Open Source Software Adoption:
Anatomy of Success and Failure

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ABSTRACT

Current estimates suggest widespread adoption of open source software (OSS) in organizations worldwide. However, the problematic nature of OSS adoption is readily evidenced in the fairly frequent reports of problems, unforeseen hold-ups, and outright abandonment of OSS implementation over time. Hibernia Hospital, an Irish public sector organization, have embarked on the adoption of a range of OSS applications over several years, some of which have been successfully deployed and remain in live use within the organisation, whereas others, despite achieving high levels of assimilation over a number of years, have not been ultimately retained in live use in the organization. Using a longitudinal case study, we discuss in depth the deployment process for two OSS applications – the desktop application suite whose deployment was unsuccessful ultimately, and the email application which was successfully deployed. To our knowledge, this is the first such in-depth study into successful and unsuccessful OSS implementation.

INTRODUCTION

Open source software (OSS) has elicited a great deal of research interest across a range of disciplines since the term was introduced in 1998. Much of this research, however, has focused *inward* on the phenomenon itself, studying the motivations of individual developers to contribute to OSS projects, or investigating the characteristics of specific OSS products and projects, for example. Far less has been done in looking *outward* at the process of OSS adoption and implementation in organizations. The need for rigorous research into this process is important for several reasons: Firstly, recent estimates suggest widespread adoption of OSS: A survey of public administrations in 13 European countries reported that 78% were using open source (Ghosh and Glott, 2005). Similarly, a large-scale survey in the US estimated that 87% of organizations were using open source software (Walli et al., 2005). However, these surveys did not distinguish between primary adoption (the initial decision to adopt at the organizational level) and secondary OSS adoption (the actual implementation process which involves adoption by individuals throughout the organization). Primary and secondary adoption

have been identified as quite different scenarios (Gallivan, 2001; Zaltman et al., 1973). This distinction and the problematic nature of OSS adoption is readily evidenced in the fairly frequent (and somewhat controversial) reports of problems, unforeseen hold-ups, and outright abandonment of OSS implementation over time (e.g. Birmingham City Council (Thurston, 2006); Crest Electronics (Turner, 2005); Scottish Police (Niccolai, 2005), Newham Council (McCue, 2004).

Here we present the case of Hibernia Hospital, an Irish public sector organization, who embarked on the adoption of a range of OSS applications. Some of these applications have been successfully deployed and remain in live use within the organisation, whereas others, despite achieving high levels of assimilation over a number of years, have not been ultimately retained in live use in the organization. Using a longitudinal case study, we discuss in depth the deployment process for two OSS applications—a desktop application suite whose deployment was ultimately unsuccessful and abandoned, and an email application which was successfully deployed. To our knowledge, this is the first such study into successful and unsuccessful OSS implementation, although there have been several studies of OSS adoption (e.g. Lundell et al., 2006; Rossi et al., 2006; Ven et al., 2006; Zuliani and Succi, 2004).

As a starting point, we drew on Gallivan's (2001) process framework for studying secondary adoption of technology. This framework extends the classical diffusion of innovation theory of Rogers (1962-2003) by drawing on critiques of this theory (e.g. Fichman, 1992; Fichman and Kemerer, 1999; Moore and Benbasat, 1991). Our goal in this study was not to test a factor model of OSS deployment but rather to provide a rich description of the process of successful and unsuccessful OSS adoption in a single organizational context, with a focus more on theory development rather than theory testing.

Furthermore, researchers have identified a tendency in traditional innovation adoption research towards a pro-innovation bias (Fichman,

2004; Rogers, 2003). As a result, innovation is invariably seen as beneficial and positive for all participants, and, indeed, more has been written about successful adoption than rejection. Thus, our study here of the successful and failed adoption of OSS products can provide useful insights and contrasts which can contribute to theory development in this area.

The remainder of the paper is structured as follows. In section 2, we discuss the process model approach adopted here and present the conceptual framework we use in the study. Following this, section 3 discusses the research approach adopted. Section 4 presents the adoption process trajectories for both OSS applications in Hibernia. Following this, in section 5 we discuss this deployment using the framework derived in Section 2. Finally, the conclusions and the implications of the study for a theory of OSS deployment are discussed.

CONCEPTUAL GROUNDING

Process versus Factor Research Models

Process and factor approaches have been identified as alternative but complementary approaches to research (e.g. Markus and Robey, 1988; Mohr, 1982). Briefly summarising, factor research is concerned with identifying predictor and outcome variables. These are cast as independent and dependent variables and the research focus tends towards rigorous measurement of the variables and statistical analysis of the relationship between them. The variables are assumed to be causally related with the predictor/independent variable accounting for variation in the outcome/dependent variable. However, such research cannot provide any in-depth explanation as to how and why the variables may be related (Newman and Robey, 1992). Process model research, on the other hand, seeks to elaborate the story of the underlying dynamics which reveals how and why outcomes are reached over time. In this study, given the lack of research on organizational

adoption of OSS, successful or otherwise, a process model which could afford increased understanding of significant OSS adoption events was important.

While process and factor models are acknowledged as complementary, researchers have warned against combining into a single model (Markus and Robey, 1988; Newman and Robey, 1992; Mohr, 1982). This argumentation is based on the fact that the models differ in form and operate a different model of causality. That is rather than a 'push type' causality of factor models where the levels of the independent variables cause the levels of the dependent variables, in the process model approach, outcomes are implied by preceding events—a 'pull-type' causality.

Notwithstanding this argument, several researchers have combined process and factor models to good effect (Gallivan, 2001; Sambamurthy and Poole, 1992; Shaw and Jarvenpaa, 1997). Indeed, combining factor and process models has been advocated when the focus is on understanding the adoption events and the factors that promote or constrain adoption outcomes (Gallivan, 2001; Shaw and Jarvenpaa,

1997). Therefore a somewhat hybrid model was followed here in that an overall conceptual framework of innovation adoption was identified, primarily as a conceptual lens to theoretically ground the study (Klein and Myers, 1999) and also as a means of bounding the study focus (Newman and Robey, 1992).

Innovation Adoption Research

In a review of technology diffusion research, Fichman (1992) proposes a 2x2 matrix of innovation adoption contexts where the axes are locus of innovation adoption (individual or organization) and class of technology to be adopted (low user interdependencies and knowledge burden versus high user interdependencies and knowledge burden). The model is presented in Figure 1.

Fichman argues that the assumptions underpinning traditional innovation adoption models hold best for the lower-left quadrant in Figure 1. In our study, we focus on organizational adoption of open source which is best characterised by organizational mandate to use the technology and also extensive knowledge

Figure 1. IT diffusion classification matrix (from Fichman, 1992; Gallivan, 2001)

Locus of Adoption

Class of Technology	**Individual**	**Organizational**
High knowledge burden/High user interdependencies	Knowledge Burden	Organizational Mandate and Knowledge Burden
Low knowledge burden/Low user interdependencies	Traditional Adoption	Organizational Mandate

required to overcome barriers to implementation and use. This is represented by the upper-right quadrant in Figure 1.

Such a characterisation of OSS as a technology subject to organizational mandate, high user interdependencies and high knowledge burden is justifiable for a number of reasons. Firstly, the OSS products that we focus on in this study include desktop and email application platforms. Both of these represent horizontal infrastructure systems in widespread use within organizations. As such they would be subject to the IT governance policy within an organization, and use of these systems would typically be organization-wide.

Furthermore in terms of knowledge burden, Fichman and Kemerer (1999) argue that IT assimilation may be hindered by knowledge barriers due to the learning required to obtain the necessary deep knowledge and skills to successfully deploy complex technologies. These knowledge barriers cause deployment to be a risky venture for an organization, but it may still undertake deployment so as to be in a position to avail of benefits at the appropriate time.

