An Evaluation of Open Source Software Adoption by UKSMEs in the IT Industry

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by

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Abstract

This study evaluates the adoption of Open Source Software (OSS) by IT Small to Medium-sized Enterprises (SMEs) in the UK. The growing popularity and acceptance of OSS continues to draw much attention in research and practice. However, researchers and IT practitioners within the UK SME sector still face challenges in understanding the issues that influence the acceptance, adoption, and diffusion of OSS. While previous research studies have focused mainly on the software development model and the unique characteristics of OSS, the area of OSS adoption by UK SMEs has largely been ignored. Furthermore, there is a lack of widely-acceptable theories that explain the adoption of OSS, implying that there is limited understanding of OSS adoption by UK SMEs. This gap in research has led this thesis to evaluate existing adoption theories and then apply the 'Decomposed Theory of Planned Behaviour' to model the adoption of OSS by SMEs. Based on the emerged conceptual model, an innovative and structured qualitative research design that uses a case study strategy was developed to evaluate the adoption of OSS across 10 UK SMEs in the IT industry. The analysis of the standardised data from the case study interviews led to the definition of the 16 factors of an emergent theory of OSS adoption by IT SMEs. The analysis of that empirical model has led to important conclusions including the following five issues, summarily. (1) The participant IT SMEs were drawn to different benefits, and experienced different challenges, in using OSS, suggesting that there is subjectivity and complexity in the factors influencing OSS adoption. (2) As in most Information and Communication Technology (ICT) adoption, IT-capability was identified to be essential for successful adoption of OSS, and therefore, it presents potential for important cooperative and collaborative support with OSS communities. (3) The emergent theory from this research study provide researchers and practitioners with variables for surveying critical-success-factors and a reference model for understanding the adoption of OSS. (4) The emergent theory and other general findings from this study are likely to have relevance in other areas of Information Systems research and practice, owing to the factors and theoretical framework that are common to OSS and general ICT acceptance, adoption, and diffusion. (5) This study appears to be the first that has focused on developing a widely-acceptable theory of OSS adoption by IT SMEs in the UK, suggesting that this innovative research study is a novel contribution that has important implications for theory and practice in OSS and general ICT acceptance, adoption, and diffusion.

Keywords: Information and Communication Technology Adoption, Open Source Software Adoption, Case Study Evaluation, Interpretivist, Qualitative Research, Theory-building, Decomposed Theory of Planned Behaviour, Acceptance and Diffusion of OSS.

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In loving memory of –

To Habiba,

aka Mama Kabiru

aka Amansi

To Iya

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1

Introduction

1.1 Introduction

This thesis presents an evaluation of Open Source Software (OSS) adoption by UK Small-to-Medium sized Enterprises (SMEs) in the IT industry. Thus, 'IT SMEs', as used particularly in the empirical research sections of this thesis, refers to UK SMEs in the IT industry, unless stated otherwise. The term 'OSS adoption', as used in this research study, refers to the decision of any individual or organisation to make use of an idea, object or information that qualifies as an OSS (Benbasat and Moore 1992; Roger 1995; Taylor and Todd 1995a, 1995b). The motivation for this study stems from the growing popularity and acceptance of OSS and an increasing awareness of the potential benefits for UK SMEs to use OSS as a viable and competitive information and communication technology (ICT) 'platform' (Dedrick and West 2003; Fitzgerald 2006; Fitzgerald and Agerfalk 2005; Fitzgerald and Kenny 2003; Fugetta 2003; Glynn *et al.* 2005; Holck *et al.* 2005; Larsen *et al.* 2004; Overby *et al.* 2006). In this introductory chapter, we present a brief discussion of OSS and its relevance for organisations using ICT, leading us to the argument that OSS, which is an emerging form of ICT 'platform' (Fitzgerald and Kenny 2003; Fugetta 2003; Glynn *et al.* 2005; Holck *et al.* 2005; Larsen *et al.* 2004), is relevant to SMEs. Then, we briefly discuss SME challenges in adopting ICT (Darch and Lucas 2002; Dutta and Evrard 1999; Gelinas and Bigras 2004; Houghton *et al.* 2001; Martin and Matlay 2003; Mehrtens *et al.* 2001; Ritchie and Brindley 2005; Stockdale and Standing 2004), leading us to the argument that they are likely to face similar challenges in adopting OSS.

The arguments presented above led us to undertake an overview of existing research in the area of OSS adoption where we identified that previous research studies and theories in this area are still emerging and few studies have focused on developing widely-valid theories of OSS adoption by SMEs. This state of the research on OSS adoption presents a challenge which has implications for theory and practice related to OSS adoption by SMEs. From a research perspective, this challenge suggests that there are research gaps in the theories that help to explore and understand OSS adoption. From a practice perspective, this challenge suggests there is limited understanding of OSS adoption and, therefore, a problem for SMEs seeking to develop policies that guide their decisions about the use of OSS (Gilmore *et al.* 2001; Matlay 2000; Mehrtens *et al.* 2001; Ritchie and Brindley 2005). This challenge is the focus of this study, which will explore factors that influence the adoption of OSS by IT SMEs and seek to understand why and how they influence adoption.

In order to discuss the issues above in greater detail and also provide an overview of the work done in this study, this chapter is organised around five topics – research context, existing work, aim and objectives, methods, and thesis outline – leading to the next five sections of this chapter, which will now be introduced.

Section 1.2 discusses the research context, providing background information about the adoption of OSS by organisations and an overview of the potential challenges in its adoption by SMEs. In doing so, the discussion will cover areas including: the growing popularity and acceptance of OSS by organisations; the opportunity for SMEs to leverage their ICT needs using OSS; and a brief review of SMEs challenges in ICT adoption, which are likely to be relevant in their adoption of OSS.

In section 1.3, existing work in the area of OSS adoption is discussed, briefly exploring research issues and problems that have been explored and identifying gaps that currently exist in this field of IS research. In particular, the discussion explores research related to SMEs and their challenges in ICT adoption; the development and competitiveness of OSS; and the factors influencing the adoption of OSS. The discussion leads to the argument that there is little focus on exploratory research to understand the adoption of OSS by IT SMEs, leading to an opportunity and the focus of this study.

Section 1.4 presents the research aim and objectives associated with the research question which focuses on the research gaps discussed in section 1.3. The aim and objectives provide a

clear research goal and the scope of this research study, focusing on developing a theory that helps to explore and understand the adoption of OSS by IT SMEs.

In section 1.5, an introductory overview of the research methodology applied in this study is presented, providing an overview of the relationship between the research aim and objectives and the empirical research design developed for this study. In doing so, we discuss and justify our research methodology, which includes the choice of an interpretivist stance, qualitative research mode and case study strategy.

Section 1.6 presents the thesis outline, providing the reader with a guide to each chapter of this thesis. In doing so, a brief description of each chapter of this thesis is presented, including the literature analysis, the development of conceptual model, the design of empirical research, analysis of empirical data, presentation of research findings and the conclusions from this research study.

1.2 Research Context

The increasing popularity and growth of OSS, such as Linux, the Apache Web server, the Google search engine, the Firefox web browser, the Mozilla Thunderbird email and news client and the Oasis-OpenOffice office suite, and enterprise computing solutions such as the Ubuntu from Canonical, the OpenSuse from Novell, and the Fedora from Red Hat (see, for details, http://sourceforge.net), continue to draw significant attention from academic researchers and enterprise practitioners (Bonaccorsi and Rossi 2004; Dedrick and West 2003; Fitzgerald 2006; Fitzgerald and Agerfalk 2005; Fitzgerald and Kenny 2003; Fugetta 2003; Glynn *et al.* 2005; Holck *et al.* 2005; Larsen *et al.* 2004; Overby *et al.* 2006). But what is OSS and how is it different from traditional proprietary software? In light of the varying meanings ascribed to the term OSS and the confusion in terminology between OSS and Free Software (Fitzgerald 2006; Fitzgerald and Agerfalk 2005; Gacek and Arief 2004; Johnson-Eilola 2002; Wang and Wang 2001), we will now briefly discuss the term 'OSS' to provide the context for its use in this thesis.

The Open Source Software Initiative (OSI) has published the Open Source Definition (OSD Version 1.9) which describes many characteristics of OSS including: the royalty-free licensing model; the public access to software binary and the related source code; the freedom to redistribute the software; and the freedom to modify the software (www.opensource.org/docs/definition.php; http://perens.com/OSD.html). These

characteristics suggests that the use of OSS can provide benefits, including: economic benefits; the flexibility of full-scale software sampling and testing before formal implementation; the flexibility of software customisation; the assurance of software quality and standards; and the opportunity to contribute innovations in an 'Open' community. We argue that such benefits draws the attention and interests of organisations seeking competitive and flexible ICT 'platforms' and can drive the adoption of OSS in such organisations.

The growing interest in OSS and its adoption appears to have also drawn a lot of debate where various questions have been asked: why OSS is free and successful (Bonaccorsi and Rossi 2003; Hars and Ou 2002); whether software quality is an issue with OSS (Fitzgerald 2004; Fitzgerald and Agerfalk 2005; Hedberg *et al.* 2007; Holck *et al.* 2004; Raja and Barry 2005); whether OSS improves system security and dependability (Lawrie and Gacek 2002; Payne 2002; Witten *et al.* 2001); why individuals and firms participate in the OSS movement (Bonaccorsi and Rossi 2004); and who provides support for OSS (Lakhan and von Hippel 2003; Singh *et al.* 2006). Such debates have yielded valuable lessons that extend our knowledge about OSS and highlight it as a competitive and viable software 'platform', and as being more flexible for organisations than the traditional proprietary and closed-source 'platforms' (Fitzgerald 2004; Fitzgerald 2006; Forrester Consulting 2007; Dalle and Jullien 2002; Geira 2004; Lin 2006; Valimaki *et al.* 2005). Considering the characteristics of, benefits gained from, and the opportunity to make contribution back into OSS communities, we argue that SMEs have the opportunity to benefit from OSS and also to contribute to diverse and growing OSS projects.

However, various studies suggest that SMEs face challenges when adopting ICT, leading us to argue that, because it is a form of ICT, OSS is likely to present similar challenges to SMEs adopting it. The literature suggests that SMEs' lack of capital investment in IT infrastructure is related to their lack of resources, such as money and IT staff (Darch and Lucas 2002; Dutta and Evrard 1999; Houghton *et al.* 2001; Martin and Matlay 2001; Robert *et al.* 2003); SMEs' lack of skills appears to be related to their lack of human resources and time to develop professional IT skills (Lawson *et al.* 2003; Martin and Matlay 2003; Matlay 2000; Stockdale and Standing 2004; Taylor and Murphy 2004); SMEs' lack of knowledge appears to be related to their management's lack of innovativeness and understanding of ICT (Gelinas and Bigras 2004; Houghton *et al.* 2001; Martin 2005; Poon and Swatman 1999; Simpson and Docherty 2004); and some studies even suggest that SMEs' propensity to use particular ICT is related to their industry sector (Dutta and Evrard 1999; Frambach *et al.* 1998; Martin and Matlay 2003;

Poon and Swatman 1999; Robert *et al.* 2003). Such challenges in SMEs' adoption of ICT appears to be associated with organisational characteristics such as firm size, capital and human resources, management qualities and industry sector (Gilmore *et al.* 2001; Matlay 2003; Matlay 2000; Mehrtens *et al.* 2001; Ritchie and Brindley 2005).

Based on the discussions above, we argue that SMEs' characteristics influence their adoption of ICT and, therefore, their characteristics are likely to influence their adoption of OSS. For this reason, the understanding of SMEs' characteristics and characteristics of the OSS being adopted are important if they are to gain better understanding of their influence on adoption. Thus, the issues around the characteristics of SMEs and the characteristics of OSS leads to the focus of this study to understand the adoption of OSS by IT SMEs.

1.3 Existing Work

Although there are many studies on SMEs' adoption of ICT in diverse contexts, such as e-business and e-commerce applications (Daniel and Grimshaw 2002; Duan *et al.* 2002; Simpson and Docherty 2004; Stansfield and Grant 2003; Taylor and Murphy 2004), and Internet technologies (Houghton *et al.* 2001; Jeff *et al.* 2003; Sadowski *et al.* 2002; Shih and Fang 2004; Sillince *et al.* 1998), the area of OSS adoption by SMEs has been largely ignored by researchers. This is an interesting observation because previous research studies have investigated the use and spread of OSS in many contexts, for example, in large enterprises (Dedrick and West 2004; Holck *et al.* 2005; Overby *et al.* 2006); public sector areas (Valimaki *et al.* 2005); developing economies (Kshetri 2004; Mindel *et al.* 2007); and in the health-care industry (Fitzgerald and Kenny 2003). Thus, there is a research gap in the area of OSS adoption by SMEs in general.

There appears to be, also in previous studies on the use of OSS, a research gap in use of theory-grounded frameworks for developing valid and generalisable research models. Although there are existing theories, such as the Technology Acceptance Model (TAM) (Davis 1989; Venkatesh and Davis 2000), the Theory of Reasoned Action (TRA) (Albarracin *et al.* 2001; Fishbein and Ajzen 1975), the Theory of Planned Behaviour (TPB) (Ajzen 1985; Ajzen 1991), the Decomposed Theory of Planned Behaviour (DTPB) (Liker and Sindi 1997; Shih and Fang 2004; Taylor and Todd 1995a; 1995b), and the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh *et al.* 2003), which are suitable for exploring and better understanding the adoption of ICT including OSS, it appears that there has been limited use of such theories in previous research studies of OSS adoption. Instead, there has

been a wider use of a semantic 'technology–organisation–environment' framework for analysing factors that influence the use of OSS (Dedrick and West 2004; Glynn *et al.* 2005; Houghton *et al.* 2001; Kuan and Chau 2001; Overby *et al.* 2006; Robert *et al.* 2003). The lack of validity of such semantic frameworks may be a contributing factor in the limitations in validity of findings from such research studies, leading to a lack of valid theories in the area of OSS adoption.

Considering the limitations in previous research studies of OSS adoption, we also acknowledge that OSS adoption is still an emerging research area (Agerfalk *et al.* 2006; Dedrick and West 2003; Fitzgerald and Kenny 2003; Holck *et al.* 2005; Larsen *et al.* 2004; Overby *et al.* 2006). The lack of proven theories and, therefore, a lack of common understanding of OSS adoption suggests that there continues to be a gap in theory-building research on OSS adoption by SMEs. This gap has implications for both theory and practice perspectives which will now be discussed.

From a theory perspective, the lack of accumulation of theories in OSS adoption research presents researchers with a difficulty in undertaking a critical analysis of the literature on OSS adoption. Another implication from a theory perspective is that, as we have experienced, the lack of theories makes it difficult to evaluate research findings against other research studies on OSS adoption. From a practice perspective, an implication of the research gap is that the lack of accumulation of theories may suggest that there is limited understanding of OSS adoption by SMEs, which, we argue, continues to be a complex problem for enterprise policy-makers such as SME managers/owners (Donellan *et al.* 2005; Fitzgerald and Kenny 2003; Forrester Consulting 2007; Geira 2004; Glynn 2005; Holck *et al.* 2005; Larsen *et al.* 2004; Singh *et al.* 2006).

Based on the discussions above, we argue that there is a need to fill this gap in research and that doing so would have positive implications for theory and practice in the area of OSS and general ICT adoption. From a theory perspective, filling this gap in research could provide an important theoretical foundation for future research studies seeking to explore and understand OSS or general ICT adoption. Another implication is that addressing this research gap could provide a strong reference study for a critical analysis of the literature on OSS adoption, and the evaluation of research findings from other studies of OSS or general ICT adoption. From a practice perspective, SMEs or other industry practitioners are likely to benefit from the emergent theory of OSS adoption which can help them to explore and better understand OSS adoption. Another example is that an emergent theory of OSS adoption, as a

reference model, is useful to SMEs seeking to identify empirical variables that can be used in guiding their decisions and IT-policies about the use of OSS in the organisation.

Having argued, from a theory and practice perspective, about the gap in research in the area of OSS adoption by SMEs, and presented justification for seeking to address this gap, the next section will present the research focus, focusing on the research question being addressed and the subsequent research aim and objectives arising from it.

1.4 Research Aim and Objectives

This section presents the research aim and objectives, providing a clear research goal and determining the general scope of this study. As mentioned in section 1.3, there are research gaps arising from the lack of theories in OSS adoption research. These gaps have led us to an important research question that is addressed in this study, and that is stated as the following:

What factors influence the adoption of OSS by IT SMEs and why?

This exploratory research question seeks to identify the factors that influence the adoption of OSS by SMEs. The research question also seeks an explanation to understand why factors influence the adoption of OSS by SMEs and, therefore, there is an explanatory aspect to it. These two characteristics of the research question are important and are considered in developing a clear research aim and objectives.

Based on the research question and its exploratory and explanatory characteristics, the aim of this study is stated as the following:

To identify factors that influence the adoption of OSS by IT SMEs and to explain how.

The research aim focuses on identifying factors, representing and exploration of factors, and also on providing an explanation of how the factors influence the adoption of OSS by IT SMEs. These exploratory and explanatory aspects of the research aim leads to two key research objectives, which are stated as follows:

(1) To identify factors that influence the adoption of OSS by IT SMEs.

(2) To develop a valid explanation of how the factors influence the adoption of OSS.

These research objectives show that the exploratory and explanatory characteristics of the research question and research aim were considered, leading to two important justifications for the research objectives. First, the identification of factors is an exploratory objective,

which will allow us to focus on developing an important foundation of empirical knowledge of factors influencing OSS adoption by IT SMEs. Second, the development of a valid and generalisable explanation of the influence of factors is an explanatory objective, which will enable us to focus on developing a framework for common understanding of the factors and how they their influence OSS adoption by IT SMEs.

1.5 Research Methodology

This section presents an overview of the research methodology applied in this research study, providing a structural guide to the empirical research carried out and also helping the reader to understand the link between the research focus (in section 1.4) and the research methodology used. Important issues in the research methodology, including the researcher's interpretivist stance, the choice of a qualitative research mode and the choice of a case study strategy, will now briefly be discussed and justified.

The exploratory nature of the research question and the research aim and objectives (in section 1.4) led us to adopt an interpretivist research epistemology in this study. The interpretivist stance allows us to take into consideration complexity and subjectivity (Cepeda and Martin 2005; Fitzgerald and Howcroft 1998; Mingers 2003; Mingers and Brocklesby 1997; Sandelowski 2000) in the adoption of OSS by IT SMEs, as we seek to identify factors and understand their influences.

