect the confidence of managers are proposed: government support for the adoption of F/OSS may increase the confidence of managers; managers are unsure about the costs involved in moving towards F/OSS and this can negatively affect their confidence; and the perception of the lack of technical support also influences the confidence of managers in F/OSS. Consequently, we propose that:

*P<sub>5</sub>: Government support positively affects the confidence of managers.*

*P<sub>6</sub>: The lack of technical support negatively affects the confidence of the managers.*

*P<sub>7</sub>: The uncertainty of the cost of moving to F/OSS negatively affects the confidence of managers.*

## TESTING THE PROPOSITIONS AND FUTURE RESEARCH

The propositions outlined in the previous section have not been empirically tested. This is the next stage of the research. In this next phase we plan to devise measures for the concepts and variables advanced in the framework presented in Figure 1. In devising the measures we will first investigate whether there are already validated measures that can be adapted to suit our concepts. Failing that we will develop measures based on our review of the literature. We will then seek to validate the measures through at least two processes: (1) interviews (structured and semi-structured) with practicing business and IT managers get their insights on factors influencing F/OSS adoption (this will help us to address face and construct validity issues) and; (2) conduct a cross-sectional survey of organizations in different contexts to assess their perceptions on the subject.

To collect data we will develop a questionnaire and administer it to managers at different levels in organizations. The collected data can then be analyzed using structured equation modelling (SEM) techniques for reliability and validity. The SEM techniques will allow us to measure the latent constructs and assess our framework by testing the linkages between the constructs (Gefen et. al., 2000). We plan on using PLS-GRAPH to test the measurement model and the structural model of the framework that has been proposed. Testing the propositions in this manner will be a step towards validating our framework.

## CONTRIBUTIONS AND FUTURE WORK

Open source has the potential to offer tremendous monetary savings. Countries, particularly developing countries, and their organizations seek to seize this opportunity to reduce their operating costs. The work described is a first step in identifying the factors that serve as enablers or barriers to the adoption of F/OSS.

Once the enablers/barriers to adopting open source software are identified, they can be examined to determine how the benefits of F/OSS can

be realized. For example, if organizations feel that there is not enough support for open source, the characteristics of an open source support provider can be identified and developed by a local software development company to address the technical support gap. This may provide an infrastructure for a home-grown IT industry (Sojo, 2004) and may make organizations less reliant on proprietary foreign sources of technology, a longstanding problem, especially in developing countries.

Although there is a great deal of attention being given to open source software in the media, based on the preliminary review of literature, there does not seem to be a lot of formal research on F/OSS application adoption by organizations. This paper is an attempt to fill this gap by offering an F/OSS adoption framework and identifying several propositions (that are by no means exhaustive). We hope to encourage further work in refining the proposed framework and to translate the propositions into testable research hypotheses.

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