These issues are especially pertinent in the case of OSS. Given the fact that OSS is quite a new phenomenon, there is no well-established and codified base of knowledge that can guarantee successful deployment. OSS adoption represents a significant risk and a fundamental change in how software is acquired and maintained (Agerfalk and Fitzgerald, 2008). For example, there is usually no vendor to market an OSS product and verify that the product meets required functionality. Nor is there the automatic provision of the guaranteed maintenance contract that comes with the acquisition of proprietary software. These issues represent a considerable knowledge burden for organizations that embark on the process of OSS adoption.

A Conceptual Framework for the Innovation Adoption Process

Gallivan (2001) draws on a wide range of innovation adoption research, including Rogers diffusion of innovation, Davis' (1989) TAM model and, particularly the Theory of Planned Behavior (Ajzen, 1985) to propose a process framework specifically addressing secondary adoption and organizational assimilation of technology (see Figure 2).

Figure 2. Secondary adoption process (adapted from Gallivan, 2001)
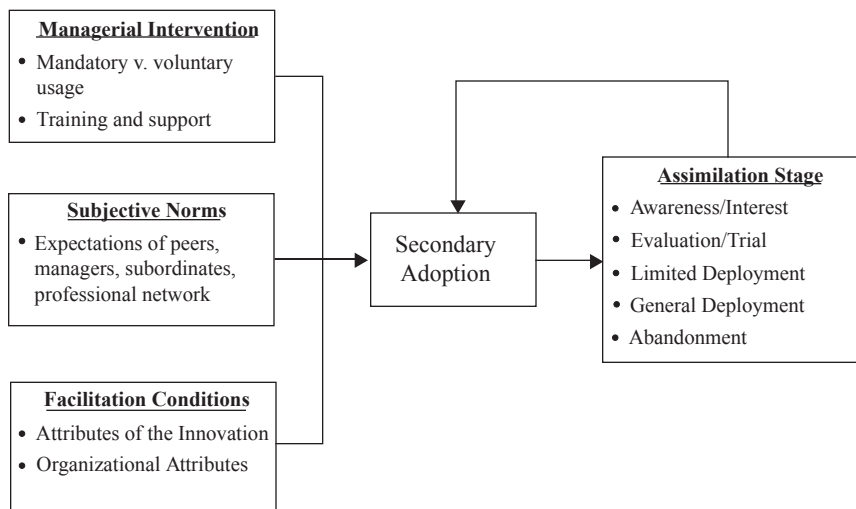
This framework operates at quite a high-level in identifying issues relevant to the IT adoption process. Here we briefly discuss the components of the framework and how they are relevant in an open source context. Later, we use this framework to structure our discussion of the deployment process for the various OSS applications in Hibernia.

Managerial Intervention

Managerial intervention refers to the actions taken and resources made available by management to expedite secondary adoption. Gallivan identifies issues such as voluntariness of adoption, training and support here. Voluntariness has also been proposed as a significant factor in other innovation research (Moore and Benbasat, 1991), and the issue of organizational mandate in relation to OSS adoption was discussed above.

Management support is undoubtedly critical for radical, high-risk initiatives such as OSS deployment since it contravenes the traditional model where ongoing support is legally guaranteed by a vendor. Indeed, management support is likely to become even more important in the future as OSS adoption moves out of the domain of invisible infrastructure systems to more visible, high-profile applications.

Subjective Norms

Subjective norms have to do with individual beliefs about how relevant peers and co-workers expect them to behave in relation to the technology. This can lead to greater effort to learn about and adopt an innovation or even cause abandonment of a technology. This issue has resonances with attributes of the innovation, such as compatibility and image, discussed below.

From a values and norms perspective, the ideology represented by OSS may have significant implications. The importance of ideological values has been illustrated in several studies of OSS. For example, Stewart and Gosain (2006) identify how adherence to an overarching OSS community ideology facilitates team effectiveness. Similarly, the protracted and heated dispute over several years among the Linux kernel development community concerning the use of a proprietary version control system (BitKeeper) represented an ideological crisis for many in that community, and certainly influenced the choice of adoption and non-adoption of the technology (Shaikh, 2006).

Facilitating Conditions: Attributes of the Innovation and Organization

Much prior research on innovation adoption has focused on attributes of the technology and the organization. Rather than discuss exhaustively the range of attributes that have been identified, a number of attributes are briefly presented here and we discuss how they are relevant to an OSS context.

Attributes of the Innovation

Rogers (2003) identifies five key perceived attributes of an innovation that influence the outcome of the adoption process:

- **Relative advantage:** the extent to which an innovation is perceived as being better than its precursor.
- **Compatibility:** the degree to which an innovation is perceived as being consistent with the existing values, norms, needs and past experiences of potential adopters.
- **Complexity:** the degree to which an innovation is perceived as difficult to understand and use.
- **Trialability:** the degree to which an innovation can be experimented with.
- **Observability:** the degree to which the results of an innovation are visible to others.

In short, Rogers suggests that innovations will diffuse more quickly and successfully when they are readily trialable, of high relative advantage, compatible with the status quo, not

too complex to use, and where use is readily observable to others. These attributes have been confirmed in many studies. Additional attributes, such as image and voluntariness, have been identified (Moore and Benbasat, 1991), and indeed some attributes have been found to overlap—relative advantage and compatibility, for example (Moore and Benbasat, 1991; Carter & Belanger, 2006). While Rogers' work is applicable to innovation in general, in the specific category of IT adoption, the technology assessment model (TAM) has been proposed by Davis (1989) with two central attributes—perceived usefulness and perceived ease of use. These are subsumed by the Rogers attributes of relative advantage and complexity respectively.

These attributes are readily apparent in the context of OSS. In terms of relative advantage, compatibility and complexity, for example, many OSS products have been purposefully designed to replicate proprietary counterparts. There should therefore be a sense of familiarity thus mitigating adoption problems in relation to these attributes. On the other hand, the observability of OSS use is less obvious due to the strategy of replicating proprietary software. For example, it is very difficult to tell the difference between MS Word, Excel and Powerpoint and the respective OpenOffice counterparts, Writer, Calc and Impress, merely by looking at users working online on these applications.

Given that acquisition of OSS products is usually extremely straightforward, often as simple as a zero-cost download from a web site, trialability is greatly facilitated in the specific case of OSS. Indeed, many OSS implementations up to now have been deployed by technologically-literate IT personnel who have not sought organizational approval to acquire the products.

In Rogers's work, image is considered to be subsumed in relative advantage, but Moore and Benbasat concur with previous studies which have shown image to be a separate factor (Tornatzky and Klein, 1982). Image is defined as the degree to which an innovation can enhance one's image or social status. This has emerged as a complex issue in relation to open source. Studies of the motivation of OSS developers reveal that the intrinsic satisfaction of belonging to a meritocratic community where talented developers can progress to become core developers is a powerful force (e.g. Kuk, 2006; Lakhani and Wolf, 2006). Similarly, from a user perspective, public administrations, particularly in Europe, have been enthusiastically seeking to deploy open source, seeing it as a positive initiative which frees them from the constraints of a proprietary software industry. However, other reports have found that developers do not necessarily embrace open source (Zachary, 2003), and equally, from a user perspective, there may be resistance to the use of open source products (van Reijswoud, 2005).

Organizational Attributes: Absorptive capacity

Fichman (1992) recommends that theoretical frameworks of traditional innovation research be complemented by additional perspectives, including absorptive capacity (Cohen and Levinthal, 1990). Absorptive capacity refers to an organization's ability to recognise the value of new information, absorb it and subsequently leverage it productively. An absorptive capacity perspective has been used by Daniel et al. (2006) to study OSS development group performance in relation to knowledge acquisition and transfer. However, absorptive capacity certainly seems relevant for OSS adoption more generally. The ever increasing number of OSS applications appearing in the marketplace represents a significant knowledge challenge to be overcome—for example, the knowledge of what applications exist, which ones are most viable, how well they are supported, what functionality they offer, how they may be integrated with other OSS or proprietary applications. Indeed, developers in the past have referred to the "exhilarating succession of problem-solving challenges" when installing OSS products (Sanders, 1998). Furthermore, given that there is no tried and tested roadmap indicating a clear series of steps to guarantee successful deployment, organizations cannot

expect to have the type of lengthy experience with OSS deployment that could guarantee success. Thus, the process of OSS implementation is clearly one where absorptive capacity may play a crucial role.