The interpretivist stance is consistent with the qualitative research mode chosen for this study. This mode of research is suitable for exploring, explaining and understanding a complex and subjective phenomenon, such as OSS adoption, by observing it in its natural setting (Cronbach 1975; Fitzgerald and Howcroft 1998; Hannabuss 1996; Hoepfl 1997; Trauth 2001). Therefore, it was found to fit the research aim and objectives (see section 1.4) which focus on exploring and explaining the complexity and subjectivity of factors, leading to an understanding of their influence on the adoption of OSS by IT SMEs.

This study uses a case study strategy, in a qualitative research mode, which provides instruments and procedures suitable for exploring a complex and subjective research phenomenon, and therefore fits with the research aim and objectives (see section 1.4). Furthermore, this strategy is suitable for investigating a contemporary research phenomenon (Miles and Huberman 1994; Yin 2002), such as the adoption of OSS. The use of a case study strategy also fits with the research aim (in section 1.4) which seeks to develop a widely-valid

explanation of OSS adoption. This reason fits with a focus to discover regularities or theories of OSS adoption (Creswell *et al.* 2007; Tellis 1997; Eisenhardt 1989; Yin 1994) to help to develop an analytically generalisable (Eisenhardt 1989; Yin 1993, 1994), or simply, a common understanding of OSS adoption.

Based on the choice of a case study strategy, the interview was applied as the data collection method. The interview data was analysed using a theory-building approach comprising of within-case and cross-case stages of analysis. The analysis uses a theoretical framework and the empirical data to develop generalisable definition of factors, which formed an emergent theory of OSS adoption by IT SMEs. The emergent theory provided a framework for conclusion-drawing about the factors identified and their influence on the adoption of OSS in this study.

1.6 Thesis Outline

This section presents an overview of the chapters in this thesis to provide the reader with a guide to its structure.

Chapter 2 presents a critical review and analysis of the literature, addressing the research question (in section 1.4). Because there is limited research in this emerging research area, the literature research is expanded by drawing on more general literature related to factors that influence the adoption of ICT by SMEs. The factors identified provide a foundation for developing a framework that allow us to analyse and try to understand the scope of factors influencing the adoption of OSS by SMEs in general. The analysis of the factors and the framework leads to the argument that OSS adoption is complex and subjective, and the assertion that there appears to be a lack of common understanding of the factors and how they influence the adoption of OSS by SMEs. Based on this argument, the literature research then focus on identifying a suitable existing ICT adoption theory, for developing a theoretical framework that supports a common explanation and understanding of OSS adoption.

Having argued for a need for a theoretical framework in Chapter 2, Chapter 3 presents the research conceptual model which was developed to support a valid explanation and therefore, a common understanding of factors and their influence on the adoption of OSS by SMEs. Initially, existing ICT adoption models are identified and evaluated according to their exploratory and explanatory capabilities. That evaluation leads to the selection of the Decomposed Theory of Planned Behaviour, which is operationalised using factors identified in

Chapter 2. The operationalisation yields theoretical concepts for exploring factors and research propositions for explaining their influence on the adoption of OSS. Bringing together concepts and research propositions forms a conceptual model of OSS adoption by SMEs. The conceptual model provides a scope of initial concepts relevant for exploring and explaining factors that can lead to an understanding of the adoption of OSS by SMEs.

Chapter 4 presents the empirical research methodology, which establishes a structural guide for the empirical inquiry conducted in this study. Five important issues are discussed. The first issues is the research paradigm which takes into consideration the research question, the research aim and objectives (in section 1.4), and leads to an interpretivist stance in this study. Second, the choice of a qualitative research mode is discussed, arguing that it fits with the exploratory nature of the research question, the research aim and objectives and the interpretivist stance taken in this study. Third, the choice of a case study strategy is discussed, arguing the decision on the basis of the research question, the research aim and objectives, and the contemporary nature of OSS adoption. Fourth, the instruments and procedures for the field research are discussed, justifying the choice of interviews as the data collection method applied in this study and the use of relevant qualitative data analysis techniques. Fifth are the measures taken to ensure quality and relevance of the research methodology, leading to discussions about research credibility, transferability, dependability and confirmability of the empirical research methodology and the research findings.

Having developed a research methodology in Chapter 4, the analysis of empirical data is presented in Chapter 5. Four topics are covered in this chapter. First, the sampled cases are discussed, showing that the IT SMEs were strategically sampled in this research study to provide rich and diverse empirical data on OSS adoption by IT SMEs in the UK. Second, the development of transcripts is discussed, showing that Conversation Analysis (CA) techniques were applied in the transcription of interview sessions to develop a high-quality and structured form of qualitative data. Third, the within-case analysis of the qualitative data is discussed, presenting the first of a two stage analysis which interprets the qualitative data, identifies and codes the factors found in each of the 10 case transcripts. Fourth, the cross-case analysis stage is discussed, presenting the processes of that second stage of analysis including: the collation of similar factors identified in the within-case analysis stage; the selection of factors that meet a set criteria for logical replication; and the use of data from multiple cases to develop a description of each factor selected.

Following the analysis of data in Chapter 5, the research findings including the emergent theory and its implications are discussed in Chapter 6. The discussion of the research findings provides an answer to the research question (in section 1.4) and fulfils the research aim and objectives (in section 1.4) set out in this study. Four important issues are discussed in this chapter. First, the empirical model is presented, showing the factors identified from the data analysis in Chapter 5 and providing a general scope of the emerged theory of OSS adoption by IT SMEs in this study. Second, the factors are explained, defining each factor and justifying the definition. Third, an explanation and justification of the influence of the factors on OSS adoption by the IT SMEs in this study is presented. The fourth issue is a discussion of the implications of the research findings, focusing on the implications for theory in OSS adoption research, and the implications for practice for SME owners/managers evaluating and adopting OSS.

Chapter 7 presents the conclusions from the work undertaken in this research study. Four important areas are presented, starting with a thesis review to remind the reader about the objectives and outcomes of each chapter of this thesis. Second, we present arguments for the novelty and originality of the contributions from the research work from research and practice perspectives. Third, we discuss the research limitations in this study, providing a scope and boundaries for interpreting the relevance and generalisability of the research findings and contributions. Fourth, the research limitations from this study also provide opportunity for future research, which are discussed as suggestions for combating the limitations in this study, and extending the research on OSS or other ICT adoption research.

2

Literature Analysis

2.1 Introduction

This chapter presents a critical analysis of the literature to identify and analyse existing knowledge on Open Source Software (OSS) adoption by UK Small-to-Medium Enterprises (SMEs). Doing so is important for two key reasons. The first reason is that the identification of factors in the literature provides the background knowledge needed to analyse and understand factors and why they influence the adoption of OSS by SMEs. The second reason is that the critical analysis of the literature allows us to identify important lessons from previous research studies in this field which can help us to better explore and understand the adoption of OSS by SMEs in this study. The analysis of factors from the literature will cover studies of factors known to influence OSS adoption, and will be augmented with studies of other factors known to influence the general adoption of ICT by SMEs. This augmentation approach to analysis will allow us to build a set of factors which has a broader scope which will, in turn, help us to better understand the potential issues influencing, or which may influence, the adoption of OSS by SMEs.

In order to achieve the aim set out in this chapter, two important objectives are considered. The first objective is to identify factors that are relevant to the adoption of OSS by SMEs. The second objective is to examine the factors together in an analytical framework. These objectives are explained as follows.

The first objective identifies factors relevant to the adoption of OSS by SMEs. This is important for identifying factors that influence the adoption of OSS and then augmenting

that with factors that influence the adoption of ICT more generally by SMEs. This provides a set of factors that help to focus this study on OSS adoption within an organisational context. This also provides a set of factors that help to consider SMEs' characteristics that influence their adoption of ICT because these are likely to be relevant to SMEs' adoption of OSS. To simplify the identification and categorisation of factors, the TOE framework is applied.

We acknowledge that there may be a debate about the origin of this framework (Dedrick and West 2003, 2004) and that there appears to be diversity in the use of the TOE framework: some studies apply partial scope (see, for example, Dedrick and West 2003, 2004; Kuan and Chau 2001; Zhu *et al.* 2006) while other studies apply a more comprehensive scope (see, for example, Chang *et al.* 2005; Hong and Zhu 2006; Raymond *et al.* 2005; Xu *et al.* 2004; Zhu and Kraemer 2005; Zhu *et al.* 2003) to the definitions of TOE components. Of note is that the technology component in the studies that apply partial scope appears to be limited to innovation characteristics – a key reason why some studies (see, for example, Raymond *et al.* 2005; Zhu and Kraemer 2005; Zhu *et al.* 2003) argue that the TOE framework is consistent with, and also attempts to address the limitations of the diffusion of innovation theory (DOI) (Rogers 1995). In contrast, the technology contexts for the studies that apply a more comprehensive scope also take into consideration other technologies that support the use of the innovation under focus.

This diversity suggests that there is a lack of theory about this framework, an observation consistent with that of Dedrick and West (2003, 2004) who suggests that the TOE framework is simply a taxonomy for categorising variables, but not a well-developed theory. The observed discrepancies lead us to take a more analytically generalisable perspective on the definitions of the TOE components, consistent with many other studies that have applied it. Thus, the TOE framework is applied in this study as a semantic framework and analysis tool for discussing complex adoption factors from three contexts: technological context (section 2.2), organisational context (section 2.3), and environmental context (section 2.4). The definitions of these components, as applied in this study, will be introduced in the relevant sections.

The second objective is to examine together the factors identified, as a single framework of factors likely to influence the adoption of OSS by SMEs. This objective seeks to understand the nature and any interrelationships between the factors and why they are likely to influence the adoption of OSS by SMEs. This objective is important in identifying and understanding

similar factors that are likely to emerge from the empirical research. These issues will be discussed in two additional the discussions in section 2.5 and 2.6 which are described below.

Section 2.2 discusses technological context of factors, including the characteristics of OSS, which may influence the adoption of OSS by SMEs. However, OSS and their characteristics vary and, therefore, they are likely to influence the adoption of OSS differently. For this reason, it is expected that characteristics of OSS will lead to diverse factors that can influence the adoption of OSS.

Section 2.3 presents organisational context of factors that may influence the adoption of OSS by SMEs. The factors focus on organisational readiness for OSS adoption. This context of factors is important because it allows us to take into consideration organisational characteristics of SMEs and their influence on the adoption of OSS.

Section 2.4 presents environmental context of factors that may be relevant to SME's adoption of OSS. These factors include the influence of external entities such as OSS vendors, IT consultants, government agencies, peers, and family on the adoption of OSS. Such external entities are relevant because they may provide supplementary information, support services or infrastructure that influences the adoption of OSS by an SME.

Section 2.5 presents an analysis of an emergent TOE framework, bringing together the adoption factors from the previous sections. Doing so allows us to evaluate the factors identified and the effectiveness of the TOE framework, in our understanding of why the factors may influence the adoption of OSS by SMEs.

Section 2.6 presents discussions to justify the need to develop a theory-based OSS adoption framework for this study. The discussion presents this study's consideration of the lessons learnt from the analysis of previous research on OSS adoption which suggests a lack of theoretical grounding in existing studies of OSS adoption.

2.2 Factors of Technological Context

In this study, the technological context encompasses issues around the focus of innovation (OSS), and internal and external technologies relevant and already assimilated by the SMEs (Chang *et al.* 2005; Hong and Zhu 2006; Raymond *et al.* 2005; Xu *et al.* 2004; Zhu and Kraemer 2005; Zhu *et al.* 2003a,b). A summary of related factors identified in the literature is

presented in Table 2.1 and discussed as a set of common examples to allow us to understand their influence on OSS adoption by SMEs. The factors that will be discussed include cost savings, functionality, IT infrastructure, quality characteristics, and trialability. These factors were identified as occurring frequently in the literature, suggesting that they are likely to be relevant in the adoption of OSS by SMEs.

***Table 2.1** Technological Factors Influencing the Adoption of OSS*

Factors	Description	References
Cost saving	Refers to the potential for accumulative financial savings in OSS license fees and free license redistribution even across diverse applications and computing platforms. Cost saving has also being identified in terms of benefit from the use of ICT in general, e.g., cost management, improving efficiency, reaching new markets, managing business partnerships.	Dedrick and West (2003) Fitzgerald (2004) Fitzgerald and Kenny (2003) Forrester Consulting (2007) Giera (2004) Larsen *et al.* (2004) Mehrtens *et al.* (2001) Valimaki *et al.* (2005) Stockdale and Standing (2004)
Functionality	Refers to the usefulness of the OSS for supporting business functions in areas such as communications, business management, collaboration and partnerships. Also discussed in terms of the use of ICT as a business tool in various areas including communication, internal and external business operations, and decision management.	Dedrick and West (2003) Mehrtens *et al.* (2001) Overby *et al.* (2006) Poon and Swatman (1999) Sadowski *et al.* (2002) Schillewaert *et al.* (2005) Sillince *et al.* (1998) Stockdale and Standing (2004)
IT infrastructure	Refers to the supporting infrastructure, such as IT workspace, networking infrastructure, client and server systems, which are needed for the use of an OSS.	Dedrick and West (2004) Holck *et al.* (2004) Kwan and West (2005) Larsen *et al.* (2004) Mehrtens *et al.* (2001)
Quality characteristics	Refers to issues that make OSS very competitive when compared to other software platforms. These quality issues include reconfigurability, security, reliability, scalability, flexibility, and open standards compliance.	Dedrick and West (2003) Fitzgerald (2004) Fitzgerald and Kenny (2003) Glynn *et al.* (2005) Mannaert and Ven (2005) Overby *et al.* (2006) Raja and Barry (2005) Wang and Wang (2001)
Trialability	Refers to the unrestricted access to OSS applications and source code, which may be tested and tried prior to a total commitment to using it.	Dedrick and West (2003) Kwan and West (2005) Rossi and Bonaccorsi (2005)

2.2.1 Cost Saving

The first factor in Table 2.1 is cost saving. This factor was identified from both OSS and ICT adoption literature. Cost saving is a motivating factor in SME adoption of ICT and has been frequently reported as a cost benefit (see, for example, Daniel and Grimshaw 2002; Fitzgerald 2004; Mehrtens *et al.* 2001; Rossi and Bonaccorsi 2005; Sillince *et al.* 1998). This suggests that cost savings in using a particular ICT can influence an SME in adopting the ICT. However,

the reason why cost savings may influence OSS adoption becomes relevant in this study as it could enable a better understanding of the concept of cost savings within the context of OSS adoption by SMEs, as will now be discussed.

OSS projects offer free licenses and unlimited redistribution of licenses to OSS applications and source code (OSD Version 1.9). This is an important characteristics of OSS and differentiates it from proprietary or Closed Source Software which do not provide source code to the applications, generally are not licensed as 'free', and generally prohibit redistribution of the copyright of the proprietary product (such as software binary and source code). This suggests that, relatively, there is a lower acquisition cost in the procurement of OSS licenses (Fitzgerald 2004; Giera 2004; Kumar and Krishnan 2005). Such lower acquisition costs can be seen as a cost saving benefit for a SME in the adoption of OSS.

The cost savings from the adoption of OSS can have a direct impact on SME ICT expenditure, which can include OSS application expenditure, labour expenditure and business expenditure (Holck *et al.* 2004; Kumar and Krishnan 2005). Studies suggest that SMEs are particularly sensitive to ICT expenditures owing to their limited financial resources (Dutta and Evrard 1999; Houghton *et al.* 2001; Saloheimo 2005). This suggests that although scarce financial resources can constrain SME acquisition of ICT, the cost saving factor in OSS procurement can enable SMEs to leverage their limited resources for ICT expenditure and perhaps boost their ICT adoption. From this discussion, we argue that potential cumulative cost savings in OSS procurement can enable SMEs to leverage limited investment in ICT adoption. In this context, cost savings can be seen as a factor that motivates SMEs to adopt OSS.

2.2.2 Functionality

The second factor presented in Table 2.1 is functionality. The functionality of OSS in various areas of ICT adoption fits with the information systems needs of different organisations (Dedrick and West 2004; Fitzgerald 2003; Glynn *et al.* 2005; Kshetri 2004; Overby *et al.* 2006). Various studies on SME adoption of ICT, including the Internet (Daniel and Grimshaw 2002; Martin and Matlay 2003; Schillewaert *et al.* 2005), e-business (Saloheimo 2005; Taylor and Murphy 2004) and e-commerce (Daniel and Grimshaw 2002; Martin 2000), suggest that ICT functionality is a major factor in the adoption of the particular ICT. Studies on ICT adoption and diffusion also suggest that functionality is an important determinant in decisions to adopt an innovation such as OSS (Davis 1989; Fishbein and Ajzen 1975; Rogers 1983; Taylor and Todd 1995; Venkatesh *et al.* 2003).

In this study, further consideration is given to the fit of OSS functionality with respect to the diversity of SME activities. This is relevant in understanding the fit of OSS functionality with respect to varying SMEs' needs for ICT, which have been differentiated across factors such as industry sector and business size (Darch and Lucas 2002; Frambach *et al.* 1998; Martin 2005; Matlay 2000; Taylor and Murphy 2004).

There is diversity and variety in OSS and their functionality. For example, different OSS such as the GNU/Linux operating system, OpenOffice suite of office applications, MySQL database application, Apache web server, the GNU family of programming languages, Compiere ERP-CRM enterprise resource management suite, Postfix, Sendmail, and Mozilla Thunderbird email applications (see, for details, www.sourceforge.org), provide diverse functions in organisational information systems including areas such as electronic communication, marketing, data processing, resource management and business modelling (Fitzgerald and Kenny 2003; Forrester Consulting 2007; Overby *et al.* 2006). Therefore, OSS can fit with diverse business activities across varying SME business or industry sectors. Such diversity of SME need for ICT has been discussed in the literature.

The UK DTI ICT adoption ladder (Martin and Matlay 2001; Martin 2005) suggests that SMEs adopt ICT for several business functions, including messages (email), on-line marketing (websites), on-line ordering, payment and tracking (e-commerce) and integration of internal processes (e-business). The examples of OSS discussed above already fit with most, or even all, of these business functions. Therefore, OSS does have functional value to SME business needs in various areas, which is an important factor for consideration in SME adoption of OSS.