Secondary (Individual) Adoption Process

Gallivan suggests this component to address the details of the organizational implementation process whereby individuals throughout the organization adopt the innovation. This is taken to include when and how the innovation is adopted, what obstacles are encountered and how these influence the outcome and the degree of organizational assimilation.

Level of OSS Assimilation

Given that technology acquisition and deployment represent different assimilation events, the level or degree of assimilation can be viewed as a staged process from awareness/interest through to general deployment. The following, adapted from Fichman & Kemerer (1997), indicate the range of OSS assimilation levels experienced over time in Hibernia.

- **Awareness/Interest:** Key decision makers in organization aware of OSS and actively committed to learning more
- **Evaluation/Trial:** Organization has acquired specific OSS products and has initiated evaluation or trial
- **Limited Deployment:** Organization has established a program of regular but limited use of OSS products
- **General Deployment:** Organization is using OSS products for at least one large and mission critical system
- **Abandonment:** Organization has discontinued live use of OSS products

RESEARCH APPROACH

At a high level, research epistemologies may be classified as positivist, interpretivist or critical (Chua, 1986), although Klein and Myers (1999) recognise that classifying individual research studies is not always straightforward. To the extent that positivist research involves quantifiable measures, formal hypothesis testing and the pursuit of statistical generalization, this research study is not primarily a positivist one. Likewise given that critical research seeks to elucidate the negative and discriminatory conditions inherent in the status quo, this study does not follow a critical approach. Interpretivist research assumes the social construction of reality through language and shared meanings, and explicitly recognises the importance of a deep understanding of the context in all its inherent complexity. This research is largely compatible with these assumptions and our epistemology is thus closest to the interpretivist one. However, this classification should be tempered with our use of a high-level conceptual framework to ground the research, and to which we also link our findings. Nevertheless, Klein and Myers (1999) recommend the use of a conceptual framework in interpretivist research for such a purpose.

We sought to develop a rich understanding and insight based on a deep analysis of a single case context—what has been termed a "revelatory case" (Yin, 1994). This is also relevant given that there are undoubtedly political and social factors at play in IT assimilation (Fichman & Kemerer, 1999), which are difficult to elucidate in survey research, for example. Also, by definition postal surveys usually only elicit information from a single key informant (or perhaps two) in an organisation. Thus, there is merit in investigating the view of multiple stakeholders in a particular case context, particularly for the complex secondary adoption process (Fichman, 1992; Gallivan, 2001; Rogers, 2003). Also, just as quantitative research highlights findings that are of greatest statistical significance, in qualitative research, the aptness

of a respondent's quote can memorably highlight the essence of the research.

Given that the OSS implementation process in Hibernia was not uniformly successful, we chose to focus on two example implementations—the desktop application suite which was unsuccessfully deployed and the email suite which was successful, thus representing 'extreme cases' (Miles and Huberman, 1994). Both applications are broadly similar—they are applicable to users throughout the organization, and there are strong proprietary alternatives in each case. Furthermore, by limiting our study to a single case context, certain factors are controlled to some extent—organizational attributes, for example. This makes it easier to isolate the salient elements influencing the success or failure of the process.

Data Collection and Analysis

In terms of data collection, a number of sources were drawn on (see Table 1). Over a three-year period, a series of formal face-to-face interviews, and more informal telephone interviews and meetings, were conducted with IT staff, key users and relevant management. In addition, interviews were conducted with external consultants from local firms who provided technical support for Hibernia's OSS implementation, and also with external experts who were familiar with overarching IT policy issues in the hospital sector. Formal interviews were generally of one to two-hour duration. These interviews were complemented by comprehensive reviews of documents and presentations, and fortnightly project workshops of half-day duration over a 12-month period. Furthermore, in the context of a collaborative funded research project between the author's university and Hibernia, there was prolonged and extensive access and interaction with the relevant personnel. Thus, clarification and refinement of emergent issues happened frequently through informal interviews and meetings with key personnel.

While the initial primary adoption of OSS in Hibernia was a straight-forward organizational decision, it soon became obvious that the secondary adoption of specific OSS applications by individuals throughout the organization would not be straightforward. Given this, we drew on the conceptual framework (Figure 2) which had been specifically designed to investigate secondary adoption (Gallivan, 2001). Data analysis occurred over two phases. Firstly, all the data gathered over the entire duration of the study was analysed from the high level perspective of the conceptual framework. Examples of issues which related to managerial intervention, subjective norms, organizational attributes, and attributes of the innovation were identified. Following this, in a second coding phase, the specific details which underpinned the high-level constructs were identified thereby elaborating the high-level constructs of the framework. The method of constant comparison (Glaser and Strauss, 1967; Miles and Huberman, 1994) was used here as both cases of successful and unsuccessful OSS deployment were also drawn on to help isolate the most salient issues.

While generally guided by an interview protocol which specified the specific topics of research interest, interviews were conducted in a reflexive manner, in that it was accepted that responses to certain questions could stimulate new awareness and interest in particular issues which could then require additional probing. This strategy is also recommended by Eisenhardt (1989) who labels it "controlled opportunism". This probing was also a feature of the informal interviews and meetings which followed the formal interviews.

Reliability and Validity Issues

Research reliability is concerned with the consistency with which research results can be replicated. A frequent criticism of interpretivist research is that due to its subjective nature, replication is problematic. While acknowledging that interpretivist analysis would not expect all researchers to interpret the findings in exactly the same way, it is important that the research process be transparent and accessible to others. To help address research reliability, Yin (1994) recommends the use of a case study

Table 1. Data sources

Activity	Criteria
22 interviews in Hibernia and with relevant external experts	Interviews with 17 IT staff, OSS users and management in Hibernia over the period Feb 2003 to Nov 2006
	Interviews with three consultants from three local organisations providing support to Hibernia (Feb 2004, Jun 2004)
	Interviews with two Government and Health Board personnel about general OSS implementation policy issues in the health sector in Ireland (Nov 2004 and Jun 2005)
Fortnightly half-day workshops	In context of a joint research project, half-day OSS implementation workshops held fortnightly in the period Mar - Dec 2004
Informal meetings/interviews	Frequent informal interviews/meetings with relevant staff refine/clarify issues in the period Feb 2003 to Nov 2006
Project Documentation	Various reports and presentations relevant to the OSS implementation process
Feedback presentations	Findings were presented at three workshops attended by relevant staff

database and protocol. This strategy has been operationalised in other interpretivist case studies (e.g. Kirsch, 2004) and we followed a similar approach here. A case study database was established which contained the raw field notes, transcribed interviews, and coding of this data according to our conceptual framework. The case study protocol specifies the criteria for selecting the case applications, the choice of whom to interview, and the interview protocol in terms of broad interview questions.

Research validity is concerned with whether the actual research in practice matches what it purports to be about. In interpretive research this is primarily concerned with the "truth value" of the research (Miles and Huberman, 1994).

Construct validity deals with the extent to which the constructs as operationalized relate to the research phenomenon being studied. In this study, given the lack of research on OSS adoption, and our goal of theory development, construct validity was important. Yin (1994) describes three tactics to deal with construct validity: the use of multiple sources of evidence, the establishment of a chain of evidence, and key informants reviewing draft findings. In this case, the collection of data on the same

phenomenon from multiple interviewees both within and external to Hibernia, together with information gleaned from project documents and presentations, helped address the multiple sources of evidence criterion. In relation to the chain of evidence criterion, this was addressed through the establishment of a case study database, the rigorous analysis and coding of data according to the conceptual framework, illustration of the theoretical constructs with quotes from interviewees who fulfilled a variety of roles in the implementation, and the process description of the deployment trajectory over time. Finally, key informant review and feedback was addressed in several workshops in the context of a joint research project on OSS implementation in Hibernia, and also several draft reports and presentations on the topic were reviewed by Hibernia staff.

External validity is concerned with the extent to which a study's findings can be generalised. One of the limitations of this study might appear to be the fact that it is based on a single case and thus there is limited scope for generalization. However, Lee and Baskerville (2003) identify a fundamental and long-standing misapplication of generalization whereby researchers have solely focused on statistical

sampling-based generalizability from a sample to a population, and have sought to overcome the perceived problem of attempting to generalize to other settings beyond the current one. Following this conventional model, researchers have suggested increasing sample size or number of case study organizations, but Lee and Baskerville argue cogently for the ultimate futility of this flawed strategy. They propose an overarching framework that proposes four distinct categories of generalizing, only one of which corresponds to statistical sampling-based generalization. One of the other categories in their framework, that of generalizing from empirical description to theoretical statements, is more applicable to our research study. This view of generalizing from thick description to theoretical concepts, specific implications and rich insight is also recommended as a strategy by Walsham (1993) and Klein and Myers (1999, p.75) who argue for such a theoretical link as being key to distinguish "interpretive research…from just anecdotes". In this study, the findings were analysed and integrated using the theoretical framework derived from Gallivan (2001).

OSS ADOPTION IN HIBERNIA HOSPITAL

Hibernia Hospital, which began as a merger of two of the oldest hospitals in Ireland, operates in a public sector environment, employing around 3,000 staff directly, which would make it quite a large organization by Irish standards. Similar to many other organizations worldwide, Hibernia's IT budget had undergone a significant contraction since 2000 in the wake of the increased budget in the lead up to the Y2K. For example, in 2003, Hibernia faced an overall budgetary shortfall of €17 million. Further compounding this issue, was the fact that Hibernia would face an annual expenditure in the region of €1 million just to achieve compliance with the licensing conditions in the proprietary software products in use. It was clear that this level of funding would not be available. Thus,

Hibernia was faced with the choice of either reducing the overall level of service to cope with cost restrictions, or embarking on some radical innovation in implementing less costly alternatives. Consequently, it began to investigate what could be found in the open source market-place. The IT staff in Hibernia undertook an extensive phase of desk research into various OSS products over a six-month period. The quality of the exchanges on SourceForge and Slashdot were sufficient to convince the IT Manager that OSS was worth investigating further. Some direct experimentation with downloaded OSS programs was then sufficient to convince him that the risk involved was acceptable.

StarOffice Desktop Suite

StarOffice is available from Sun Microsystems who were also the driving force behind OpenOffice. Some proprietary software is bundled with StarOffice, which prevents it being offered on the same terms as the pure open source, OpenOffice, with which it shares a common code base. Hibernia decided to implement StarOffice, as Hibernia could then purchase support from Sun. This was considered important to mitigate the risk in embarking on a radical new initiative such as OSS deployment.

In February 2002, Hibernia began the roll-out of Sun's StarOffice 5.2 desktop suite. This deployment was very problematic for users and the technical staff. However, this was felt to be largely due to problems in that version of StarOffice. In September 2002, StarOffice 6.0 was deployed with some support from Sun. However this was also troublesome. The IT Manager wanted to pursue a thin client strategy based around the concept that all applications should be downloaded from the network where practical. The StarOffice package was initially loaded onto a single Linux server, but this became overwhelmed, and it was then clustered to sustain a dual server strategy. Despite this, users continued to lose network connections in an unpredictable fashion. This inevitably increased frustration and tension amongst the

entire workforce who were dependent on these tools. The IT Manager conceded that:

"we stuck with the network solution too long. It was only after a series of ferocious encounters with users—and with my own staff—that I recognised that we had to shift".

StarOffice was reinstalled on the desktop instead for those who wanted it, which did improve the situation somewhat according to technical staff, In November 2003, Hibernia installed StarOffice 7.0. This solved many of the existing problems, to the extent that the IT Manager could report that there were no open bug reports in Hibernia for StarOffice 7.0. Nevertheless, the users' perception of the StarOffice system appears to have been damaged irreparably.

Further compounding the problems was the fact that when Hibernia started StarOffice implementation in 2002, there was very little by way of training material. Thus, a lot of material had to be prepared internally which increased the workload for IT staff and trainers.

Even though the move to StarOffice was mandated, not everyone was obliged to migrate. The CEO, although a committed supporter who mandated the move to OSS, did not become a StarOffice user. In addition to this, Hibernia comprises many largely autonomous units which behave independently and raise research funds to support their activities. Across these units about 120 users chose to ignore the overall move to StarOffice. Typically, these users had sufficient funds to remain independent of central IT support. However the IT Manager informed them that this would have consequences in that they would have to assume responsibility themselves for ensuring that the hardware which they use is upgraded, and provide resources for future maintenance upgrades, etc.

Email Platform

Prior to the move to OSS, Hibernia's email system was a proprietary one with a 500-user license limit. This limit had been reached and the IT Manager had to refuse recurring requests for new email accounts. Hibernia initially adopted the SuSE eMail application which was an open source email platform supported by Novell following acquisition of SuSE Linux. Given that there was no upper limit on the number of user email accounts with the SuSE eMail application, Hibernia sought to satisfy increased user demand for extra email accounts. However, when it reached about 700 user email accounts, the SuSE eMail system became prone to frequent problems of hanging and crashing. Hibernia had paid a consultant a once-off fee to implement the SuSE application initially. As with StarOffice, Hibernia sought to establish a support contract for SuSE eMail with Novell. However, the IT Manager reported that Novell at the time did not appear to be interested in offering an ongoing support contract for SuSE eMail. In the absence of a solution to the problems with SuSE eMail, Hibernia began to look for an alternative open source email platform. A multi-product open source email platform was established, comprising the Postfix mail transport agent, OpenLDAP directory access protocol service, SpamAssassin mail filter, and the SquirrelMail email client. After some initial teething problems with integration, this mixed architecture emerged as an extremely stable and scaleable email solution. Given that there were no license-imposed constraints on the number of users, Hibernia initiated a policy whereby all staff were entitled to an email account. Hibernia's IT staff were also able to add functionality to re-route emails to mobile phones and user PDAs. This, together with the impressive filtering capability of SpamAssassin, caused the email platform to be received very favourably by the general user base. At present, Hibernia supports more than 3,000 email accounts. Also, the system scope has been expanded to incorporate certificate-based external email access for about 350 authorised users. Overall, the IT Manager believes that "it would be unthinkable and completely unacceptable" to revert to a 500-user license again.

DISCUSSION OF OSS ADOPTION IN HIBERNIA HOSPITAL

Here we discuss the different implementation trajectories for both open source applications within Hibernia using the conceptual process framework derived above.

Managerial Intervention

Mandatory versus Voluntary Usage

As already mentioned, the decision to move to OSS was given full support by the CEO, largely on the basis that there was no other choice given the cuts in the IT capital budget. Thus, the use of StarOffice was seen as mandatory. This had significant negative implications. Firstly, as the Secretary Manager put it:

We did not think that StarOffice had been given to us as a bonus. Rather we felt that Microsoft Office had been taken away.

However, even in the case of StarOffice, as already mentioned, a number of users who had sufficient resources were able to opt out of the migration. Also, one department who dealt primarily with fund-raising from external stakeholders argued for the need to remain with the proprietary system due to having to liaise with these external agencies who solely used proprietary software.

On the other hand, this issue of mandatory usage did not arise in the case of the email platform suite. Hibernia was offering an additional service in terms of email access to those who sought it and who had not been able to get email access in the past. Thus, the email platform was implemented in the context of voluntary user demand rather than there being any perception of mandatory usage by management.

Training and Support

The Secretary Manager was critical of the process by which StarOffice was initially implemented. There was no effective buy-in process in her opinion. A small pilot group which included just one secretary comprised the initial trial. This was inadequate given that the most active users of StarOffice would be the cohort of secretaries in Hibernia. The Secretary Manager suggested that

StarOffice was sold as the same thing as Microsoft Office. A two-page brochure was provided and it was suggested that no training would be needed really.