It is now clear that, in general, OSS fits with some SME ICT needs. However, due to the heterogeneity of SMEs (Martin and Matlay 2001), their ICT needs vary across business or industry sectors, such as the manufacturing and services sectors (Darch and Lucas 2002; Frambach *et al.* 1998; Taylor and Murphy 2004). Therefore, it is argued that the use of different OSS will vary across different SME business and industry sectors. A similar variation in the use of OSS can be expected in other contexts of SME heterogeneity, such as business size, information intensity and business competitiveness (Gelinas and Bigras 2004; Merhtens *et al.* 2001; Simpson and Docherty 2004).

2.2.3 IT Infrastructure

IT infrastructure is the third factor in Table 2.1 and this factor can be an important prerequisite to the successful adoption of a software innovation (Kuan and Chau 2001; Mehrtens *et al.* 2001; Robert *et al.* 2003). IT infrastructure fits into the technological context of factors because it is seen here as a representative of supporting technologies in the adoption of OSS. This discussion on the variations, selection, costs and management of IT infrastructure supports the argument that IT infrastructure is an important factor in the adoption of OSS and, therefore, relevant for our understanding of factors that influence the adoption of OSS by SMEs.

Mehrtens *et al.* (2001) identified that access to adequate computer systems would enable an SME to try-out and eventually adopt internet technology. This suggests that the technology being adopted may only be properly tested with the right IT infrastructure. Therefore, access to adequate IT infrastructure is important even prior to the final decision to deploy the technology. This implies that access to IT infrastructure would allow testing the functionality and other issues that allow an SME to evaluate the use of OSS before finally committing to the technology.

Dedrick and West (2004) suggest that while there are different manufacturers that support OSS such as Linux on their computing hardware, the actual technical architectures such as RISC processor based hardware, Intel compatible hardware and commodity hardware, are suitable for different applications in a desktop, server or mixed platform environment. This suggests that there is a decision to be made about IT infrastructure for particular business needs. Therefore, the selection of suitable IT infrastructure may be a relevant factor in the adoption of an OSS.

West and Dedrick (2001) suggest that there are differences in technical architecture between mainframe and PC hardware, much like differences in computing processors such as Intel, Motorola and RISC processors. These different technologies may be more suitable for particular computing needs and for different applications of OSS such as server, desktop and mobile communication and computing. Therefore, it is important for an SME to make an informed choice about IT infrastructure that is appropriate for its particular business purpose. This means that IT infrastructure consideration is then an important factor in their adoption of OSS.

Recently, IT vendors have 'bundled' different OSS on their different hardware. Larsen *et al.* (2004) also suggests that hardware vendors bundle OSS products as subcomponents. This appears to add value to the hardware and also may have an impact on the 'total cost of ownership' (TCO) because of the relative cost advantage over similar 'bundle' of proprietary software. Recently, there have been many hardware innovations that are developed upon or bundled with free OSS. Asus Eee PC, HP Mini 2133, Intel OLPC, and Toshiba Protege are some examples of OSS bundled with computing hardware. Accton VM3228T, Google Android, MotoRIZR Z6, and Samsung SGH-i858 are some examples of mobile computing and communication hardware bundled with OSS. These examples of ICT hardware suit different users and applications. Therefore, the selection, costs and management of the underlying IT infrastructure is relevant in the adoption of OSS.

Holck *et al.* (2004) suggest that there can be a relationship between the choice of a particular computing hardware and the type of OSS bundling and technical support that is bundled by the hardware vendor. This can lead to a complex interrelationship between the need for IT infrastructure, technical support and the potential for a complex relationship with IT vendors. This sort of relationship would be even more relevant for an SME when the need for other supporting hardware is considered. Kwan and West (2005) suggest that additional hardware to support the use and management of computing hardware includes power systems, temperature or environmental control systems and hardware security mechanisms. Thus, an SME may benefit from added value of free software and support by consideration of relevant issues surrounding the acquisition of particular IT infrastructure from particular vendors.

2.2.4 Quality Characteristics

The fourth factor in Table 2.1 is quality characteristics. This factor is a representative of various quality characteristics, and innovation characteristics of OSS which can influence its adoption, and therefore fits within the technology context of factors. Some of the quality characteristics, including configurability, reliability and extension of functionality, appear to be common across various studies (Fitzgerald 2004; Overby *et al.* 2006; Raja and Barry 2005; Wang and Wang 2001). These quality characteristics and others are considered because they are likely to be relevant to OSS adoption by SMEs.

The capability for user configurability and extension of OSS reliability and functionality appears to be related to the availability of source code of an OSS (Glynn *et al.* 2005). Glynn *et al.* (2005) also reported that access to source code is a quality characteristic of OSS because it is a key facilitator that can enable the addition of desired functionality in OSS development.

Fitzgerald and Kenny (2003) and Mannaert and Ven (2005) also suggest that access to source code and the flexibility of reconfiguration that this enables are strengths of OSS.

These views suggest that the availability of OSS code can have a positive influence for SMEs with the IT staff capacity and other resources to make use of it. The discussion now continues with a look at other quality characteristics that may arise from the availability of source code for an OSS.

Studies such as Raja and Barry (2005) and Wang and Wang (2001) have reported some important quality characteristics in OSS, including availability, customisability and extensibility, future functional upgradability, high reliability, open-standard compatibility, maintainability and reusability. Fitzgerald (2004) and Overby *et al.* (2006) also suggest that many OSS products are recognised for their high standards of configurability, efficiency, reliability, robustness and supportability. An example of the impact of such quality characteristics was highlighted by Fitzgerald (2004), who suggests that OSS such as Apache, Bind and Linux as OSS are now leading competitive products.

High reliability can reduce SMEs' IT expenditure, including replacement of hardware and software infrastructure, labour and business resources (Holck *et al.* 2004; Kumar and Krishnan 2005). High reliability can be relevant to SMEs that adopt OSS for their core business functions, and expect systems stability, effective functionality and maximum return on investment (Fitzgerald and Kenny 2003; Forrester Consulting 2007; Overby *et al.* 2006; Raja and Barry 2005).

Another example is that open-standards compatibility can enable SMEs to leverage existing staff IT skills and IT infrastructure in their adoption of OSS. This may be more relevant to SMEs that prefer flexibility and continuity in their IT platforms, rather than costly proprietary solutions with potential risks of vendor lock-in (Fitzgerald and Kenny 2003; Valimaki *et al.* 2005).

Finally, customisability and extensibility can enable SMEs to adapt their OSS to current and future business needs. With these quality characteristics, SMEs may be better able to apply their innovativeness, flexibility, human and financial resources to adapt OSS to current and future business needs. This view is consistent with some studies, such as Fitzgerald and Kenny (2003) and Mannaert and Ven (2005), which suggest that customisability and extensibility

can enable the creation of critical business applications from generic packages, by enabling full customisation to the needs of each individual user or organisation.

The discussion argues that quality characteristics of OSS can influence SMEs adoption of OSS. This influence appears to be related to the various benefits that may enable SMEs to leverage their limited IT capital investment and limited staff IT capacity in the adoption of OSS. On the other hand, in order for SMEs to realise such benefits in some of these quality characteristics, they may need to have the necessary IT skills, IT infrastructure and relevant external support. These potential requirements may impose a consideration of an SME's IT investments with respect to current standards of staff IT capacity and IT infrastructure.

2.2.5 Trialability

Trialability is the fifth factor presented in Table 2.1. It is also an innovation characteristics relevant to OSS and therefore fits within the technology context of factors. OSS licenses enable unlimited use of OSS applications and their source code (OSD Version 1.9). This suggests that potential adopters can make use of the full functionality of an OSS before committing to its adoption. Studies have shown that such ICT trials enable the potential adopter to dispel technical, financial and social uncertainty (Frambach and Schillewaert, 2002). Therefore, trials of OSS can enable SMEs to assess the features, benefits, costs and potential challenges relevant to the use of a particular OSS (Kwan and West 2005). This context of OSS trial is consistent with other studies which suggests that trialability has an influence on the adoption of an innovation (Dedrick and West 2003, 2004; Rogers 1983).

Although SME can use the trial period to assess an OSS, there are other factors surrounding the SME which may be relevant to the trial of the OSS. Because trialability can be a limited adoption of an innovation, other factors such as flexible organisational structure and the availability of adequate external support can facilitate rapid trial of OSS in the organisation. On the other hand, factors such as limited IT staff capability, staff time and access to other scarce organisational resources may constrain the trial process (Blackburn and Athayde 2000; Dedrick and West 2003).

SMEs mostly operate with a flexible organisational structure (Houghton *et al.* 2001; Saloheimo 2005). This suggests that SMEs may have the potential to apply their flexible organisational structure in ICT adoption, which can facilitate flexible trial of an ICT such as OSS (Dedrick and West 2003; Holck *et al.* 2004). However, such flexible trial still may need staff with relevant skills to try out the OSS in the organisation. Thus, while an SME may be

motivated to try out an OSS, it may be necessary for SME management to consider its IT staff capability in relation to the complexity and functionality of the OSS being considered.

An important issue that is related to SME trial of OSS is total costs in terms of application expenditure, labour expenditure and business resources (Holck *et al.* 2004; Kumar and Krishnan 2005). While an OSS may have zero or relatively low acquisition costs, unrestricted functionality, unlimited trial period for the application and source code (OSD Version 1.9; Fitzgerald and Kenny 2003), there can be other costs, such as labour time and cost on the use of organisational infrastructures. SME management may need to consider such additional costs because these can be relevant to the trial of the OSS concerned.

In the trial of an OSS, SMEs need to consider the diversity of OSS, their varying complexity and functionality in relation to SME needs and capability. This is because such issues can pose potential challenges that constrain the trial of an OSS (Fitzgerald and Kenny 2003; Overby *et al.* 2006. Consideration of such issues may lead SME management to seek external support from OSS vendors or consultants. And it can be expected that external support may better enable SME management to assess the functionality, benefits and cost of the trial of the OSS in question (Dedrick and West 2004; Fitzgerad and Kenny 2003; Rossi and Bonaccorsi 2005).

2.3 Factors of Organisational Context

Organisational context of factors refers to an SMEs' size and scope, the centralisation, formalisation, and complexity of its managerial structure, the quality of its human resources, and the availability of adequate internal slack resources for OSS adoption (Chang *et al.* 2005; Hong and Zhu 2006; Raymond *et al.* 2005; Xu *et al.* 2004; Zhu and Kraemer 2005; Zhu *et al.* 2003a,b). Table 2.2 shows a summary of related factors identified in the literature. The factors are discussed as a set of common examples to allow us to understand the organisational context that may influence the adoption of OSS by SMEs. The discussion will focus on diverse factors including capital investments, innovativeness, and staff IT-capacity. These factors were identified as occurring frequently in the literature, suggesting that they are likely to be relevant in understanding SMEs' adoption of OSS.

2.3.1 Capital Investments

The first factors in within organisation context, as presented in Table 2.2, is capital investment and it is relevant in this categorical context because it relates to issues about resources with facilitate the adoption of OSS. The need for investment of resources, such as

time, money and IT infrastructure may pose a challenge for those SMEs with limited financial capacity or inadequate IT infrastructure (Dutta and Evrard 1999; Houghton *et al.* 2001; Matlay 2000; Taylor and Murphy 2004). Studies also suggest that although free licensing and free redistribution of OSS (OSD Version 1.9) delivers low to zero OSS application expenditures, there can be other relevant expenditure, such as product assessment, product configuration, package integration, and maintenance including labour and services expenditures (Holck *et al.* 2004; Kumar and Krishnan 2005).

***Table 2.2** Organisational Factors Influencing the Adoption of OSS*

Factors	Description	References
Capital investment	Refers to the use of resources, such as access to skilled IT staff, support services and hardware infrastructure for facilitating the use an OSS.	Darch and Lucas (2002) Dedrick and West (2003) Dutta and Evrard (1999) Houghton *et al.* (2001) Kumar and Krishnan (2005) Martin and Matlay (2001) Robert *et al.* (2003) Saloheimo (2005
Innovativeness	Refers to SME manager/owner entrepreneur qualities which reflects the organisation's perceptions towards the use of OSS or other ICT. Such individual is an important change agent, having a direct influence on decisions about the adoption or non-adoption of OSS or other ICT in the organisation.	Dedrick and West (2003) Duan *et al.* (2002) Gelinas and Bigras (2004) Houghton *et al.* (2001) Martin (2005) Poon and Swatman (1999) Simpson and Docherty (2004)
Staff IT-capacity	Refers to the staff ability to use apply relevant skills in using ICT. Raising staff IT-capacity may require training of internal staff, or seeking supplementary staff IT-capacity from external sources. In the context of OSS adoption, this refers to the need for technical and informational support for the use, maintenance and development of OSS in the organisation.	Blackburn and Athayde (2000) Dedrick and West (2003) Duan *et al.* (2002) Fitzgerald (2004) Fitzgerald and Kenny (2003) Geira (2004) Lawson *et al.* (2003) Martin and Matlay (2003) Matlay (2000) Stockdale and Standing (2004) Taylor and Murphy (2004)

2.3.2 Innovativeness

The second factor presented in Table 2.2 is innovativeness, which fits within the organisational context of factors because it relates to issues about the characteristics of the enterprise and, the influence of such characteristics on the adoption of OSS. The SME manager/owner is an organisational change agent in SME adoption of ICT. Various studies suggest that the qualities of the SME manager/owner, such as IT innovativeness, entrepreneurship and risk taking, influence SME adoption of ICT (Gelinas and Bigras 2004; Martin 2005; Taylor and Murphy 2004). In this study, it is expected that such qualities of an manager/owner can influence the adoption of OSS in the organisation, suggesting that the

SME manager/owner is an important individual at the heart of OSS adoption in the organisation. It is expected that SME managers/owners would apply their awareness and knowledge of OSS potentials to leverage the need for ICT in the organisation (Blackburn and Athayde 2000; Dedrick and West 2003; Fitzgerald and Kenny 2003). In this context, the SME manager's/owner's awareness and knowledge influences the decision to use OSS in the organisation. The decisions may lead the manager/owner to consider other interrelated factors, such as the adequacy of existing staff awareness and skills.

However, SME management and staff initiatives to improve IT capacity for OSS adoption can be facilitated or constrained by various issues, including the following: lack of staff time; inadequate IT-infrastructure; scarce financial resources; poor organisational structure; lack of adequate-support from OSS vendor, consultants, government agencies; and access to skilled IT-staff in geographically remote area (Blackburn and Athayde 2000; Martin 2005; Poon and Swatman 1999; Saloheimo 2005; Taylor and Murphy 2004). The similarity between these issues and factors such as staff IT-capacity, capital investment and IT infrastructure suggests an interrelationship between some organisational factors.

Studies suggest that there is a link between IT innovativeness and organisational structure and that many SMEs adopt a flexible organisational structure (Martin and Matlay 2003; Robert *et al.* 2003; Saloheimo 2005). Therefore, SME managers/owners can be expected to better apply flexible organisational structures to enhance the adoption of OSS, even at trial levels, while maintaining their core business functions (Dedrick and West 2003; Holck *et al.* 2004). Such flexible organisational structure may better enable SME managers/owners and their staff to consider the technological, legal and business factors that may be relevant to the use of OSS in the organisation (Holck *et al.* 2004).

There is variation in OSS complexity and functionality (Fitzgerald and Kenny 2003; Kshetri 2004; Overby *et al.* 2006). In this study, the variations in OSS complexity and functionality are relevant to SME business needs for OSS. For example, staff IT training may be of less challenge in terms of time, money and need for new IT infrastructure with some OSS adoption, such as OpenOffice applications, Thunderbird electronic mail clients or Mozilla web browser. Therefore, SME management and staff need to be aware of such variation in OSS complexity and functionality. Such awareness could ensure that SME management and staff initiatives invest resources in the appropriate OSS that fits with business needs and expected benefits (Fitzgerald and Kenny 2003; Kwan and West 2005; Stockdale and Standing 2004; Walczuch *et al.* 2000).

2.3.3 Staff IT-Capacity

The third factor presented in Table 2.2 is staff IT-capacity and this factors fits within the organisational context of factors because it is related to the quality of human resources that support the use of OSS in the enterprise. Studies on SME adoption of ICT suggest that staff IT-capacity is an important factor that influences SME management and staff decisions to adopt ICT (Lawson *et al.* 2003; Martin and Matlay 2003; Saloheimo 2005; Taylor and Murphy 2004). Therefore, it is expected that SME staff IT capacity in relation to OSS knowledge and related skills will be influential in SME decisions to use OSS. Furthermore, Staff IT-capacity may be of particular importance in this study, because it is related to the knowledge and understanding of OSS, and the training, skills and access to information that enables SMEs to use ICT effectively (Tachiki 2002).

Various studies on SME adoption of ICT also suggest that SME management practices and staff IT capacity are affected by issues such as: poor awareness and knowledge of ICT; lack of understanding of ICT benefits to SME business functionality and competitiveness; lack of adequate investment to improve SME staff IT capacity; and lack of effective support from ICT vendors and government bodies (Darch and Lucas 2002; Dutta and Evrard 1999; Houghton *et al.* 2001; Stockdale and Standing 2004). These issues can be considered in the context of OSS adoption because they are relevant to SME staff IT capacity in the use of OSS.

2.4 Factors of Environmental Context

The environmental context of factors refers to external influences in the arena in which the SME adopts OSS: pressures from the SMEs' business partners, its industry, or competitors; access to resources from suppliers; and dealings with government bodies (Chang *et al.* 2005; Hong and Zhu 2006; Raymond *et al.* 2005; Xu *et al.* 2004; Zhu and Kraemer 2005; Zhu *et al.* 2003a,b). Related factors identified in the literature are summarised in Table 2.3. Again, the factors are discussed as a common set of examples to allow us to understand the environmental context of factors that may influence the adoption of OSS by SMEs and include government support, lack of support, and vendor support. These factors appear frequently in the OSS and ICT adoption literature, suggesting that they may be important issues and provide useful lessons about environmental context of factors and their influence on the adoption of OSS by SMEs.