However, even though StarOffice and MS Office are largely functionally equivalent, menus are constructed differently and terminology is slightly different. Thus, commonly-used options such as Print Preview or Track Changes are labelled differently or are in different submenus, with different key-stroke short-cuts. This contributed to a greater feeling of unfamiliarity and incompatibility than is probably warranted given the similarities between the applications.

Given these problems with the deployment of earlier versions of StarOffice, a widespread training and awareness program was created to ensure that the user community could be briefed on the new features in StarOffice version 7.0. While this could certainly address user perceptions in relation to issues of complexity, relative advantage and compatibility, it was not enough to overcome the very negative perceptions associated with StarOffice in Hibernia—this despite the fact that Hibernia have no unresolved problem reports for StarOffice 7.0.

While there was no specific training or extra support in the case of email, any differences between the original proprietary application and the subsequent OSS application have not been perceived as problematic. However, since the user base from email climbed from 500 to over 3,000, the vast majority of the users did not have an existing email application in their work context which they had learned and now needed to unlearn. Also, the fact that there are no alternative email applications elsewhere in Hibernia with which unfavourable compari-

sons could be drawn helps to minimise this as a problem.

Subjective Norms

In the case of StarOffice, the user base perceived usage as mandatory for those who did not have the resources to maintain an alternative. This led to feelings of resentment which were quick to emerge when problems became apparent. Interestingly, rather than being seen as renegades who failed to comply, the departments and users who were able to remain on the proprietary platform were envied by their colleagues. The Secretary Manager described it:

You meet people and hear that they are using Microsoft, and immediately you ask them how they managed to do that.

One of the key complaints from the administrative staff in Hibernia who moved to the StarOffice platform was that they feared being de-skilled in relation to their employment prospects if they didn't have skills in popular proprietary applications. In fact, users readily admitted that they would have preferred not to have switched from the proprietary desktop systems to OSS. Additionally, there was further resentment in some quarters to the move to OSS systems, in that some staff appear to feel somewhat 'short-changed' and believe their work is under-valued if they are asked to use OSS systems which cost less that those being used by their counterparts in hospitals elsewhere using proprietary systems.

Attributes of the Innovation

The discussion above identified several innovation attributes that have been found in previous research to influence innovation adoption. Here we discuss the ones most salient to the OSS adoption in this study—image, relative advantage, trialability and observability.

Image

Perhaps the most significant issue for StarOffice was the fact that it quickly gained a negative image, and despite improvements in newer versions of the software, this negative image persisted. One user admitted that when StarOffice was proposed, there was a widespread perception that this was a cheap and antiquated package from "Jurassic Park" which would have limited functionality. This user was genuinely surprised to hear that StarOffice was a modern application which was actively being developed. This negative view was confirmed by an Informatics Nurse who suggested that StarOffice ran into "bad publicity from the outset".

There was a fairly widespread perception within Hibernia that it is prone to disadvantage due to its being on the North side of Dublin, an area traditionally perceived as being disadvantaged (at least by those who are from there), and that StarOffice was just another example of this disadvantage working against them. Indeed, in typical Northside Dublin fashion, users have coined the succinct and disparaging term, "Star Bleedin' Office", to refer to the system.

Significant in this perception was the fact that no other hospital in Ireland had chosen to implement an open source desktop. The Secretary Manager suggested that the budget-cutting rationale behind the implementation of StarOffice caused it to be perceived as a "poor man's Microsoft", and as a result there was a pre-conceived expectation that it would be problematic.

The negative effect of StarOffice was even suggested to underpin an increased level of absenteeism and stress-related sick leave, according to the Occupation Health department. While, there was no rigorous analysis of employee absences to support this, there was a belief that the stress of moving to StarOffice had been a factor in many stress-related and work leave/absences. It will be interesting to see if the level of stress-related absences also increases when Hibernia revert to a proprietary platform.

The StarOffice image has become quite notorious within Hibernia, to the extent that at meetings to discuss new IT projects, managers have been heard to express the hope that it would not be "another StarOffice". Also, the negative image of StarOffice extended beyond Hibernia. One user described emailing an attachment, which had been saved in StarOffice's proprietary format by default, to a colleague externally. This colleague couldn't open the attachment, and emailed a response saying that the attachment was in that "StarOffice gobbledy-gook".

In sharp contrast, the email platform has no such similar baggage of negative image. While there were problems during the implementation of SuSE eMail, these were quickly overcome when an alternative email system was implemented. Also, these problems only manifested themselves when more than 200 additional users had been given email access. Thus, there was no sense in which the user service had been disimproved in any way. This has resonances with the relative advantage issue discussed next.

Relative Advantage

Clearly, the initial problems with StarOffice caused users to perceive their original proprietary system as better. There were several problems, particularly with Impress, the StarOffice equivalent of MS PowerPoint. An Informatics Nurse described it:

"I have seen people crying because of Impress. One day I was working on a presentation which I was due to give at 8:30 the following morning. At 5:30pm I checked it and it had become just one blank sheet. I had to go home and recreate it from memory in PowerPoint".

Interestingly, the Informatics Nurse also recalled losing several chapters of her thesis when using MS Word in the past, but there was a sense in which she felt less vulnerable about that. The IT Manager also recalled giving a seminar on OSS at an IT conference attended by several hundred delegates, and his Impress presentation stalled. It was not a happy experience, and certainly, the software which supports people publicly presenting, is not one where problems will be tolerated to say the least. This issue is interesting since only a very small number of actual users would need to deliver presentations, and thus the problems experienced due to the use of Impress were not all that widespread overall. Nevertheless, users seemed to very readily empathise with the negative scenario of problems with a public presentation.

While StarOffice and MS Office are more or less equivalent functionally, there are some differences, and these were were cited in some cases as a reason for not migrating to StarOffice. For example, the Finance Department cited the row number limit in StarOffice Calc which is less than that of MS Excel, as a reason for not migrating.

However, when things settled, particularly following the installation of StarOffice 7.0, a number of benefits became evident in the OSS solution. For example, one of the benefits has been the capacity of StarOffice to exploit its in-built XML capabilities. This is a very powerful feature of the application which enables documents to be structured in such a way that processing logic is built into different sections of the document, i.e. an on-line HR form request, for example, which is then automatically routed to the HR department for processing. This is a significant new feature and provides additional functionality over what was previously offered in Hibernia's proprietary desktop applications.

Also, the StarOffice suite contained an option to create PDF output, which was not available in the MS Office implementation in Hibernia. This was mentioned as a positive benefit by several interviewees. While the Impress application was clearly the most notable problem point, there was support for the other StarOffice applications. Indeed, an interviewee expressed a distinct preference for StarOffice's Calc over MS Office Excel spreadsheet software. However, such perceptions did not scale into an overarching perception of the relative advantage of StarOffice over the proprietary system it replaced.

In the case of email, Hibernia was able to satisfy additional requests for email accounts, thus offering an improved service. While there were significant problems around the use of SuSE eMail, these were very short-lived as Hibernia was able to overcome them quite quickly by implementing an alternative OSS email suite. Again, these problems only occurred after more than 200 additional email accounts had been added, so there was no real perception that the OSS system was operating at a disadvantage. This option of replacing StarOffice was not possible, and even though the problems were ironed out in subsequent installations of StarOffice, it was still perceived as StarOffice and viewed with suspicion.

Also, there were differences with the StarOffice scenario in that users were not aware of alternative email applications in simultaneous use in other departments. Furthermore, users did not typically have an alternative email application at home, which was frequently the case where MS Office was installed on home computers.

Trialability

Trialabilty was a very salient issue in Hibernia's OSS deployment. At the initial stage, Hibernia's IT staff were able to download and experiment with several OSS applications of potential interest. Given the budget situation, the fact that this was a zero-cost exercise was important. Also when Hibernia experienced problems with the SuSE eMail implementation, IT staff were again able to experiment with a range of alternative OSS email applications and quickly implement a very successful and scaleable email solution.

This mode of OSS implementation has continued. When selecting an online e-learning system, Hibernia trialed a number of OSS e-learning systems before selecting the one which appeared to meet their needs best.

Interestingly, this easy trialability appears to have implications for the training and support process in that there was less attention paid to it. If it had been a high cost initiative it would

certainly have had a higher profile within the organization and, as a consequence, more attention would have been paid to implementation issues such as pilot testing, training and support. The IT Manager summarised the dilemma:

"If you have a product which costs €1 million—it may seem appropriate to spend €500K on consulting. However if the product costs nothing—then spending €500K somehow seems to be a more difficult decision to take—yet the saving is still €1 million".

Hibernia have learned this lesson and, for example, created a more comprehensive user awareness and training package to support the implementation of StarOffice 7.0.

Observability

Rogers suggests that the extent to which results of an innovation are observable to others will affect its rate of diffusion. However, given that Hibernia wanted to achieve as smooth a transition as possible, the goal was to minimise and downplay the observability of the differences between StarOffice and MS Office to try ensure they would be perceived identically. This is often not difficult in an OSS context since applications have typically been designed to replicate the functionality of proprietary systems. Thus, rather than trying to publicly triumph the use of StarOffice as progressive and something to be enthusiastically yearned for, the emphasis was on downplaying the issue of observability. Given the negative image that has come to be associated with OSS in Hibernia, there is a conscious move to not identify IT applications as open source. Thus, the issue was not highlighted in the case of the email application. Similarly, when Hibernia implemented an OSS e-learning system subsequently, the fact that the systems being trialed were open source was deliberately downplayed as much as possible.

Organizational Attributes: Absorptive Capacity

Hibernia's absorptive capacity in relation to open source adoption was extremely important.

The IT Manager accepted that the initial roll-out of StarOffice had been poorly conceived, and Hibernia had learned from that for subsequent implementations of OSS. Clearly, there was an element of risk in proceeding on the OSS path, since ongoing product support would not be provided in the usual way. Thus, there was a need for a complete rethink of the support strategy. In the past Hibernia had always purchased support from a competent third-party provider. While with OSS this option still existed to some extent, there was a significant difference in expectation associated with OSS, as support was essentially derived from a series of bulletin boards, complemented with external consultancy initially until Hibernia became competent.

Also, it helped that a number of key staff—particularly in the computer operations department—rapidly adapted to the new OSS environment, and the IT Manager described the operations team as the "leaders in the overall adoption of OSS". The bulk of the overall OSS search selection and implementation was actually carried out by the hospital staff. This necessarily involved a process of learning/experimentation. As the staff confidence and familiarity with OSS products grows, the learning cycles were correspondingly shortened. It also helped that Hibernia already had a strong experience of UNIX applications to draw on. So the transition was not as radical as it would have been if staff experience was simply based on GUI-enabled systems administration. In the words of the Linux Systems Administrator, "We are not afraid of the command line interface".

Evidence of increased absorptive capacity in relation to open source is readily evident in the email application deployments. When Hibernia encountered insurmountable problems in relation to the open source SuSE eMail application, IT staff quickly sourced an alternative suite of email applications. This integration of an entire suite of disparate open source email applications into a single integrated email platform represented a significant technological challenge, from identifying suitable applications in the first place, to integrating them into an overall working application.

CONCLUSION

Table 2 summarises the differences in the deployment process for both the OSS desktop and email applications within Hibernia. Rather than elaborating the individual issues here, we will focus more holistically on interaction among the framework elements, as this had a significant influence on OSS implementation. Following this we discuss the implications of the study for research and practice, and discuss the limitations of the study.

Firstly, we focus on trialability and absorptive capacity as these served primarily to facilitate OSS adoption in this study. Trialability of OSS ensured that Hibernia could experiment with OSS applications in the first place and be reasonably confident that the OSS applications available could meet their needs. Also, when problems occurred as in the case of the initial OSS email implementation, an alternative could be found which solved the problem. However, while trialability certainly facilitates the primary adoption of OSS, it is absorptive capacity which ensures that the best OSS candidates are selected and successfully integrated and implemented, thereby facilitating successful secondary adoption.

However, other interlinked elements, such as voluntary versus mandatory adoption and image of the innovation, manifest themselves in such a way as to impede the assimilation of OSS within Hibernia.

Firstly, by being perceived as mandatory due to the necessity of cost-cutting, the adoption of StarOffice was inevitably perceived as reactive. Then when it emerged that some 'more privileged' users could opt out of the move, this two-tier scenario significantly contributed to the negative image bestowed upon StarOffice. When problems occurred, these served to fuel a disproportionately negative perception of StarOffice, despite the fact that it offered certain

extra functionality, and that a steady state with no open bug reports was eventually reached following the implementation of StarOffice 7.0. Interestingly, the email application shared a similar deployment trajectory in that it too faced problems initially, which likewise were subsequently overcome, and also there were advantages in the OSS email system over the original proprietary system. However, the critical difference appears to be that the move to email was not seen as a top-down mandate, rather users could request an email account. Furthermore, there was no cohort using an alternative system who might be perceived as privileged.

The issue of observability was interesting in the Hibernia OSS adoption process. It would not be obvious at a casual glance wthether a user was using StarOffice or MS Office. In the case of email, the fact that the vast majority of users got access to email for the first time within Hibernia would have highlighted the observability issue, in that users were emailing who had not done so before. Thus, this was quickly evident and led to more requests for email accounts. However, due to the negative image of open source that arose from the StarOffice experience, Hibernia sought to downplay the fact that proposed applications, such as e-learning, were open source.

Implications for Research

The study identifies several issues and streams of research which could be further elaborated. To our knowledge, it is the first rigorous analysis of successful and unsuccessful OSS adoption. Our focus on a single case context is also noteworthy as certain important factors inevitably differ across organizations in a multiple case study context, thus making it more difficult to interpret the actual influence and role of individual elements. The study illustrates how a hybrid process variance model can shed light on the innovation adoption process, and in particular, illustrating the complex interaction between the various elements.

The link between trialability and actual deployment of OSS was significant in this study, particularly in the case of email. This also seems to be borne out in OSS adoption more generally. Onetti and Capobianco (2005) report a case study of a software company who offered both traditional proprietary and OSS products. The company found that the ratio of prospects who eventually become actual customers was markedly higher in the case of OSS. Funambol found that in contrast to its traditional sales process for proprietary software, when contacted about OSS products, the prospective customers had already downloaded and actually trialed the OSS product, and were far more likely to become customers paying for support. This altered the business flow from "sales push" to "user pull" (Onetti and Capobianco, 2005).

The Hibernia study also supports the contention by Fichman (1992) and Gallivan (2001) that innovations which involve organizational mandate and high knowledge require the integration of new metaphors and constructs into the research model. The high knowledge burden in successfully deploying OSS supports the view that absorptive capacity is an important issue, and this facet could be further elaborated to potential good effect. Another potentially promising perspective identified by Fichman (1992) is that of critical mass theory (Markus, 1987). This was clearly an issue in this study as the cohort of users who opted out of the move to StarOffice served to weaken the critical mass, whereas the increased number of users who received email accounts worked in the opposite direction.