Table 2.3 *Environmental Factors Influencing the Adoption of OSS*

Factors	Description	References
Government policies	Refers to the effect of inadequate government policies for enhanced ICT adoption through raising awareness and improving access to supporting information and infrastructure.	Darch and Lucas (2002) Lawson *et al.* (2003) Martin and Matlay (2003) Simpson and Docherty (2004)
Lack of support	Refers to potential difficulty to use or maintain OSS due to limited availability of internal or external technical support. This has also been discussed in terms of concerns about the availability of support to help SMEs adopt a particular ICT.	Chester and Skok (2000) Dedrick and West (2003) Dedrick and West (2004) Fitzgerald and Kenny (2003) Geira (2004) Holck *et al.* (2005) Raja and Barry (2005) Simpson and Docherty (2004) Stansfield and Grant (2003) Stockdale and Standing (2004) Wang and Wang (2001)
Vendor support	Refers to the roles of vendors and consultants as important network players that facilitate the adoption of ICT by providing supplementary services, infrastructure and training.	Blackburn and Athayde (2000) Boekhoudt and van der Stappen (2004) Chaston and Baker (1998) Dutta and Evrard (1999) Frambach *et al.* (1998) Lawson *et al.* (2003) Martin and Matlay (2003) Simpson and Docherty (2004)

2.4.1 Government Policies

Government policies, the first factor in Table 2.3, fits within the environment context of factors because it is related to issues of government dealings in relevant to the adoption of OSS in the enterprise. Studies suggests that governments are setting up initiatives to promote ICT adoption in SMEs (Martin 2005; Poon and Swatman 1999; Stockdale and Standing 2004). These initiatives assist SMEs in the adoption of ICT through increasing public spending on ICT projects. They are aimed at improving SME innovativeness, strengthening the performance of companies, thus contributing to the economy (Dutta and Evrard 1999; Martin and Matlay 2001; Taylor and Murphy 2004). In fact, Simpson and Docherty (2004) suggest that some government agencies have proven to have initiated some of the most successful initiatives in helping SMEs with their ICT adoption challenges.

Research also suggests that government policies, which can be neutral, targeted or mandated (Mindel *et al.* 2007) in the form of incentives and legislation, can influence SMEs' adoption of ICT such as OSS. For example, some studies have reported that government initiatives to adhere to software intellectual property laws, and also improve efficiency in IT deployment in public and private sectors, influence the adoption of OSS in places such as France, Germany,

China and India (see, for example, Benssen 2002; Kshetri 2004; Mindel *et al.* 2007; Valimaki *et al.* 2005; Wheeler 2007).

Such initiatives as discussed above are likely to encourage SMEs to see OSS as a viable alternative to proprietary software, and therefore can influence their perceptions about the adoption of OSS. Drawing on these views, government initiatives, incentives and policies could influence SME adoption of OSS. However, even within the context of SME adoption of ICT, studies such as Simpson and Docherty (2004) suggest that there are criticisms of the effectiveness of government policies that help SMEs. Because of their relevance to government support for SME adoption of OSS, some of these criticisms are examined as follows.

Darch and Lucas (2002) suggest that SMEs that have sought to participate in government-backed initiatives have been disappointed with the IT capacity of the advisers in delivering advice and other information services relevant to the participating SMEs' business needs. This is consistent with the view expressed in Martin and Matlay (2003), which suggests that information from government initiatives and other business associations had proved insufficient or inappropriate for many SME business needs. This issue was also discussed in Blackburn and Athayde (2000), who acknowledge that government training initiatives should be considerate of SME ICT concerns, and also flexible and sensitive to SME financial burdens for ICT training.

The arguments presented above suggest that relevant and accurate professional advice or information from business advisers is important. Furthermore, the provision of business support which is focused specifically on the ICT needs of SMEs is also important. Hence, government initiatives that focus on such objectives can be successful in enhancing the adoption of OSS within SMEs. However, the criticisms discussed here have shown that government initiatives that are not well focused on important objectives can reduce SME confidence and potentially create barriers to their adoption of OSS.

2.4.2 Lack of Support

The second factor presented in Table 2.1 is lack of support, which fits within the environment context of factors because it relates to issues in the arena of the adoption of OSS, including access to human resources (such as external IT support) from suppliers (such as vendors and consultants) for the adoption of OSS, in the enterprise. Studies suggest that IT support is an important issue in SME adoption of ICT (Chester and Skok 2000; Simpson and Docherty

2004; Stansfield and Grant 2003; Stockdale and Standing 2004). Therefore it can be expected that availability of IT support for OSS will be an important factor for SME adoption of this type of ICT. As suggested by Fitzgerald and Kenny (2003), the availability of, and access to, adequate IT support plays an important role in assuring management and staff right across the organisation, especially during a major change in their ICT environment. Therefore, in this study, it can be deduced that IT support for SMEs is important for many reasons including the mitigation of complexities in their use, maintenance and customisation of OSS.

However, lack of adequate IT support has been reported as a major barrier for organisational adoption of OSS. Geira (2004) suggests that many organisations using OSS were concerned about the lack of support, and many organisations simply did not adopt OSS for this reason. Dedrick and West (2004) suggest that it can be difficult to find IT staff with the necessary skills to support the more complex requirements of some OSS, such as in a Linux environment. Wang and Wang (2001) suggest that technical support from commercial entities, for many OSS such as operating systems and application environments, was comprehensive but scarce.

Clearly, the lack of IT support for OSS can be problematic for SMEs adopting this type of ICT, particularly when such OSS adoption is vital for an SME's business. However, some studies suggest that there are many forms and sources of support which may meet SME needs. For example, Overby *et al.* (2006) suggest that sources of OSS support such as in-house IT support, the Open Source developer community, and commercial entities have been able to provide adequate services to support the adoption of OSS in the organisation.

Fitzgerald (2006), Geira (2004), and Wang and Wang (2001) also suggest that support for OSS can be sourced from individual developers, the Open Source community and commercial entities such as CSC, EDS, HP, IBM, Novell, and 'Red Hat'. They also suggest that such support may include training, documentation, real-time support, bug fixes and professional consulting. Dedrick and West (2003) suggest that small businesses may be happy with in-house support or support from the Open Source community partly because they lack the financial resources to buy support contracts from major IT vendors such as IBM, HP or SUN systems. These views suggest from a broader perspective, that different SMEs may have different needs for different types and levels of support in OSS adoption (Chester and Skok 2000).

As suggested by Dedrick and West (2003), some measures for getting external IT support for OSS may involve additional investment of SME resources (Holck *et al.* 2004; Kumar and Krishnan 2005). The use of scarce resources in IT adoption has often been a challenge for SMEs (Darch and Lucas 2002; Duan *et al.* 2002; Dutta and Evrard 1999; Robert *et al.* 2003). Thus, such initiatives will always require the engagement and support of SME-managers/owners where such individuals may display their innovativeness and entrepreneurship (Gelinas and Bigras 2004; Houghton *et al.* 2001; Martin and Matlay 2003).

2.4.3 Vendor Support

The third factor in the environment context is vendor support. Again, this factor is relates to issues in the arena of the adoption of OSS, including access to resources (such as OSS products and support services) from suppliers (such as vendors and consultants). Some studies suggest that vendors can influence SME adoption of ICT (Dutta and Evrard 1999). Such influence can drive SME initiatives to adopt ICT, or create barriers to SME adoption of ICT (Geira 2004; Glynn *et al.* 2005; Martin and Matlay 2003). This suggests that OSS vendors can facilitate SME adoption of OSS, and can also create barriers to SME adoption of OSS. For example, collaboration with OSS vendors can provide SMEs with access to a wide network of information and potentially increase its software platform past that initially envisaged by the SME (Dutta and Evrard 1999). Also, OSS vendors may be most effective in addressing SME concerns about their effective use of OSS by providing adequate support and providing adequate and relevant OSS products that meet the needs of SMEs (Dutta and Evrard 1999).

On the other hand, information services and products from OSS vendors can be too generalised to be sufficient and appropriate for particular needs of an SME (Dutta and Evrard 1999; Martin and Matlay 2003). SMEs may also face the vendor lock-in phenomena, which can make migration to OSS platforms costly in terms of human and financial resources, because of the vast amount of resources already invested in existing IT platforms (Fitzgerald and Kenny 2003; Glynn *et al.* 2005; Valimaki *et al.* 2005). Vendor lock-in can be seen as a strong barrier to SME adoption of OSS because many SMEs are sensitive to issues related to the use of scarce human and financial resources, which are characteristics of their small business size (Blackburn and Athayde 2000; Duan *et al.* 2002; Martin and Matlay 2001; Taylor and Murphy 2004).

2.5 Analysis of an Emergent Framework of Factors

Sections 2.2 to 2.4 discussed, from technological, organisational, and environmental contexts, factors that may influence the adoption of OSS by SMEs. This section brings together those factors into an analytical framework as illustrated in Figure 2.1. The framework allows us to examine, together, the factors and therefore better understand their interrelationships in the adoption of OSS by SMEs.

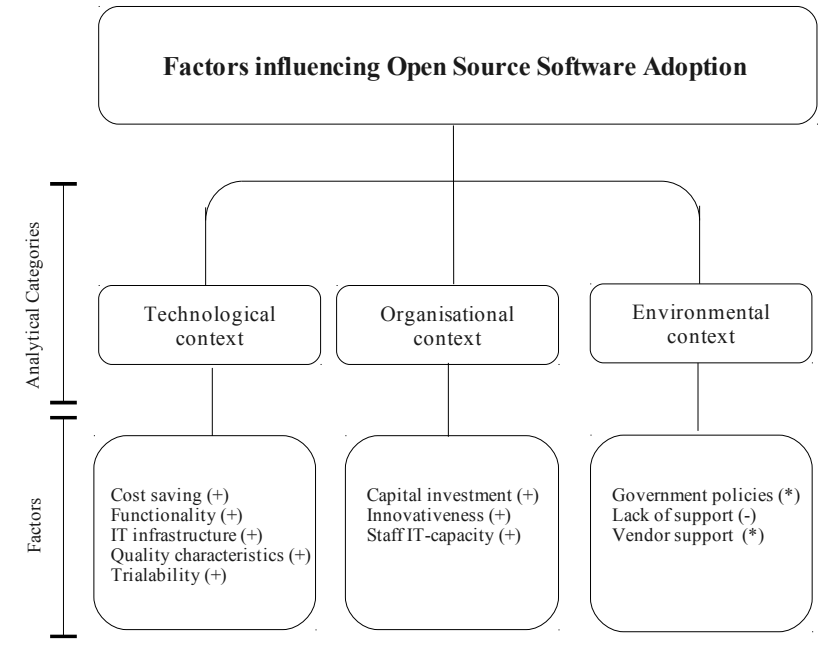

Figure 2.1 A Framework of Factors Influencing OSS Adoption by SMEs

Figure 2.1 shows that within the first category of technological factors, there are four factors: cost saving, quality characteristics, functionality, trialability, and IT infrastructure. These factors are related to particular attributes of an OSS which influence the adoption of the particular OSS. There are different types of OSS, say for example, OSS that supports platforms such as desktops, servers, and embedded systems. Therefore, such technological factors are likely to vary for different OSS. This variation is relevant because it suggests that technological factors are associated with particular attributes and characteristics of OSS (Rhodes and Corneya 2004; Gefen and Keil 1998; Taylor and Todd 1995b; Venkatesh and

Davis 2000). This contextual nature of the technological factors leads to subjectivity in the meaning of the factors and their influence on the adoption of OSS by SMEs. This argument on subjectivity is discussed in detail in section 2.5.2.

The second category in Figure 2.1 is organisational factors. There are three factors in this category: staff IT-capacity, innovativeness, and capital investment. These factors represent the SME's readiness or capability for OSS adoption. Studies show that SMEs vary from different perspectives such as ICT investment, human resources, and management innovativeness. Because such factors influence the adoption of ICT, these are likely to influence the adoption of OSS differently across varying SMEs. Therefore, such organisational factors are likely to vary for different SMEs. This variation is relevant for this research study because it also suggests that organisational factors are contextual (Rhodes and Corneya 2004; Gefen and Keil 1998; Taylor and Todd 1995b; Venkatesh and Davis 2000), leading to subjectivity in the understanding of such factors and their influences. This argument on subjectivity is discussed in detail in section 2.5.2.

The third category is environmental factors. As shown in Figure 2.1, there are three factors: lack of support, vendor support, and government support. These factors represents issues external to the organisation which can influence the adoption of OSS. Such environmental factors are likely to differ for different contexts of geographical, political, or business environments. Therefore, environmental factors influencing OSS adoption are likely to vary for SMEs in different locations or business environment. For this reason, we argue that environmental factors are subjective (Rhodes and Corneya 2004; Gefen and Keil 1998; Taylor and Todd 1995b; Venkatesh and Davis 2000). This argument is discussed in more detail in section 2.5.2.

From the discussions in the sections 2.2, 2.3 and 2.4, and the analysis of Figure 2.1, two key features of OSS adoption have emerged: the complexity of the adoption of OSS by SMEs; and the subjectivity of OSS adoption by SMEs. An understanding of these features is likely to improve our understanding of OSS adoption by SMEs. Therefore, we argue that these features are relevant for understanding the adoption of OSS by SMEs. For this reason, these feature will now be discussed in greater detail.

2.5.1 Complexity of OSS Adoption

From the discussions in section 2.5, complexity was identified as a feature associated with factors influencing the adoption of OSS by SMEs. Complexity in this study represents the

multiple factors and their different influences on the adoption of OSS by SMEs. We argue that complexity is a feature of factors and therefore relevant for understanding OSS adoption by SMEs. To support this argument, four reasons are discussed: the diversity of categories of factors; the diversity of factors; the differences or types of influences of the factors; and the interrelationships between factors.

The first reason for complexity is the diversity of categories of factors that influence the adoption of OSS by SMEs. As shown in Figure 2.1, OSS adoption is influenced by diverse categories of factors including technological factors, organisational factors and environmental factors. These diverse categories represent multiple perspectives of OSS adoption by SMEs. Because each perspective of adoption is important for understanding OSS adoption by SMEs as a whole, each category of factors is relevant in this study.

The second reason is that there are many and different factors that influence the adoption of OSS by SMEs. This is evident in Figure 2.1, which shows that even within a particular category there can be different and multiple factors that influence the adoption of OSS by SMEs. For example, cost saving is related to financial issues, quality characteristics are related to the features an OSS and functionality is related to the usefulness of an OSS to a particular user.

The third reason is the differences in the influence of factors that influence the adoption of OSS by SMEs. Based on the analysis of the factors as discussed in previous sections and as shown in Figure 2.1, factors influencing the adoption of OSS by SMEs can have different types of influence such as positive, negative and subjective influences. Positive influences such as that by cost saving may encourage adoption while negative influences may discourage adoption. Subjective influences may be positive or negative depending mostly on factors that are external to the control of the adopter such as the role of vendors and government bodies in supporting the adoption of OSS by SMEs.

The fourth reason is the interrelationships between factors, which represents the influence of one factor on another in the adoption of OSS by SMEs. Based on analysis of factors and the analytical framework in Figure 2.1, two reasons are discussed to support the argument that understanding any interrelationships between factors is important is this study. The two reasons are, first, the interrelationships between factors within a category and, second, the interrelationships between factors across different categories. These two reasons are now discussed as follows.

The first reason is the interrelationships between the factors within category. The discussions of factors and the analytical framework in Figure 2.1 suggest that within a category a factor may be interrelated with other factors. For example, within the technological factors, there is likely to be an interrelationship between cost saving and functionality factors. The interrelationship is that cost savings in adopting an OSS are likely to be relevant if its functionality is also relevant to an SME. Thus, the technological factors that represent benefits and risks in adopting an OSS are likely to be relevant to an SME if the OSS is essential for the SME's IT needs. Another example is that within the organisational factors, there is likely to be an interrelationship between staff IT-capacity, capital investment, and IT infrastructure. The reason for an interrelationship is that while staff IT-capacity is essential for OSS adoption, an SME may require capital investment for acquiring skilled staff or for training existing in-house staff.

The second reason is the interrelationship between factors across different categories. The discussions of factors and the analytical framework in Figure 2.1 suggests that a factor may be interrelated with another factor from other categories. For example, there is likely to be an interrelationship between an organisational factor such as staff IT-capacity and a technological factor such as functionality. The interrelationship is that an SME with the relevant staff IT-capacity may find the functionality of a particular OSS viable for their organisation. Another example is that some SMEs may be motivated by cost savings which is likely to have a positive effect on their IT capital investment. In such cases, the technological factor, cost savings, and the organisational factor, IT support, would be relevant in the organisational decision to use OSS.

The discussions above have argued that complexity is an important feature of OSS adoption by SMEs. The study of this important feature will enable us to better understand OSS adoption by SMEs. Therefore, exploring and understanding of the complexity of OSS adoption is relevant to this study.

2.5.2 Subjectivity of OSS Adoption

From the discussions in section 2.5, subjectivity was identified as a feature associated with factors influencing the adoption of OSS by SMEs. Subjectivity in this study represents the variation and contextual nature of key factors influencing OSS adoption across different SMEs. We argue that subjectivity is a feature of factors and therefore relevant for

understanding OSS adoption by SMEs. To support this argument, two reasons are discussed: the subjectivity of the different categories; and the subjectivity of influence of factors.

The first reason is that the three categories of factors, as shown in Figure 2.1, presents three perspectives of OSS adoption by SMEs. These are technological, organisational and environmental perspectives. Because these different perspectives lead to different contexts of OSS adoption by SMEs, we argue that the multiple perspectives represent the subjectivity of OSS adoption by SMEs. To better understand this subjectivity, these perspectives are now discussed in detail.

The first perspective is the technological perspective and represents a context of OSS adoption where the characteristics of particular OSS are the key issues that influence the adoption of the innovation. Thus, as shown in Figure 2.1, an SMEs may adopt an OSS primarily due to some technological factors such as cost saving, functionality and software quality. Because such contexts of OSS adoption focuses primarily on the influence of technological factors, this can be seen as a technology-fit strategy for SMEs' adoption of OSS.

The second perspective is the organisational perspective and represents a context of OSS adoption where the characteristics of a particular SME are the key issues that influence the adoption of the innovation. Thus, as shown in Figure 2.1, an SMEs may adopt an OSS primarily due to its capability or readiness to use such OSS. Such capability or readiness may be facilitated by organisational factors such as IT capability, OSS innovativeness, capital investment, and IT infrastructure. Because such contexts of OSS adoption focuses primarily on the influence of organisational factors, this can be seen as an enterprise-readiness strategy for SMEs' adoption of OSS.