The critical mass issue is linked to the issue of network externality effects. Some technologies become more valuable through the increasing returns to adoption that arise from the incremental contribution of other adopters. The basic argument is that for some technologies, the potential benefits are greatest when the entire ecosystem of users, suppliers and mediating institutions are in place to fully leverage the deployment of the technology. These increasing returns can arise through positive network externality effects (Katz &

Table 2. OSS deployment within Hibernia

	StarOffice Desktop	Email Platform
Managerial Intervention		
- Mandatory v voluntary usage	Usage seen as mandatory for those who could not afford to maintain proprietary alternative.	Access to email application provided upon request, thus usage not perceived as mandatory.
- Training and support	Differences between OSS and proprietary systems downplayed. Low level of training initially using in-house developed material.	No specialised training necessary. No incumbent proprietary system to unlearn.
Subjective Norms		
	Mandatory usage for users who could not afford to maintain proprietary led to StarOffice being perceived as inferior. Staff fear of being deskilled if using OSS, and also that work undervalued if using 'cheap' OSS.	More than 2500 additional users requests for email accounts were satisfied. Thus, uniformly perceived as beneficial.
	Those who opted out of the move to StarOffice envied rather than resented.	Also no alternative email system with against which unfavourable comparisons could be drawn.
Innovation Attributes		
- Image	StarOffice seen as cheap and antiquated "Jurassic Park" option for the disadvantaged. Widespread negative image of StarOffice both within and external to Hibernia.	Email access seen by many as a new privilege which hadn't been available in the past.
- Relative Advantage	Problems and instability led to StarOffice being perceived as inferior. Impress problems particularly cited. Benefits of StarOffice not widely appreciated.	Email a new application for the majority, thus no relative comparison. Also, problems with intermediate SuSE email quickly resolved, and new functionality (routing of email to PDAs) appreciated.
- Trialability	Trialability important, but limited due to lack of alternative OSS desktop suites.	Trialablity critical as Hibernia experimented with a number of OSS email applications.
- Observability	StarOffice and MS Office appear identical on casual observation. Thus, OSS usage is not readily apparent and observable.	Downplayed due to negative image associated with OSS. Not a major issue as no alternative email application in use to compare against.
Organization Attributes		
- Absorptive Capacity	Important as OSS represents new model of software acquisition, implementation and support. Prior learning evident in implementation of StarOffice 7.0.	Very relevant in this case as the first OSS email application had to be replaced by a suite of individual OSS email applications in a novel mixed architecture. High knowledge burden in selecting right applications to include in this architecture and configuring to work successfully together.

Shapiro, 1986), which are readily apparent in OSS, as the phenomenon is fundamentally predicated upon drawing sufficient voluntary interest from a worldwide network of talented hackers with complementary skills to produce industry-quality software products (Feller et al., 2008). Furthermore, the commercial business model of open source is frequently based on creating a lucrative service and support market by leveraging the zero purchase cost to create a large base of potential customers.

It is also abundantly clear that in the case of OSS a focus on secondary adoption is important. As already mentioned, estimates of OSS adoption by organizations vary greatly. However, it is certainly the case that there could be a marked gap between the initial acquisition of OSS and its eventual large-scale secondary adoption by a critical mass of individual users. Indeed, the essential characteristics of OSS render it very prone to such an assimilation gap: The widespread media coverage leads to high awareness of the concept, while its zero cost results in a very low barrier to initial acquisition. However, the newness of the phenomenon, the manner in which it transgresses traditional software support options, and the lack of any tried and tested approach which could guarantee successful implementation—these all serve to exacerbate the potential assimilation gap between initial acquisition and widespread adoption.

Again, related to this are two elements which were found to be extremely influential in this study—voluntariness of adoption and image of the innovation. While these factors have been identified in some prior research (e.g. Moore and Benbasat, 1991), the issues, and in particular the inter-relationship between them, have not been studied in detail. Voluntariness of adoption is linked to critical mass as organizational mandate can decree that a technology be universally adopted. However, this has implications for how the innovation will be perceived especially by those who feel compelled to use it, thereby affecting the image of the innovation. Furthermore, in previous research, image is assumed to have a positive effect—the use of the innovation is expected to be image-enhanc-

ing. In this study, it was certainly the case that innovations are not always seen as conveying a positive image and universally welcomed by those who are expected to use them—the fear of deskilling and the perception of work being undervalued, for example, This has resonances with Fichman's (2004) critique of the dominant paradigm which typically assumes that technology innovation is universally welcomed and perceived as beneficial by all stakeholders. This was certainly not the universal perception from the outset in Hibernia.

Implications for Practice

The study also has a number of implications for organizations who are embarking on OSS adoption. At a higher-level, an open question in prior research has been whether IT implementation should follow a 'big bang' or phased approach, as successful implementations have been reported with both approaches (Fichman, 2004). This is also an open question for OSS migration with researchers recommending both 'big bang' approaches (Ven et al., 2006) and phased pilot approaches (Zuliani and Succi, 2004). The findings of this study would support the 'big bang' approach for each individual OSS application, primarily to avoid the situation where opting out of migration is seen as the preserve of those more privileged, thereby creating image and relative advantage problems subsequently.

This is also related to the issue of whether an organization treats OSS adoption as a mandatory or voluntary initiative. If mandatory, then it is important that OSS is not perceived as a low-cost 'second-rate' alternative, thereby relegating it to an inferior status which individual adopters seek to avoid.

Trialability is more or less a given in OSS, thus ensuring that the initial experimentation with OSS is facilitated. However, the zero cost trialability of OSS should not cause organizations to downplay the importance of implementation issues such as pilot tests, training and support. Also, in the absence of any comprehensive vendor support and mar-

keting, absorptive capacity becomes critical. Identifying potential OSS solutions in the first place is not a trivial issue. Generally, there are no vendors who can answer questions on the suitability and functionality of the software or provide details on reference implementation sites. Similarly, porting OSS to new platforms and integrating OSS systems with other proprietary and OSS systems is far from trivial, as is ongoing support. In this study, some expert consultancy was sourced locally to help with initial implementation issues, but these abilities were acquired in-house over time.

Limitations of Study

One of the possible limitations of this research is that it is a single case study, although we would argue that this should be tempered by the fact that this also afforded an in-depth insight into the process, and also allowed for the keeping constant of potentially confounding factors. Of more importance perhaps is the fact that the organization is a public sector one, and there could be important differences in the OSS adoption process for organizations in other industry sectors.

Also, this study focused on desktop and email applications, both of which are highly visible mass-market applications with strong market-leading proprietary alternatives. By contrast, less visible back-office infrastructure applications such as servers running Linux, Apache, Samba, and the like, may operate differently. Our experience would suggest that the OSS is already dominant in that sector. Similarly, the Hibernia experience would suggest that OSS can be a perfectly acceptable solution for niche applications such as e-learning, particularly when these systems are introduced without having any incumbent system to replace.

Overall, one can conclude that OSS is a very viable alternative for organizations. The main problems arise in the implementation process, rather than arising due to problems of a technical nature, as the latter are usually ironed out very quickly. Indeed, the acid test is perhaps the fact that despite any problems

with StarOffice, Hibernia operated effectively as a hospital throughout this period.

REFERENCES

Agerfalk, P and Fitzgerald, B (2008) Outsourcing to an Unknown Workforce: Exploring Opensourcing as a Global Sourcing Strategy, *MIS Quarterly,* Vol 32, No. 3, pp. 385-410.

Ajzen, I. (1985), From Intentions to Actions: A Theory of Planned Behavior, in *Action Control: From Cognition to Behavior*, ed. Julius Kuhl and Jeurgen Beckmann, New York, NY: Springer, pp.11-39.

Carter, L and Belanger, F (2006) The Influence of Perceived Characteristics of Innovating on e-Government Adoption, *Electronic Journal of E-Government*, Vol 1, No 2.

Chua, W. (1986) Radical Developments in Accounting Thought. Accounting Review, 61, 601.

Cohen, W. M. & Levinthal, D. A. Absorptive Capacity: A New Perspective on Learning and Innovation, *ASQ*, 35 (1990), 128-152.

Daniel, S, Agarwal, R and Stewart, K (2006) An absorptive capacity perspective on OSS development group performance, *27th International Conference on Information Systems,* Milwaukee Dec 2006.

Davis, F. (1989) Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology, *MIS Quarterly*, Volume 13, pp. 319-340.

Eisenhardt, K. (1989) Building theory from case study research, *Academy of Management Review*, **14**, 4, 532-550

Feller, J, Finnegan, P, Fitzgerald, B and Hayes, J (2008) From peer production to productization: a study of socially-enabled business exchanges in open source service networks, *Information Systems Research,* Vol 19, No. 4.

Fichman, R.G. (1992). Information Technology Diffusion: A Review of Empirical Research," in J.l. DeGross, J.D. Becker, and J.J. Elam (Eds.), *13th International Conference on Information Systems*, Dallas, TX, pp. 195-206.

Fichman, R. G., (2004) "Going Beyond the Dominant Paradigm for IT Innovation Research: Emerging Concepts and Methods", *Journal of the Association for Information Systems*, 5(8)

Fichman, R. G., and Kemerer, C. F. The Assimilation of Software Process Innovations: An Organizational Learning Perspective, *Management Science* (43:10), 1997, pp. 1345-1363.

Fichman, R.G. and Kemerer, C.F., (1999) "The Illusory Diffusion of Innovation: An Examination of Assimilation Gaps," *Information Systems Research*, 10(3), 255-275.

Gallivan, M (2001) Organizational adoption and assimilation of complex technological innovations: development and application of a new framework, *Data Base*, Vol 32, No 3, pp. 51-85.

Ghosh, R and Glott, R (2005) Results and policy paper from survey of Government authorities, Technical report, MERIT, University of Maastricht, Free/Libre and Open Source Software: Policy Support.

Glaser, B. & Strauss, A. (1967) *The Discovery of Grounded Theory,*, Aldine, Chicago.

Kaplan, B. and Duchon, D. (1988) Combining qualitative and quantitative methods in IS research: a case study, *MIS Quarterly*, **12**, 4, 571-587.

Katz, M.L., and Shapiro, C. "Technology Adoption in the Presence of Network Externalities," *Journal of Political Economy* (94:4) 1986, pp 822-841.

Kirsch, L. (2004) Deploying common systems globally: the dynamics of control, *Information Systems Research*, Vol. 15, No. 4, pp. 374-395.

Klein, H.K., and Myers, M.D. (1999) A Set of Principles for Conducting and Evaluating Interpretive Field Studies in Information Systems, *MIS Quarterly*, Vol. 23, No. 1, pp.67-93.

Kuk, G. (2006) Strategic Interaction and Knowledge Sharing in the KDE Developer Mailing List," *Management Science,* (52:7), pp 1031-1042

Lakhani, K. and Wolf, B. (2005) Motivation and Effort in Free/Open Source Software Projects: The Interplay of Intrinsic and Extrinsic Motivations, in Feller, J, Fitzgerald, B, Hissam, S, and Lakhani, K. (2005) (Eds) *Perspectives on Free and Open Source Software*, MIT Press, Cambridge.

Lee, AS and Baskerville, RL (2003). Generalizing Generalizability in Information Systems Research. *Information Systems Research*, 14 (3), 221-243

Lundell, B, Lings, B and Lindqvist, E (2006) Perceptions and uptake of open source in Swedish organizations, in Damiani, E, Fitzgerald, B, Scacchi, W and Succi, G (2006) *Open Source Systems*, Springer-Verlag, New York, pp. 155-164.

Markus, M.L. (1987). Toward a 'Critical Mass' Theory of Interactive Media: Universal Access, Interdependence and Diffusion, *Communications Research*, Vol. 14, pp. 491-511.

Markus, M.L., and Robey, D. (1988). Information Technology and Organizational Change: Causal Structure in Theory and Research, *Management Science*, Vol. 34, No. 5, pp. 583-598.

McCue, (2004) London council ditches Linux plans, http://news.zdnet.co.uk/software/0,1000000121,39118909,00.htm, last accessed on 8 Jan 2007.

Miles, M. and Huberman, A. (1994) *Qualitative Data Analysis: A Sourcebook of New Methods*, Sage, Beverley Hills.

Mohr, L.B. (1982). *Explaining Organizational Behavior*, San Francisco, CA: Jossey-Bass.

Moore, G.C., and Benbasat, I. (1991) Development of an Instrument to Measure Perceptions of Adapting an Information Technology Innovation, *Information Systems Research*, Vol. 2, No. 3, pp. 192-222.

Newman, M., and Robey, D. (1992) A Social-Process Model of User-Analyst Relationships, *MIS Quarterly*, Vol. 16, No. 2, pp. 249-265.

Niccolai, J (2005) Scottish police pick Windows in software line-up, *InfoWorld*, http://www.infoworld.com/article/05/08/11/HNscottishpolice_1.html, last accessed 20 Dec 2006

Onetti, A & Capobianco, F (2005) Open source and business model innovation. the Funambol case, in Scotto, M and Succi, G (Eds) *Proceedings of First International Conference on Open Source (OSS2005)*, Genoa, 11-15 July 205, pp. 224-227.

Rogers, E. (1962) *Diffusion of Innovations,* The Free Press, NY.

Rogers, E. (2003) *Diffusion of Innovations* (5th ed), The Free Press, NY.

Rossi, B, Russo, B and Succi, G (2006) A study of the introduction of OSS in public administration, in Damiani, E, Fitzgerald, B, Scacchi, W and Succi, G (2006) *Open Source Systems*, Springer-Verlag, New York, pp. 165-172.

Sambamurthy, V., and Poole, M.S. (1992) The Effects of Variations in Capabilities of GDSS Designs on Management of Cognitive Conflict in Groups, *Information Systems Research*, Vol. 3, No. 3, pp. 225-251.

Sanders, J. (1998) Linux, open source, and software's future, *IEEE Software*, Vol. 15, No. 5, pp. 88-91.

Shaikh, M (2006) Version Control Software in the Open Source Process: A Performative View of learning and Organizing in the Linux Collectif, Unpublished Thesis, London School of Economics.

Shaw, T., and Jarvenpaa, S.L. (1997). Process Models in Information Systems, *IFIP WG8.2 Working Conference on Information Systems and Qualitative Research*, May 31-June 3, Philadelphia, PA.

Stewart, K and Gosain, S (2006) The impact of ideology on effectiveness in open source software development teams, *MIS Quarterly*, Vol 30, No 2, pp. 291-314.

Thurston, R. (2006), Criticism mounts over Birmingham's Linux project, last accessed on 15 Jan 2007 at: http://www.zdnet.com.au/news/software/soa/Criticism_mounts_over_Birmingham_s_Linux_project/0,130061733,339272293,00.htm

Tornatzky, L. and Klein, K. (1982) Innovation Characteristics & Innovation Adoption Implementation: A Meta-Analysis of Findings, *IEEE Transactions on Engineering Management*, Vol. EM-29, pp. 28-45.

Turner, A (2005), Linux misses Windows of opportunity, last accessed on 15 Jan 2007 at http://www.theage.com.au/articles/2005/09/26/1127586780339.html?from=top5

Van Reijswoud, V (2005) OSS for development: myth or reality? last accessed 17 Jan 2007 at http://www.calibre.ie/events/limerick/docs/calibre_Reijswoud_presentation.pdf

Ven, K, Van Nuffel, D and Verelst, J (2006) The introduction of OpenOffice.org on the Brussels Public Administration, in Damiani, E, Fitzgerald, B, Scacchi, W and Succi, G (2006) *Open Source Systems*, Springer-Verlag, New York, pp. 123-134.

Walli, S, Gynn, D and von Rotz, B (2005) The Growth of Open Source Software in Organizations, available at http://www.optaros.com/en/publications/white_papers_reports (last accessed 31 Jul 2006)

Walsham, G. (1993) *Interpreting Information Systems in Organizations*, Wiley, UK.

Yin, R. (1994) *Case Study Research: Design and Methods*, 2nd Ed, Sage Publications, California.

Zachary, G (2003) Ghana, Information Technology and Development in Africa, http://www.cspo.org/products/articles/BlackStar.PDF (Current 11 Aug 2006)

Zaltman, G., Duncan, R., & Holbeck, J. (1973), *Innovations & Organizations*, New York: Wiley & Sons.

Zuliani, P and Succi, G (2004) Migrating public administrations to open source software, *Proceedings of e-Society IADIS International Conference,* Avila, Spain, 2004.

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