The third perspective is the environmental perspective and represents a context of OSS adoption where issues within SMEs' environment or OSS community influences adoption. Such issues, as shown in Figure 2.1, may include IT vendor support for adopting OSS and government policies that influence the adoption of OSS. Because such contexts of OSS adoption focuses primarily on the influence of environmental factors, this can be seen as a social-integration based approach to adoption of OSS by SMEs.

The second reason why subjectivity is important in this study is the different influences that factors can have on the adoption of OSS by SMEs. The analysis of the factors and the discussions of the analytical framework in Figure 2.1 suggest two points about the type of

influences of factors. The first point is a fixed positive or negative influence and the second point is a dynamic or contextual influence.

The first point is that different factors may have a positive or negative influence on the adoption of OSS by SMEs. For example, Figure 2.1 suggests that while factors such as cost saving, functionality, quality characteristics, staff IT-capacity, OSS innovativeness, capital investment, and IT infrastructure can have a positive influence, lack of support from a technical point of view, lack of government and vendor support can have a negative influence on OSS adoption by SMEs. Thus, the mode of influence of a factor is dependent on the particular factor.

The second point is that some factors such as staff IT-support, capital investment, IT infrastructure, vendor support, and government support can have a contextual influence that depends on the particular context of adoption. For example, although organisational factors such staff IT-capacity, capital investment, and IT infrastructure facilitate adoption, problems with these factors may inhibit the adoption of OSS. Similarly, although vendor support and government support may encourage adoption, problems with vendors and lack of government support due to unfavourable legislation, may act as barriers to the adoption of OSS.

The discussions above have argued that subjectivity is an important characteristic of OSS adoption by SMEs. The understanding of this important characteristic enables us to better understand OSS adoption by SMEs. Therefore, exploring and understanding of the subjectivity of OSS adoption is relevant to this study.

So far, we have identified that subjectivity and complexity are important characteristics of OSS adoption by SMEs and, therefore, these are relevant for better understanding the adoption of OSS. Thus, it is important to consider these characteristics when developing a framework of OSS adoption by SMEs. However, previous studies on OSS adoption have mostly ignored the importance of understanding these characteristics of OSS adoption. This may be explained from different perspectives such as: the lack of common frameworks in the previous studies that investigate OSS adoption; and the lack of analytically generalisable theories that allow researchers to develop common conceptualisation of the OSS adoption phenomenon. In consideration of these lack of common theories and understanding of OSS adoption, and an appreciation of understanding the characteristics of OSS adoption, we argue that there is need to develop an adoption framework that takes these characteristics into consideration. This paves the way for the next section which discusses and justifies the need

for a theoretical approach to developing a framework for exploring and explaining OSS adoption by SMEs.

2.6 Towards a Theory-Based Approach for Evaluation of OSS Adoption

Following the analysis of factors and characteristics of OSS adoption in sections 2.2 to 2.5, we argue that there is a need to develop, in this study, a theory-based framework for exploring and explaining OSS adoption by SMEs. Although the framework in Figure 2.1 allows us to present factors and their semantic contexts of technology, organisation and environment (as used frequently in many OSS and other ICT adoption studies (see, for example, Dedrick and West 2003; Dedrick and West 2004; Glynn *et al.* 2005; Houghton *et al.* 2001; Kuan and Chau 2001; Overby *et al.* 2006; Robert *et al.* 2003), this framework lacks the construct validity and the capabilities of proven ICT adoption models and theories. In this study, the use of theoretical concepts has important implications for the validity and generalisability of a framework for exploring and explaining OSS adoption. This argument is consistent with many studies which suggests that the use of theoretical concepts improves the validity and generalisability of research design and empirical findings (see, for example, Eisenhardt 1989; Hoepl 1997; Miles and Huberman 1994; Patton 1990; Sandelowski 1995; Yin 1993, 1994).

In order to develop a theoretically-valid framework for exploring and explaining the adoption of OSS, it is necessary to apply a valid theory of OSS adoption. However, there seems currently to be no proven or validated theories on OSS adoption. The lack of such a theory is consistent with many studies which suggest that research in OSS adoption is still in its infancy and, therefore, that OSS adoption theories are still in development (Agerfalk *et al.* 2006; Dedrick and West 2003; Fitzgerald and Kenny 2003; Holck *et al.* 2005; Larsen *et al.* 2004; Overby *et al.* 2006).

Although there are a few studies (see, for example, Dedrick and West 2003) that have used theoretical concepts, including some from the Diffusion of Innovations (DOI) theory (Rogers 1983, 1995, 2004), to investigate the adoption of Open Source 'platforms', the DOI theory appears to be more suitable for predicting factors that influence the diffusion of an innovation (Bradford and Florin 2003; Rogers 2004; Wejnert 2002; Wilkinson 2005) than it is for exploring and explaining the adoption of an innovation. The differece between diffusion and innovation becomes even clearer as we examine their definitions.

Studies suggests that diffusion refers to a process through which an innovation spreads through communication channels over time among the members of a social system (Rogers 1995, 2004; Rogers and Scott 1997). This definition suggests an observation of an innovation as it spreads across a social system to new users and, therefore, a dynamic and external view of an innovation and its users and non-users within a social system. On the other hand, adoption refers to the decision processes from first knowledge of the innovation, through forming attitudes toward the innovation, to the decision to use or not use, to the implementation, and to the confirmation of this decision (Benbasat and Moore 1992; Roger 1995; and Taylor and Todd 1995a). This definition suggests an evaluation of an innovation to determine its use or rejection and, therefore, an internal view of the innovation from the perspective of a decision-maker. From the perspectives of these definitions, we argue that although the DOI theory has some theoretical concepts that may be useful for examining ICT adoption, the use of purpose-built ICT adoption theories is more likely to lead to a valid theoretical framework for this research study's aim and objectives (see section 1.4).

Many studies on ICT adoption suggest that there are other proven theories which are suitable for exploring and explaining ICT adoption (see, for example, Brown *et al.* 2006; Frambach and Schillewaert 1999; Horton *et al.* 2001; Hsu and Chiu 2004; Hwang 2005; Kwon and Chidambaram 2000; Ndubisi and Jantan 2003; Rawstorne *et al.* 1998; Wu and Wang 2005). Furthermore, many studies which have tested ICT adoption theories suggest that such theories have varying capabilities for exploring the complexity and subjectivity of factors that influence ICT adoption (see, for example, Ajzen 2002; Davis 1989; Rhodes and Corneya 2004; Gefen and Keil 1998; Taylor and Todd 1995b; Venkatesh and Davis 2000; Venkatesh *et al.* 2003). This leads us to argue that there are ICT adoption theories that may be suitable for exploring and explaining OSS adoption.

Based on the discussion above, we argue that the use of a suitable and proven theory will be of benefit in this study because this could lead us to better explore and explain factors that influence OSS adoption by SMEs. Hence, the next chapter will identify relevant ICT adoption models and theories, and select one suitable for this research study's aim and objective (see section 1.4). In doing so, lessons learnt in this chapter, such as the factors, categories and features of OSS adoption, will be applied in the next chapter in the selection and use of a suitable theory of ICT adoption for this research study.

2.7 Summary

This chapter has presented a critical literature analysis of diverse issues relevant to the adoption of OSS by SMEs. In doing so, background knowledge of issues that can influence the adoption of OSS by SMEs was gained. This provided an initial scope of issues relevant to the research objective to explore and understand factors that influence the and option of OSS by SMEs.

In this literature analysis, knowledge of factors from studies on SMEs' adoption of ICT and adoption of OSS were augmented. This has enabled us to identify factors within the context of ICT adoption by SMEs, but which appear to be relevant to the adoption of OSS. The factors were categorised according to technological, organisational and environmental contexts. The factors and their categories were used in developing an analytical framework of OSS adoption by SMEs in Figure 2.1. This was used as an analytical tool for discussions on features of OSS adoption by SMEs.

The analysis of factors, their contexts and the analytical framework suggests that complexity, subjectivity, and the interrelationships between the factors are important features of OSS adoption by SMEs. The relevance of these features were discussed as the diversity, variations, and cross-influences of factors that influence the adoption of OSS by SMEs. However, the limitations of the framework in terms of the scope of exploration and understanding of the three features, suggests that there is potential for a greater scope of understanding beyond.

In order to enhance our scope of exploration and understanding of OSS adoption by SMEs, it is argued that mature and proven theories on ICT adoption can be applied. This approach will provide an opportunity to use a suitable and proven theory that can enable better exploration and understanding of OSS adoption by SMEs. This approach also paves the way to the next chapter, where knowledge gained in this chapter will be applied in evaluating and selecting a suitable theory for better exploring and understanding OSS adoption by SMEs.

3

Conceptualisation of Open Source Software Adoption

3.1 Introduction

This chapter leads to the development of a research conceptual model. The need to develop a conceptual model stems from the limitations of the literature-based framework (see Figure 2.1 and section 2.5) for exploring and explaining the adoption of OSS. Thus, the conceptual model will represent the theoretical framework that will be applied better to explore factors and explain their influence on the adoption of OSS in this research study.

For this study, the Decomposed Theory of Planned Behaviour (DTPB) is chosen as the theoretical foundation that will be applied in developing the conceptual model. The justification for the choice of the DTPB will be discussed in an evaluation of ICT adoption models and theories. The discussion will show that the exploratory and explanatory capabilities were used as the key criteria for the comparison of ICT adoption models and theories which led to the selection of the DTPB. The discussion will also show that the factors identified in the literature analysis (see sections 2.2, 2.3 and 2.4) are used as contexts for the capabilities of the models and theories that will be evaluated.

Having justified the selection of the DTPB in this study, operationalisation of the DTPB for exploring OSS adoption in this study will then be discussed. The operationalisation will develop theoretical concepts and research propositions that form the conceptual model for this research study. The operationalisation will show that factors identified in the literature

analysis (see sections 2.2, 2.3 and 2.4) are again used to provide contexts for defining the theoretical constructs of the DTPB.

The aim of this chapter described above, leads to two key objectives: (1) to justify the selection of the DTPB as the most suitable ICT adoption theory to support the exploration and explanation of OSS adoption, and (2) to operationalise the DTPB for explotring factors and explaining their influence on the adoption of OSS The first objective will be covered in section 3.2 and the second objective will be covered in sections 3.3 and 3.4. These sections will now be introduced in greater detail.

Section 3.2 will present a justification for the choice of the Decomposed Theory of Planned Behaviour (DTPB) as the underlying theory that will be used in developing the research conceptual model. This section will argue for the validated exploratory and explanatory capabilities of the DTPB as the main criteria for its selection over other ICT adoption models and theories. In particular, the features of the DTPB that will enable the exploration of factors and an explanation of their influence on OSS adoption will be discussed.

In section 3.3, the discussion will focus on the operationalisation of the DTPB which leads to the development of research propositions and an emergent research conceptual model. For this operationalisation, two issues are considered. First, the DTPB constructs will be defined within the context of OSS adoption. The definitions will determine and distinguish the exploratory function of each theoretical construct. Doing so will establish the construct validity of each construct that will be featured in the conceptual model. The factors identified in the literature analysis (see sections 2.2, 2.3 and 2.4) will provide the contexts for defining the constructs that will be applied in developing the conceptual model.

Second, the nomological networks which represent the relationships between a theoretical construct and other constructs within the DTPB, will be used in developing research propositions. Thus, the research propositions will explain why factors influence the adoption process. The nomological networks also establish the construct validity in the research propositions and the conceptual model as a whole. This is important and shows a validity in the relationships between the theoretical constructs in the research propositions and the conceptual model as a whole.

In section 3.4, there will be two strands of discussion about the emergent conceptual model. First, the conceptual model will be presented as the theoretical framework that will be

applied in exploring factors and explaining their influence on the adoption of OSS. Second, the exploratory and explanatory capability of the emergent conceptual model will be discussed. This discussion will focus on the ability of the conceptual model to provide an understanding of the complexity and subjectivity of OSS adoption.

3.2 Justification for the Choice of the Decomposed Theory of Planned Behaviour

Many research studies in the field of Information Systems have identified and applied validated models/theories which were reported to enhance the reliability of research design and the validity of empirical findings (see, for example, Benbasat and Moore 1992; Burton-Jones and Hubona 2005; Gefen and Keil 1998; Horton *et al.* 2001; Madden *et al.* 1992; Mathieson *et al.* 2001; Ndubisi and Jantan 2003). Following in the path of such studies, we seek to identify and apply a model/theory, suitable for developing a reliable theoretical framework, which will enhance the reliability of the empirical research design and the validity of the research findings. For this reason, a variety of adoption models and theories will now be examined.

***Table 3.1** An Evaluation of Proven Adoption Model/Theories*

Model/Theory	Determinants of Intention			Scope of Decomposition
DTPB (Taylor and Todd 1995a; Taylor and Todd 1995b)	Attitude	Subjective norms	Perceived behavioural control	Attitude, subjective norm and perceived behavioural control
TPB (Ajzen 1985; Ajzen 1991)	Attitude	Subjective norms	Perceived behavioural control	N/A
TAM (Davis 1989)	Attitude	N/A	N/A	Attitude
TRA (Fishbein and Ajzen 1975)	Attitude	Subjective norms	N/A	N/A

As shown in Table 3.1, the models and theories being reviewed in this section include: the Technology Acceptance Model (TAM) (Davis 1989; Venkatesh and Davis 2000); the Theory of Reasoned Action (TRA) (Albarracin *et al.* 2001; Fishbein and Ajzen 1975); the Theory of Planned Behaviour (TPB) (Ajzen 1985; Ajzen 1991); and the Decomposed Theory of Planned Behaviour (DTPB) (Liker and Sindi 1997; Shih and Fang 2004; Taylor and Todd 1995a; 1995b). Studies of these models and theories suggests that the adoption of an innovation can be modelled based on a beliefs-intention-behaviour structure (see, for example, Burton-Jones

and Hubona 2005; Mathieson *et al.* 2001; Ndubisi and Jantan 2003; Rhodes and Courneya 2004; Riemenschneider and McKinney 1999; Sideridis 2005; Wu and Wu 2005). Therefore, this structure represents the exploratory and explanatory capability of the adoption models and theories and considered to be of value for exploring and explaining the adoption of OSS in this study. The beliefs element of this structure represents the determinants of intention in any of the models and theories. Although all four models and theories feature a beliefs-intention-behaviour structure, the determinants of intention vary across the models and theories and each determinant of intention has a unique exploratory and explanatory capability.

Many studies have observed that all three determinants of intention significantly influence the intention to use a particular innovation (see, for example, Albaraccin *et al.* 2001; Hsu and Chiu 2004; Rawstorne *et al.* 2000; Shih and Fang 2004). Therefore, it is important to review the determinants of intention in all four models and theories in Table 3.1. The TRA includes the determinants of intention – attitude and subjective norms – which are not decomposed in this theory. The TAM includes only attitude, which is partially decomposed (see, for details, Davis 1989; Venkatesh and Davis 2000). The TPB includes attitude, subjective norms and perceived behavioural control (PBC). The DTPB also includes all the three determinants of intention. Table 3.1 shows that unlike the TPB, all three determinants of intention in the DTPB are decomposed into their multi-dimensional belief structures (see, for details, Shih and Fang 2004; Taylor and Todd 1995a; 1995b).

3.2.1 Criteria for the Appraisal of Relevant Adoption Models

The discussions above suggests two important points: (1) that the determinants of intention provide a criteria for appraising the exploratory and explanatory capabilities of the four models and theories in Table 3.1 because of their variation across the models and theories and also because each determinant of intention has a unique exploratory and explanatory capability; (2) that the decomposition of the determinants of intention also provides a criteria for appraising the exploratory capabilities of the models and theories owing to three reasons which will now be discussed.

The first reason is that decomposition will provide clearer identification, analysis, and understanding of specific factors that influence the adoption of OSS, enhancing the construct validity which improves the reliability of empirical research design and the validity in the empirical findings (Benbasat and Moore 1992; Benbasat and Zmud 1999; Calder *et al.* 1982; Taylor and Todd 1995b). Furthermore, the monolithic determinants of intention (see Table

3.1) are complex and therefore are more appropriately presented as multi-dimensional belief structures (Taylor and Todd 1995a; Taylor and Todd 1995b; Venkatesh *et al.* 2003), overcoming the operationalisation challenges common with traditional intention models and theories, such as the TRA, the TAM and the TPB (Shih and Fang 2004; Taylor and Todd 1995a, 1995b). In contrast to decomposition, Taylor and Todd (1995b) warn that combining the cognitive components of belief into a single conceptual or cognitive unit could lead to invalid results.

The second reason is that decomposition enables the extension of the exploratory capability of a model/theory. This view is consistent with many studies that evaluated major models and theories of adoption and concluded that the decomposition of belief components in the DTPB extends its exploratory and explanatory capability (see, for example, Agarwal 2000; Hernandez and Mazzon 2007; Hsu and Chiu 2004; Lin 2007; Shih and Fang 2004; Tan and Teo 2000; Taylor and Todd 1995b; Venkatesh *et al.* 2003). Therefore, it is arguable that further decomposition, using belief structures such as trialability and observability (see the DOI model – Rogers 1983), might extend the exploratory capability of attitude in the DTPB. However, Taylor and Todd (1995b) suggest that existing belief structures of attitude in the DTPB were found to be most significant across various studies. Therefore, for developing a theoretical framework in this study, further decomposition appears to be unnecessary.

The third reason is that decomposition of the determinants of intention in the DTPB appears to allow for easier identification and implementation of cross-over effects, improving the explanatory capabilities of a model/theory (see, for example, Hsu and Chiu 2004; Pavlou and Mygenson 2006; Taylor and Todd 1995b). Such crossover effects provide extended explanation for the influence of factors and their belief structures on other determinants of intention (see Table 3.1) than the ones with which they have direct relationship (see, for details, Taylor and Todd 1995b).

3.2.2 Comparison of Exploratory and Explanatory Capability Across the Adoption Models and Theories

Having identified the determinants of intention and decomposition as criteria, these will now be applied in comparing the exploratory and explanatory capabilities of the models and theories in Table 3.1. The appraisal compares, in turn, the capabilities provided by each determinants of intention, comparing its decomposition across the models and theories in Table 3.1. This appraisal, which will now be explained, led us to select the DTPB to be the underlying theoretical framework in this study.

The first determinant of intention to be used in this appraisal is 'attitude', which is common across all four models and theories (see Table 3.1). Literature suggests that attitude can be used for identifying and understanding favourable or unfavourable attributes or characteristics of OSS, which influence its adoption (Ajzen 1985; Ajzen 1991; Davis 1989; Fishbein and Ajzen 1975; Taylor and Todd 1995a). Therefore, it is argued that attitude is relevant for exploring and explaining the influence of factors such as cost saving (see section 2.2.1), functionality (see section 2.2.2), and quality characteristics (see section 2.2.4).

Table 3.1 shows that the TAM and the DTPB decompose attitude into its belief structures. Although attitude in the TAM and the TAM2 are decomposed (Davis 1989; Venkatesh and Davis 2000), the decomposition of Attitude in the DTPB provides a better range of validated and consistent multi-dimensional belief structures (Shih and Fang 2004; Taylor and Todd 1995b). For the reasons discussed so far, it is clear that attitude is relevant for this study and its decomposition provides simpler belief structures which enhance the exploratory and explanatory capabilities of the DTPB for this study.

The second determinant of intention is subjective norms. Studies in ICT adoption suggest that an organisation may have normative beliefs, such that it perceives social pressures to use or not use an innovation (see, for example, Houghton *et al.* 2001; Poon and Swatman 1999; Venkatesh *et al.* 2003), suggesting that there are subjective norms within adopters' social environments which influence the decisions to use or not use an innovation. The literature analysis (in section 2.4) also discusses that factors – government policies (see section 2.4.1), vendor support (see section 2.4.2), and social agents (see Table 2.3) – which can influence the decisions to use an OSS. The factors discussed above can be classified as subjective norms because the factors are actors within the social environment but can influence the adoption of OSS by the organisation (Ajzen 1991; Taylor and Todd 1995a).

Table 3.1 shows that the TRA, the TPB, and the DTPB include subjective norm. However, the decomposition of subjective norm into normative influences based on peers and superiors referent groups, in the DTPB (Shih and Fang 2004; Taylor and Todd 1995a), provides better identification, analysis, and understanding of the perceived social pressures that can influence the adoption of an OSS. Thus, we have shown that subjective norm is relevant in this study, and its decomposition enhances the exploratory and explanatory capability of the DTPB for this study.

The third determinant of intention is the PBC and is included in the TPB and the DTPB (see Table 3.1). The PBC enables the identification and understanding of perceived control over ability or confidence, and resources that may facilitate or constrain the use of an OSS (Ajzen 1991; Taylor and Todd 1995a). Factors such as capital investment (see section 2.3.1), innovativeness (see section 2.3.2), staff IT-capacity (see section 2.3.3), and IT infrastructure (see section 2.2.3) fit with the PBC, suggesting that it is relevant in this study. Then, its decomposition also plays an important role in enabling better identification, analysis and understanding of such factors and their influence on the adoption of OSS. Therefore, we argue that the DTPB offers better capabilities for exploring such organisational factors and explaining their influence.

All three determinants of intention have now been shown to be relevant in this study. The decomposition of all the determinants in the DTPB has been argued to provide simple and standard multi-dimensional belief structures, making the DTPB the theory to provide the most exploratory and explanatory capability, over the other adoption model and theories shown in Table 3.1. This analysis is consistent with many studies that evaluated major models and theories of adoption and concluded that the theory, the DTPB, has a better exploratory and explanatory capability than the others (see, for example, Agarwal 2000; Hernandez and Mazzon 2007; Hsu and Chiu 2004; Lin 2007; Shih and Fang 2004; Tan and Teo 2000; Taylor and Todd 1995b; Venkatesh *et al.* 2003).

Having justified the selection of the DTPB, it will be used in developing research propositions for exploring factors and explaining their influence on the adoption of OSS. This leads to the next objective in this chapter, the development of research propositions that in turn leads to a research conceptual model.

3.3 Development of Research Propositions Using the Decomposed Theory of Planned Behaviour

This section leads to the development of research propositions by operationalising the DTPB – the theoretical foundation in this study. The research propositions will describe the theoretical constructs of the DTPB and their relationships, which will enable us to identify factors and explain their influence on the adoption of OSS. The constructs will be operationalised within the context of OSS adoption by SMEs, using the factors identified in the literature analysis (see sections 2.2, 2.3 and 2.4).

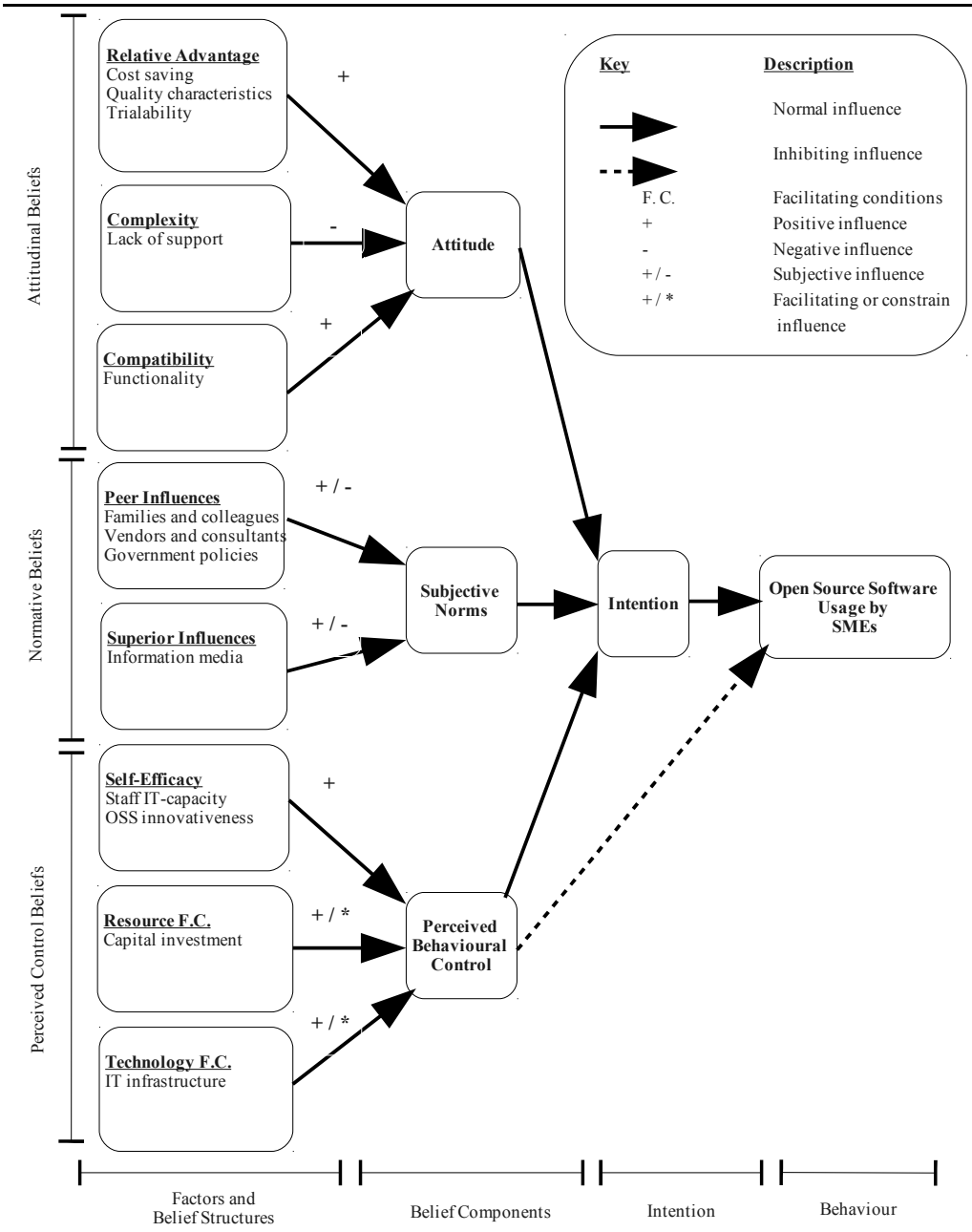

Figure 3.1 A Conceptual Model of Open Source Software Adoption by SMEs

The research propositions will be developed using the beliefs-intention-behaviour structure of the DTPB (Ajzen 1991; Shih and Fang 2004; Taylor and Todd 1995a; Venkatesh *et al.* 2003), to model the adoption of OSS by SMEs. Figure 3.1 illustrates four levels of constructs in the beliefs-intention-behaviour structure of the DTPB – 'belief structures', 'belief components', 'intention', and 'behaviour'. This structure of the DTPB will now be explained in detail, to better understand how it models the adoption of OSS in this study.

The first level in Figure 3.1 is the 'belief structures' and constitutes the multi-dimensional belief structures (Shih and Fang 2004; Taylor and Todd 1995a; Venkatesh *et al.* 2003), from the decomposition of belief components: relative advantage, complexity, and compatibility are the decomposed structures of 'attitude'; peer influences and superior influences are the decomposed structures of 'subjective norm'; and self efficacy, resource facilitating conditions, and technology facilitating conditions are the decomposed structures of 'PBC'. Thus, as explained in section 3.2, the belief structures are the 'simplest' theoretical concepts which enable accurate identification and classification of factors influencing the adoption of OSS in this study.

Figure 3.1 shows that the second level of constructs is the 'belief components' comprising of attitude, subjective norms, and perceived behavioural control (PBC) belief components, which are theoretical concepts that explain the influence of factors and classify such factors according to their underlying belief structures. The belief components are also the determinants of intention and, by having a direct influence on intention, each belief component will explain the influence of its associated factors on the intention to use OSS in this study.

Both the 'behaviour' level and the 'intention' level comprise of a construct of the same name. The third level of constructs in Figure 3.1 is intention with a construct of the same name and is the antecedent of behaviour in the next level. The direct relationship between intention and behaviour will explain the effect of factors and constructs influencing intention, on behaviour. 'Behaviour' is the fourth and last level in Figure 3.1 and represents the actual usage of OSS.

The constructs within all four levels in the structure of the DTPB, as introduced above, will be operationalised using two processes. In the first process, each construct is defined within the context of OSS adoption, distinguishing and differentiating it from other constructs and therefore enhancing the discriminant validity of the constructs in this study (Bagozzi *et al.* 1992; Benbasat and Moore 1992). The second process defines the interrelationships between the constructs and within the context of OSS adoption, establishing the external construct validity of the relationships between the constructs (Benbasat and Moore 1992; Calder *et al.* 1982), which is also a check of nomological validity (Bagozzi *et al.* 1992). The definition of the relationships or nomological networks forms the research propositions, which will be used to explain the influence of factors on the adoption of OSS by UK SMEs.

The constructs and the nomological networks in the DTPB will now be operationalised according to the belief structures within each belief component, in the following sections: attitude (section 3.3.1); subjective norm (section 3.3.2); and PBC (section 3.3.3). Following that, intention and behaviour will be operationalised in section 3.3.4.

3.3.1 Attitudinal Belief Structures

The attitudinal belief structures are associated with the first belief component in Figure 3.1, attitude, and that is defined as the perception (and evaluations or judgement) that the use of an OSS is favourable or unfavourable (Ajzen 1991; Benbasat and Moore 1992; Davis 1989; Taylor and Todd 1995b; Venkatesh *et al.* 2003). This definition supports the argument that attitude can be applied to explore innovation features (see section 2.2: cost saving, functionality, quality characteristics, and trialability) influencing OSS because such factors fit with the feature of perceived favourable benefits and unfavourable risks in the use of OSS. Because of the diversity and complexity of innovation features (see discussion in section 2.5.1), factors will be better explored using decomposed attitudinal belief structures. Doing so will allow better identification of the diverse and complex technological factors that lead to the formation of attitude. Therefore, attitudinal belief structures will be operationalised for this purpose.

Attitude is formed from the combined influence of factors from the attitudinal belief structures (Ajzen 1991). Based on the structure of the DTPB, and because it is a belief component, an emerged positive or negative attitude has a direct influence on intention (Ajzen 1991; Taylor and Todd 1995a; Venkatesh *et al.* 2003). This relationship leads us to the following proposition:

> **Proposition 1:** An SME's attitude towards the use of an OSS has a direct influence on intention.

This proposition explains the influence of attitude on the formation of intention. Therefore, it will explain how the combined influence of technological factors that lead to the formation of attitude will influence the formation of intention to use or not use OSS. The attitudinal belief structures – relative advantage, complexity and compatibility (Shih and Fang 2004; Taylor and Todd 1995a, 1995b; Venkatesh *et al.* 2003) – will now be operationalised in turn, identifying different technological factors and explaining how they influence the formation of attitude towards the use of OSS.

Relative advantage is defined as the degree to which an OSS provides benefits, including economic benefits, image enhancement, convenience, satisfaction and performance, which

supersede those of its precursor (Davis 1989; Rogers 1995; Taylor and Todd 1995a, 1995b). The analysis of the literature in Chapter 2 has shown that there are factors which we argue to be benefits that drive the use of OSS. Three examples of such factors, including cost saving, quality characteristics and trialability, will now be discussed to support this argument.

Cost saving (see section 2.2.1) is the first example of relative advantages in Figure 3.1. This factor is an economic benefit (Dedrick and West 2003; Fitzgerald 2004; Forrester Consulting 2007; Giera 2004; Larsen *et al.* 2004; Valimaki *et al.* 2005), related to the zero cost of OSS licenses. This factor is relevant, particularly to SMEs, which are sensitive to the need for capital investment in ICT adoption (Dutta and Evrard 1999; Houghton *et al.* 2001; Saloheimo 2005).

The second example in Figure 3.1 is the factor – 'quality characteristics' (see section 2.2.4). We argue that quality characteristics represents different types of benefit: reliability fits with a satisfaction benefit; configurability and Open-Standards fit with convenience benefits; and efficiency fits with performance benefit (Fitzgerald and Kenny 2003; Glynn *et al.* 2005; Mannaert and Ven 2005; Overby *et al.* 2006; Raja and Barry 2005; Wang and Wang 2001).

Trialability (see section 2.2.5) is the third example in Figure 3.1 and it fits with features of convenience and satisfaction benefits (Dedrick and West 2003; Kwan and West 2005). Trialability represents the convenience of testing an OSS to determine its suitability for the organisations' need. Also, the flexibility of trying an OSS before commitment to its full implementation in the organisation extends user satisfaction that the OSS is suitable for use in the organisation.

These example have shown the different types of benefits which fit with the features of the construct 'relative advantage'. Therefore, these factors are relative advantages that positively influence the decision to use OSS. Based on this argument and the relationship between relative advantage and attitude, we offer the following proposition:

> **Proposition 1a:** Relative advantages have a positive influence on an SME's attitude towards the use of an OSS.

This proposition means that relative advantage can be used in identifying factors which represent economic benefits, image enhancement, convenience, satisfaction and performance benefits from the use of OSS. It also provides an explanation of how factors representing such benefits influence attitude towards the use of an OSS.

The second belief structure in Figure 3.1 is complexity and is defined as the degree to which an SME perceives an OSS to be difficult to understand, learn or use (Rogers 1995; Taylor and Todd 1995a, 1995b; Venkatesh *et al.* 2003). We argued that the factor – 'lack of support' (see section 2.4.2) has a negative influence on the decision to use OSS, and will now provide justification for this argument.

The lack of support for an OSS can have a negative influence on an SME's decision to use an OSS because it increases the difficulty of using an OSS (Dedrick and West 2004; Fitzgerald and Kenny 2003; Geira 2004; Holck *et al.* 2005; Raja and Barry 2005; Wang and Wang 2001). Such difficulty is a feature that fits with the definition of complexity, suggesting that lack of support is a complexity factor, which has a negative influence on the decision to use OSS. In light of this argument and the relationship between complexity and attitude, the following proposition is offered:

> **Proposition 1b:** Complexity has a negative influence on an SME's attitude towards the use of an OSS.

Based on this proposition, complexity can be used in identifying factors that represent a difficulty in learning or using an OSS. The proposition also helps to explain how complexity factors contribute to the formation of attitude towards the use of an OSS.

Compatibility is the third belief structure in Figure 3.1 and is defined as the degree to which an OSS fits with an existing value, previous experiences or current needs (Rogers 1995; Taylor and Todd 1995a, 1995b; Venkatesh *et al.* 2003). Functionality (see section 2.2.2) was identified in the literature, and we argue that this factor has a positive influence on the decision to OSS. The justification for this argument is presented in the next paragraph.

Studies such as Dedrick and West (2003) and Overby *et al.* (2006) suggest that functionality is a factor that influences the decisions to use an OSS because an OSS would be more appealing to an SME if its functionality meets the SME's business values and needs. From this context, the fit of OSS to business values or needs is similar to the feature of 'fit with existing values or needs' from the definition of compatibility. Therefore, functionality of OSS is seen as a compatibility factor, which positively influences the decision to use the OSS. Thus, functionality should have a positive influence on attitude towards the use of OSS. Based on this argument and the positive influence of compatibility factors on the decision to use OSS, the following proposition is offered:

> **Proposition 1c:** Compatibility has a positive influence on an SME's attitude towards the use of an OSS.

This proposition means that compatibility can be applied in identifying factors which suggest that OSS fits with the existing values or needs of SMEs. It also provides an explanation of how such factors influence attitude toward the use of OSS, and therefore, how compatibility factors contribute to the formation of attitude towards the use of OSS.

3.3.2 Normative Belief Structures

The normative beliefs structures are associated with subjective norm, which is the second monolithic belief component in Figure 3.1 and is defined as the perception of social pressures on the decision-makers to use or not use an OSS in the organisation (Ajzen 1991; Roger and Scott 1997; Taylor and Todd 1995b; Venkatesh *et al.* 2003). This definition suggests that subjective norms can be applied to explore environmental factors, such as government support (see section 2.4.1) and vendor support (see section 2.4.3), because such factors originate from the social environment surrounding the use and adoption of OSS.

There is complexity in the influence of referent groups owing to the variation in the motivation to comply with particular referent groups (Taylor and Todd 1995b; Venkatesh *et al.* 2003), suggesting that different referent groups may have different level of influence on the decisions to use OSS. Due to this complexity, we argue that referent groups will be better identified using normative belief structures. Therefore, peer influences and superior influences will be operationalised for identifying environmental factors related to subjective norms about the use of OSS and explaining their influence.

The combined influence of environmental factors identified by peer influences and superior influences leads to the formation of subjective norms about the use of OSS. Consistent with the DTPB, Figure 3.1 shows that subjective norm has a direct influence on intention, leading to the proposition that:

> **Proposition 2:** Subjective norms about the use of OSS, have a direct influence on intention.

This proposition explains the influence of subjective norms on the formation of intention and, therefore, can explain how the combined influence of environmental factors that lead to subjective norms, influence the intention to use or not use the OSS. The decomposed normative belief structures – peer influences and superior influences – which will identify environmental factors, will now be operationalised in turn.

Peer influence is defined as the perception that peers, such as friends, families, and colleagues, influence the normative beliefs that using an OSS is good or bad for the SME

(Taylor and Todd 1995a, 1995b). Consistent with Ajzen (1991) and Taylor and Todd (1995b), we also argue that when there is high motivation to comply with actors in the social environment, such as vendors, consultants, and government agencies (see section 2.4), such actors can influence the decisions about the use of OSS. However, such actors can have different influences, as the following three example will show.

Studies suggest that family members, friends, and other actors within the social environment can influence the decisions of the manager/owner of a family-owned business to use or not use an innovation (see, for example, Brown and Venkatesh 2003; Houghton *et al.* 2001). This type of influence is relevant to the adoption of OSS because the manager of a family-owned SME is the decision-maker and a change agent (Gelinas and Bigras 2004; Martin 2005; Taylor and Murphy 2004), and family or business colleagues can influence the decisions of such person(s) to use or not use an OSS in the organisation.

A second example in Figure 3.1 is that vendors and consultants (see section 2.4.3 and Dutta and Evrard 1999), can provide facilities or professional information that aid the adoption of an OSS. However, the facilities and information provided may be inadequate and ineffective (Dutta and Evrard 1999; Martin and Matlay 2003), or inhibit flexibility and choice by lock-in or monopoly (Blackburn and Athayde 2000; Duan *et al.* 2002; Martin and Matlay 2001), constraining the successful use of OSS. This example shows that social agents, such as IT vendors and consultants, can influence the decision to use OSS in the organisation.

The factor, government policies (see section 2.4.1), is the third example of peer influences in Figure 3.1 and is discussed in some literature as government initiatives which promote ICT adoption in SME businesses (Martin 2005; Poon and Swatman 1999; Stockdale and Standing 2004). This factor was also discussed in terms of government legislations, such as the upholding of IP laws in the software industry (Benssen 2002; Kshetri 2004; Mindel *et al.* 2007; Valimaki *et al.* 2005). These perspectives suggest that government bodies can influence the adoption of OSS. Based on these examples presented to support the argument that different peers in the social environment may have different influences on the decisions to use OSS, we offer the following proposition:

> **Proposition 2a:** Peer influences have a subjective influence on the normative beliefs of SMEs about the use of OSS.

This proposition explains how peers within the social environment affect decisions to use or not use an OSS. Therefore, 'peer influences' can be used to identify peers, within the SME's social environment, that affect the decisions to use or not use OSS in the organisation.

The second belief structure of normative beliefs in Figure 3.1 is superior influence, defined as the perception that information from secondary sources, such as news on the Internet, TV, and newspapers, influences the normative beliefs that using an OSS is good or bad (Ajzen 1991; Brown and Venkatesh 2003; Taylor and Todd 1995b). Again, as a subjective norm, a high motivation to comply with such information will have an influence on the decision to use or not use the OSS in the organisation (Ajzen 1991, Taylor and Todd 1995b). The definition suggests that information from secondary sources, such as the Internet or other public media, can influence adoption. Studies suggest that there is theoretical justification for the influence of information media on the adoption of innovation and this will now be discussed to support the use of 'superior influences' in this study.

The diffusion of innovation theory (DOI) (Rogers 2004; Rogers and Scott 1997) suggests that the 'communication channel' is the second main element in the diffusion of innovation. The Internet is an important communication channel for the adoption and diffusion of OSS because it is the primary source of OSS products, and support information and services, accessible from the OSS communities. However, other information from the Internet, such as user forums, software benchmarking and marketing information from software competitors, vendors and consultants, may provide information that discourages the use of competing OSS, having a potentially negative influence on SME decisions to use OSS. Thus, information from media such as the Internet are superior influences that can influence the decision to use or not use OSS in the organisation. This argument leads to the following proposition:

> **Proposition 2b:** Superior influences have a subjective influence on an SME's normative beliefs about the use of an OSS.

This proposition explains how superior influences contribute to the formation of subjective norms about the use of OSS, meaning that superior influences can identify the SME perceptions of the secondary information sources which influence their decisions to use or not use an OSS.

3.3.3 Perceived Behavioural Control Belief Structures

The third belief component in Figure 3.1 is perceived behavioural control (PBC), associated with belief structures of the same name. This belief component is defined as an SME's perception of the control over the personal/internal or external factors that may facilitate or constrain the use of OSS (Ajzen 1991; Taylor and Todd 1995b; Venkatesh *et al.* 2003). This definition suggests that PBC can help us to identify controllability factors that represent an SME's capability or readiness, and understand how such factors affect its control over the use

of OSS. We argue that, owing to their subjectivity across different SMEs, organisational factors will be better explored using the decomposed belief structures of the PBC. Therefore, the decomposed belief structures of the PBC will be operationalised for identifying organisational factors.

Following that the PBC is relevant in this study, because it allows us to identify organisational factors that influence the perceived control over the use of OSS, the structure of the DTPB shows that perceived control also contributes to the formation of intention to use or not use OSS. This argument leads to the proposition that:

> **Proposition 3:** An SME's perceived control over the use of OSS has a direct influence on intention.

This proposition explains the influence of perceived control on the formation of intention. Therefore, the PBC can explain how the combined effects of organisational factors lead to the formation of intention to use or not use OSS. The belief structures of the PBC – self-efficacy, resource facilitating conditions (RFC), and technology facilitating conditions (TFC) (Taylor and Todd 1995b; Venkatesh *et al.* 2003) – will now be operationalised in turn, to enable the identification of the internal capabilities and resource conditions that can facilitate or constrain the use of OSS and the explanation of their influence.

The first control belief structure in Figure 3.1 is self-efficacy and is defined as the SME's personal/internal ability or confidence to use an OSS successfully (Taylor and Todd 1995b). Thus, self-efficacy represents an organisational capability for using an OSS and, consistent with Ajzen (1991) and Taylor and Todd (1995b), subjects with self-assured skills and confidence to use an OSS are more inclined to adopt it. This argument will now be supported with examples of the related organisational factors – staff IT capacity and OSS innovativeness.

Literature on general ICT adoption suggests that staff IT capacity (see section 2.3.3 and Blackburn and Athayde 2000; Darch and Lucas 2002; Duan *et al.* 2002; Houghton *et al.* 2001; Lawson *et al.* 2003; Martin and Matlay 2003), can influence the decision to use an ICT. This factor was also identified as influencing the usage of OSS (Fitzgerald and Kenny 2003; Geira 2004) and it is seen as a personal/internal ability that enables the use of OSS in the organisation. Thus, staff IT-capacity represents an aspect of self-efficacy in the use of the OSS.

The second example of self-efficacy in Figure 3.1 is the innovativeness of management and staff and this is seen as the confidence driving the use of an OSS in the organisation (see

section 2.3.2 and Dedrick and West 2003). Thus, OSS innovativeness represents the personal/internal confidence to use OSS in the organisation. In this context, OSS innovativeness is an aspect of self-efficacy in the use of the OSS.

Based on these examples of self-efficacy, we argue that if an SME has the relevant IT skills or staff IT capacity, or OSS innovativeness, this has a positive influence on its perceived control over the use an OSS. This leads to the following proposition:

> **Proposition 3a:** Self-efficacy has a positive influence on an SME's perceived control over the use of an OSS.

This proposition explains the effect of personal/internal factors on the perceived control over the use of OSS in the organisation. Thus, self-efficacy can be applied to explore related organisational factors that represent an SME's ability or confidence to use an OSS.

The second control belief structure in Figure 3.1 is resource facilitating conditions (RFC) and is defined as the supporting resources, such as time and money, that may facilitate or constrain the use of OSS (Taylor and Todd 1995b). This definition suggests that while resources such as time and money are essential in using OSS, a lack of them can inhibit its use in the organisation. Literature analysis suggests that capital investments (see section 2.3.1) is a resource related factor that can influence decisions to use an OSS, and this will now be discussed in the context of this study.

Capital investments can include money spent on supporting the use of an OSS (Dedrick and West 2003; Dutta and Evrard 1999; Kumar and Krishnan 2005; Martin and Matlay 2001; Robert *et al.* 2003; Saloheimo 2005). Thus, we argue that having capital investment, for the development of IT capacity by staff recruitment and training, and acquisition of relevant IT infrastructure, has a positive effect on the perceived control over the use the OSS. In this context, capital investment is essential for using OSS and, therefore, a lack of it has a negative effect on the perceived control over the use of OSS which could inhibit the use of OSS in the organisation. This argument leads to the proposition that:

> **Proposition 3b:** Having relevant resource facilitating conditions has a positive influence, while the lack of them has a constraining influence on an SME's perceived control over the use of an OSS.

This proposition explains how having relevant resources influences control over the use of OSS in the organisation and, therefore, RFC will be used in identifying the resource-related organisational factors that influence an SME's control over the use of OSS.

The third control belief structure in Figure 3.1 is technology facilitating conditions (TFC) and is defined as technology compatibility issues that may facilitate or constrain the use of an OSS (Taylor and Todd 1995b), suggesting that the TFC represents the access to IT infrastructures to support the use of OSS (Venkatesh *et al.* 2003).

Access to IT infrastructure was discussed in the literature analysis (in section 2.2.3) in terms of the availability of adequate IT hardware and support services, such as computer systems, network hardware and maintenance, and Internet connection. Mehrtens *et al.* (2001) also reported that access to adequate computer systems can enable the trial, and eventual adoption of Internet technology.

Thus, we argue that having relevant technological infrastructure has a positive effect on the perceived control over the use of OSS and that, a lack of it has a negative effect. This argument leads to the proposition that:

> **Proposition 3c:** Having relevant technology facilitating conditions has a positive influence, while the lack of these has a constraining influence, on an SME's perceived control over the use of an OSS.

This proposition allows us to explain the influence of having or lacking technological infrastructure on an SME's control over the use of an OSS and therefore TFC can be applied in identifying those organisational factors related to technology infrastructure that influence an SME's control over the use of OSS.

Taylor and Todd (1995b) suggest that a lack of the RFC or the TFC can be a barrier to the actual use of OSS. On the other hand, although having these facilitating conditions enhances perceived control over the use of OSS and contributes to the formation of intention to use OSS, they do not guarantee actual usage. Based on this discussion, we argue that a lack of any of the two facilitating conditions will inhibit the actual usage of OSS in the organisation. This argument leads to the proposition that:

> **Proposition 4:** Lack of facilitation conditions has an inhibiting influence on an SME's actual use of the OSS.

This proposition explains the effect of a lack of facilitating conditions on the actual usage of OSS in the organisation. It also shows that facilitating conditions are essential for actual usage of OSS and, therefore, represent critical failure factors in the adoption of OSS.

3.3.4 A Theoretical Definition of Intention and the Adoption of OSS

Having discussed and operationalised the belief components or determinants of intention (in section 3.3.1 to 3.3.3 and Figure 3.1), the next concepts in the DTPB structure are intention and behaviour, which will now be operationalised in the context of this study.

Intention is defined as an SME's evaluations or judgement that using an OSS is good or bad for the organisation (Ajzen 1991; Davis 1989; Taylor and Todd 1995a and Venkatesh *et al.* 2003). This definition shows that the cumulative influence of all belief components contributes to the formation of intention and, hence, the evaluations or judgement that using OSS is good or bad for the SME. The structure of the DTPB in Figure 3.1 (see, for discussions, section 3.3) suggests that the evaluations and judgement have a direct effect on the actual use of OSS because intention is an immediate determinant of behaviour (Ajzen 1991; Taylor and Todd 1995a). Thus, we propose that:

> **Proposition 5:** An SME's intention to use an OSS has a direct influence on actual usage.

This proposition explains the influence of SME's evaluations or judgement about using OSS on the actual use of it, showing that intention is a strong determinant of its use in the organisation.

The last concept in the structure of the DTPB in Figure 3.1 is behaviour and refers to the actual usage of OSS, which in this study is defined as the implementation of an OSS and the confirmation of its use in the organisation. This definition is based on the definition of adoption (see definitions in Benbasat and Moore 1992; Roger 1995; and Taylor and Todd 1995a, 1995b), which suggest that OSS adoption is the process through which an SME passes from first knowledge of OSS, to forming attitudes towards it, to decisions to use or reject it, its implementation, and to confirmation of this decision. These theoretical definitions set a clear meaning to the terms 'OSS usage' and 'OSS adoption', as used in this study. The definitions also show that OSS adoption is a decision process, involving the knowledge of the OSS, formation of attitude, decision to use or not use, implementation, and finally, a confirmation of the decision. The components of the decision process will now be discussed in the context of the concepts operationalised for modelling the adoption of OSS by SMEs.

The first decision process is knowledge of OSS, and fits with the need for self efficacy that stems from knowledge about how OSS is suitable for an SME, the potential benefits and challenges in using it, and the resources required for its successful implementation in the organisation. The second process is formation of attitude and fits with the cumulative effect of knowledge about OSS, leading to formation of attitude that its use in the organisation is

favourable or unfavourable. The third process is the decision to use or reject, and fits with the formation of intention to use or reject an OSS, following the formation of attitude, and a consideration of the perceived control or organisational capability to use the OSS and the subjective norms in the social environment which affect the perception that using the OSS is good or bad. The last process is the implementation and confirmation of use of OSS and refers to the usage of OSS. This final stage of adoption depends on the outcomes from the previous decision processes.

3.4 Discussions on the Research Conceptual Model

This section brings together the operationalised constructs of the DTPB and the research propositions (in section 3.3), forming the research conceptual model of OSS by SMEs (see Figure 3.1). This model is important for two reasons which will now be discussed.

First, the conceptual model is a theoretical framework for identifying factors that influence the adoption of OSS and explain their influence. In this context, the conceptual model allows us to explore factors and understand how such factors influence an SMEs' decisions to use or not use an OSS.

Second, the conceptual model provides the scope of the issues relevant to understanding the adoption of OSS and therefore provide a framework for developing empirical research to explore and understand such issues. Thus, the model will be applied in Chapters 4, 5 and 6 for developing data collection instruments, the analysis of empirical data, and the presentation of empirical findings.

The exploratory and explanatory capability of the conceptual model in Figure 3.1, which were important justification for the selection of the DTPB in section 3.2, will now be discussed to demonstrate its capability for identifying factors that influence the adoption of OSS and explaining their influence.

3.4.1 Exploratory and Explanatory Capability of the Conceptual Model

The exploratory and explanatory capability of the conceptual model is derived, respectively, from the 'beliefs' elements and the 'beliefs-intention-behaviour' structure of the model. The exploratory capability comes from the use of the 'beliefs elements' to identify and classify factors that influence the adoption of OSS. The explanatory capability comes from the use of

the 'beliefs-intention-behaviour' relationships to explain the influence of factors. The conceptual model will now be shown to use this capability in identifying factors and explaining how they influence the adoption of OSS in this study.

The conceptual model in Figure 3.1 represents the 'beliefs-intention-behaviour' structure, with the beliefs element represented as the decomposed belief structures and the belief components, the intention element represented as the construct of the same name, and the behaviour element represented as the usage of OSS. The decomposed belief structures in each belief component are used in identifying factors. Thus, we will discuss the exploratory function of the decomposed belief structures, in turn, for each of the belief components – attitude, subjective norms and perceived behavioural control. In doing so, the influence of the factors identified by each decomposed belief structure will be explained, showing the explanatory capability of each particular decomposed belief structure used in the conceptual model.

Attitude consists of three decomposed belief structures that enable the identification of the perceptions that the use of an OSS is favourable or unfavourable for the SME (section 3.3.1). The first belief structure – relative advantage – identifies factors such as cost saving (see section 2.2.1), quality characteristics (see section 2.2.4) and trialability (see section 2.2.5), which represent the perceived benefits that using an OSS supersedes those of its precursor. Relative advantage also explains that such factors have a positive influence on the adoption of OSS. The second belief structure is complexity and identifies factors such as 'lack of support' (see section 2.4.2), which represents the perceptions that an OSS is difficult to use or learn by the SME and it explains that such factors have a negative influence on the adoption of OSS. The third attitudinal belief structure, compatibility, identifies factors such as functionality (see section 2.2.2), which represents the perceptions that an OSS fits with the SME's existing values, previous experiences or current needs. This belief structure also explains that compatibility factors have a positive influence on the OSS adoption by the SME.

The cumulative influences from the three decomposed belief structures of attitude presented above leads to the formation of attitude towards the use of OSS (see Figure 3.1). Consistent with the 'beliefs-intention-behaviour' relationships, the conceptual model shows that attitude contributes to the formation of intention (see section 3.3.4), which is the evaluations or judgement that using the OSS is good or bad for the SME. Therefore, the attitudinal factors from relative advantage, complexity and compatibility, through the formation of attitude, contribute to the formation of intention to use or not use an OSS. From the formation of

intention, the direct relationship between intention and behaviour in the conceptual model shows that the attitudinal factors contribute to the actual usage of OSS (see section 3.3.4), which is the implementation of OSS and confirmation of the decision to use it in the organisation. This discussion has shown that the 'beliefs-intention-behaviour' structure can explain the influence of attitudinal factors on the adoption of OSS. Similar explanation will now be developed for the factors in the other belief components and their decomposed belief structures.

The second belief component is subjective norms and includes two belief structures that enable the identification of an SME's perception of social pressure, to use, or not use, an OSS (section 3.3.2). The first belief structure, peer influences, identifies the influences of factors such as friends, families and colleagues (see section 3.3.2), government policies (see section 2.4.1) and vendors and consultants (see section 2.4.3), which represent peers within the social system that influence the decision-makers to use or not use an OSS in the organisation. Peer influences explain that, cumulatively, such factors have a subjective influence on the adoption of OSS in the organisation. The second belief structure – superior influences – identifies factors such as information media (see section 3.3.2), which represent information from secondary sources such as TV, the Internet, or printed media, that influence the SME decision-makers to use or not use an OSS.

Again, the cumulative influences from peer influences and superior influences, as shown in the conceptual model in Figure 3.1, lead to the formation of subjective norms about the use of OSS in the organisation. The conceptual model also shows that subjective norms contribute to the formation of intention (see section 3.3.4) to use or not use an OSS. Therefore, the normative factors through the formation of subjective norms about the use of OSS in the organisation, contribute to the formation of intention. Again, owing to the direct relationship between intention and actual usage (see section 3.3.4), the influences of the normative factors contribute to the implementation and the confirmation of the decision to use OSS by the SME – the actual usage of OSS in the organisation.

The third belief component, perceived behavioural control, consists of three belief structures that enable the identification of an SME's perceived control over the factors that may facilitate or constrain the use of OSS in the organisation (see section 3.3.3). Self-efficacy is the first belief structure and identifies the influence of factors such as innovativeness (see section 2.3.2) and staff IT capacity (see section 2.3.3), which represent the SME's ability and confidence to use the OSS and explains that such factors have a positive influence on the

SME's control over the adoption of OSS in the organisation. The second belief structure is resource facilitating conditions and identifies factors such as capital investment (see section 2.3.1), which represent the availability or lack of resources, such as time and money, that enable or constrain the use of an OSS. This facilitating condition explains that such factors enable the use of OSS but a lack of them can inhibit its use in the organisation. The third belief structure is technology facilitating conditions, which identifies factors such as adequate IT infrastructure (see section 2.2.3), which represent the access to supporting technological resources that enable or constrain the use of an OSS. This belief structure also explains that while availability of such factors enables the use of OSS, a lack of them can inhibit the SME's use of the OSS.

From the discussion above, the cumulative influences of factors from the control belief structures – self-efficacy, resource facilitating conditions and technology facilitating conditions – leads to the perception of control over the personal/internal and external factors that facilitate and may constrain the use of OSS by the SME (see Figure 3.1). The conceptual model shows that perceived behavioural control contributes to the formation of intention. Therefore, the influences of the factors from the control beliefs contribute to the evaluations or judgement that using an OSS is good or bad for the SME. Again, owing to the direct relationship between intention and actual usage, the factors from the control beliefs contribute to the actual usage of OSS in the organisation (see section 3.3.4). The conceptual model shows that there can be a direct relationship between perceived behaviour control and actual usage of OSS, which can inhibit the actual use of OSS in the organisation. This inhibiting influence is due to the effects of a lack of facilitating conditions (see section 3.3.3), constraining the perceived control over the external factors that facilitate the use of OSS in the organisation.

The discussion above has shown how factors are identified using decomposed belief structures, leading to the formation of belief components of the related belief structures. The explanation has also shown that all belief components contribute to the formation of intention to use or not use an OSS. Because intention is the immediate determinant of actual usage of OSS, the cumulative influences of factors, through their belief components and intention, contribute to the implementation and the confirmation of the decision to use an OSS. The discussion has also explained why the actual usage of OSS can be inhibited by the constraining influences from the perceived behavioural control components, showing that although intention is the immediate determinant of actual usage, a lack of 'facilitating conditions' can inhibit actual usage of OSS in an organisation.

3.5 Summary

This chapter has discussed the selection and operationalisation of the Decomposed Theory of Planned Behaviour (DTPB), leading to the development of research propositions for exploring factors that influence the adoption of OSS and explaining their influence. The presentation of the research propositions together led to a research conceptual model of OSS adoption by UK SMEs.

The DTPB was chosen over other theoretical models owing to its enhanced exploratory and explanatory capabilities over other ICT adoption models and theories evaluated in this chapter. The importance of monolithic belief components was discussed, as criteria for the comparison of major ICT adoption models and theories and, were given as a justification for the selection of the DTPB in this study.

The used of the DTPB as an underlying theory led us to develop research propositions, which required the definition of the DTPB constructs and their nomological networks. Factors from the literature analysis in Chapter 2 were used to support the arguments leading to the research propositions. Together with the supporting factors, all the research propositions were presented as a conceptual model for exploring factors that influence the adoption of OSS by SMEs and explaining their influence. The demonstration of the exploratory and explanatory capabilities of research conceptual model has shown that it can be applied in exploring factors explaining their influence on the adoption of OSS.

The conceptual model developed also represent an analysis of the scope of technological, environmental and organisational issues relevant to the adoption of OSS by SMEs and, therefore, has implications for the scope and design of empirical research in the next chapters of this thesis. In this context, the conceptual model provides a theoretical framework which acts as an important empirical research focus, and useful for the scope and design of empirical data collection instruments and analysis methods in Chapter 4 and the reporting format for research findings in Chapters 5 and 6.

4

Research Methods

4.1 Introduction

Chapter 3 presented the development of research propositions which formed the research conceptual model of Open Source Software (OSS) adoption by SMEs. This chapter now focuses on the research methodology, with the three key objectives of establishing (1) the nature and focus of the empirical inquiry, (2) the empirical research instruments, and (3) the procedures, which will be applied in the empirical research. In doing so, this research methodology takes into consideration the research problem, as stated in section 1.4, and uses the research conceptual model (see sections 3.3 and 3.4), as an underlying framework for developing the data collection instrument and the data analysis framework. Thus, the research methodology also guides the design and procedures for the empirical data collection, the data analysis, and the framework for reporting emergent research findings.

In this research methodology, four important issues are considered, including a justification for taking an interpretivism research paradigm, the choice of a qualitative research mode, a justification for case study as the chosen research strategy for this qualitative research, followed by a presentation and implementation of the case study research design. These issues lead to the next four sections of this chapter, which will now be introduced.

Section 4.2 will discuss and justify the research foundations of this study. The discussions encompass three major issues. First, the elements of research paradigms chosen in this study, including the use of an interpretivist stance, are discussed because it establishes the relevance of the empirical research objectives, which aim to explore and explain factors influencing OSS

adoption by IT SMEs, to the research problem identified in section 1.4. Second, the choice of a qualitative research mode is discussed, explaining the need to apply a naturalist approach in exploring and interpreting factors observed in the empirical research. The choice of qualitative research mode also paves the way towards the selection of relevant research methods and procedures for representing that form of knowledge. The third major issue is a justification for the choice of the multiple-case studies research strategy, and focuses on the need to explore the adoption of OSS across multiple IT SMEs and allowing us to identify generalisable factors that may lead to the formulation of theories.

In section 4.3, the design of case study strategy will be discussed. The discussion encompasses three elements of the design of this multiple case study research: (1) the focus of the case study inquiry; (2) the fit of the research paradigm to the research focus; and (3) the sampling of empirical data and evidence for this study.

Section 4.4 will discuss the data collection methods and procedures applied in the field. The discussion focuses the justification for the selection of interviews as a primary data collection instrument and phases of interviews applied in this study.

In section 4.5, the techniques and procedures applied in the case study data analysis will be discussed. The discussion includes the techniques and procedures applied for data reduction, data displays and conclusions drawing in this multiple-case study research.

Section 4.6 will discuss the measures that will be taken to ensure rigour in this empirical research is presented. Research rigour in this study will focus on measures to enhance the credibility of the data collection and analysis processes, in an aim to ensure that OSS adoption by IT SMEs is properly represented. The research rigour will also consider the reporting format chosen.

4.2 Research Foundations

This section presents the methodological foundations underlying the empirical research. The methodological foundations, as shown in Figure 4.1, are important components of the design and the structure of the empirical research. The research paradigms which led to the selection of a qualitative research mode and a case study research strategy are introduced and justified in turn.

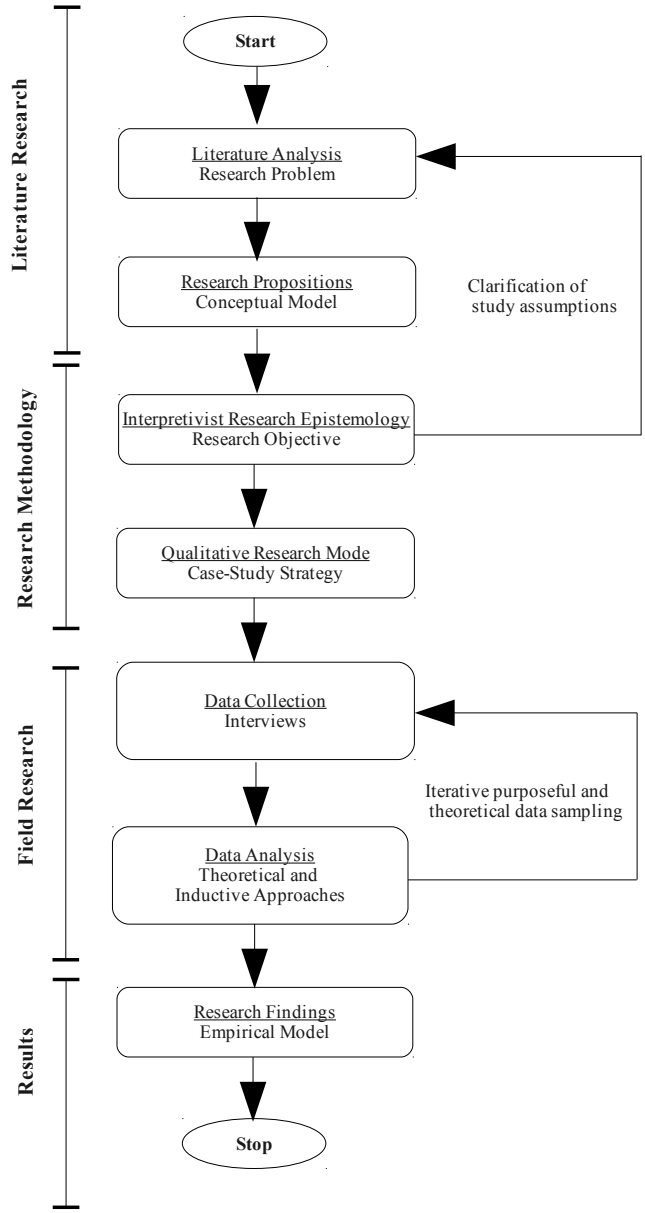

Figure 4.1 Research Design

4.2.1 Research Paradigms

The research design of this study, as illustrated in Figure 4.1, uses relevant research paradigms in representing different forms or meanings, philosophical perspectives, coherent foundations or assumptions about knowledge, how it can be created or obtained, its potential implications, possibilities and limitations (Guba and Lincoln 1994; Hirschheim 1985; Mingers 2003a; Mingers and Brocklesby 1997; Orlikowski and Baroudi 1991; Patton 1999; Spender 1998). Doing so is important because the research methods that are applied must take into

consideration the subjective and complex nature of factors and their influences on the adoption of OSS (Robert *et al.* 1987). Therefore, key elements of research paradigms, including ontology, epistemology, and axiology (Fitzgerald and Howcroft 1998; Mingers 2003; Mingers and Brocklesby 1997), were examined, and Figure 4.2 will be used as a guide to the discussions.

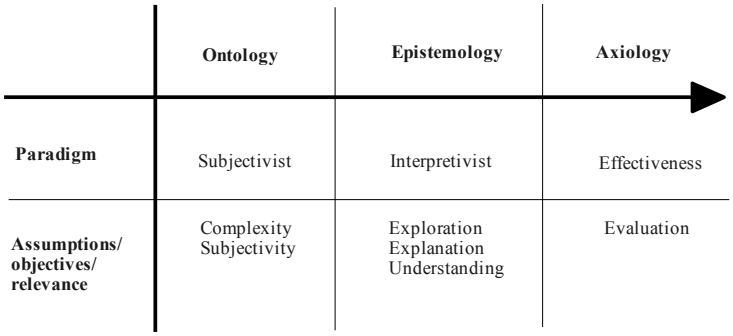

Figure 4.2 Research Paradigm

As shown in Figure 4.2, the first element of research paradigm, ontology, has been described as the type of reality assumed to exist and the nature or view of that reality, which can be objectivist with a singular or objective view of reality, and subjectivist with a multiple, individually or culturally constructed view of reality (Cepeda and Martin 2005; Fitzgerald and Howcroft 1998; Mingers 2003; Mingers and Brocklesby 1997; Sandelowski 2000). Clearly, a subjectivist stance is more consistent with the subjective and complex nature of the contexts and meanings of factors that influence OSS adoption (see section 2.5.2 and section 3.3). This is even so given that a subjectivist stance allows us to consider the complexity of factors that influence OSS adoption, and its subjectively multiple contexts with respect to the heterogeneous SMEs. This emergent ontology of complexity and subjectivity, on the nature of factors influencing the OSS adoption, has implications on epistemology in this study, which is the next element that will be discussed.

The second element of research paradigm shown in Figure 4.2 is epistemology, which has been described as a form of representation of reality, related information sources and how to obtain it, possibilities of and limitations on knowledge of that reality (Hirschheim 1985; Mingers 2003; Mingers and Brocklesby 1997; Myers 1997; Sandelowski 2000). These descriptions of epistemology present some issues that raise questions about research assumptions on knowledge, which has often led to choices of a interpretivist and positivist epistemological stances in MIS research fields (Fitzgerald and Howcroft 1998; Galliers 1992;

Guba and Lincoln 1994; Miles and Huberman 1994; Orlikowski and Baroudi 1991; Walsham 1995; Yin 1994). Therefore, these two approaches are examined within the context of the three issues relevant to the description of epistemology above.

The first issue is the form of representation of factors that influence OSS adoption. This form of representation must be consistent with the subjectivist ontology established earlier. Therefore, in consideration of the complex and subjective nature of context and meanings of the factors that influence the adoption of OSS, an interpretivist approach is selected because this accepts the complexity and subjectivity of the research phenomena (Fitzgerald and Howcroft 1998; Myers 1997; Sale *et al.* 2002), and thus it is consistent with a subjectivist view adopted in this study. On the other hand, a positivist epistemology would not be consistent here because it assumes an objective view (Metcalfe 2005; Sale *et al.* 2002) and thus would be more appropriate for simplification of the complexity of research issues to achieve control or quantification over such research issues (Fitzgerald and Howcroft 1998).

The second issue is identifying appropriate sources of knowledge on factors influencing OSS adoption and how to obtain it. First, due to their subjectivity and complexity, knowledge on factors influencing OSS adoption may be better explored from their multiple natural settings (Myers 1997; Sale *et al.* 2002). This is consistent with an interpretivist approach which places an emphasis on the realism of the contexts of the phenomenon, which here means the subjective and complex nature of factors influencing OSS adoption. Second, due to their subjectivity and complexity, knowledge about factors influencing OSS adoption may be better explored by capturing the subjective participants' complex experiences of OSS adoption, within their subjective, natural settings. This is also consistent with an interpretivist approach which allows knowledge to be explored from the multiple perspectives of the observer (researcher) and participants within the natural setting of the phenomenon (Fitzgerald and Howcroft 1998; Myers 1997; Robert *et al.* 1987; Sale *et al.* 2002). Thus, the researcher is also involved as a subjective observer focused on exploring, explaining, and understanding the factors influencing OSS adoption.

The third issue is a consideration of the possibilities of, and limitations on, knowledge (Mingers and Brocklesby 1997) of the factors, which can be assumed to be subjective to the views of the researcher and the participants within the natural contexts of OSS adoption. Such exploration of the possibilities and limitation of knowledge of the factors is relevant in this area of OSS adoption, which is still in its infancy (Agerfalk *et al.* 2006; Dedrick and West 2003; Fitzgerald and Kenny 2003; Holck *et al.* 2005; Larsen *et al.* 2004; Overby *et al.* 2006).

Therefore, exploring possibilities and limitations on knowledge of the factors can lead to a better understanding of the factors influencing OSS adoption. This fits with an interpretivist approach which accepts that knowledge can be gained through an appreciation of possibilities and limitations of known or new concepts as they emerge from empirical observations (Galliers 1992; Kaplan and Maxwell 1994; Yin 1994).

The third element of the research paradigm is axiology, which has been described as the relevance of knowledge to practice (Fitzgerald and Howcroft 1998), a purpose or value of the knowledge being sought, or how one should act in an informed and reflective manner (Mingers 2003; Mingers and Brocklesby 1997; Sandelowski 2000). Thus, as shown in Figure 4.2, the relevance of exploring and understanding factors influencing OSS adoption is the development of a framework for evaluation of OSS adoption. Such evaluation may provide insight into the effectiveness, ethical, or moral values (Habermas 1993) of OSS adoption. However, this research study is focused on developing a framework of empirical factors that can be used to evaluate the adoption of OSS by IT SMEs.

4.2.2 Justification for a Qualitative Research Mode

The choice of a qualitative research mode for this study, as shown in Figure 4.1, is consistent with this research's aims to explore, explain, and understand a complex phenomenon by considering the context of its settings (Fitzgerald and Howcroft 1998; Hannabuss 1996; Hoepfl 1997; Malterud 2001; Myers 1997). Four major reasons for the choice of a qualitative research mode (Tesch 1990; Trauth 2001), were considered in this study. The reasons, which are discussed below, include the research problem, the researcher epistemological stance, the discovery of regularity, and the degree of uncertainty surrounding the phenomenon.

The first reason for this choice of qualitative research mode is the research problem, which focuses on *what* factors influence the adoption of OSS, and also seeks to explain and understand *why* such factors influence the adoption of OSS by IT SMEs. These *what* and *why* questions are more appropriately approached using a qualitative research mode for two reasons below.

The first reason, based on the *what* aspect of the research question (see section 1.4), is that a qualitative research mode is able to accept the complexity and subjectivity (Myers 1997; Rouse and Dick 1994; Trauth 2001). The second reason, based on the *why* aspect of the research question, is that a qualitative research mode enables the researcher to use their observations and interpretations of the phenomenon (Lincoln 2002) to understand and

explain the many complex and subjective interactions within the natural settings of the research phenomenon (Cronbach 1975; Fitzgerald and Howcroft 1998; Hannabuss 1996; Hoepfl 1997; Trauth 2001). On the other hand, a quantitative research mode is not suitable for exploring or explaining the complexity (see section 2.5.1) and subjectivity (see section 2.5.2) within this research phenomenon. Rather, it is reported to be more appropriate for confirming or refuting *what* is already known, or formulating an objective theory about a predefined concept, following a process that reduces the complexity and subjectivity of the phenomenon (Fitzgerald and Howcroft 1998; Miles and Huberman 1994; Myers 1997).

The second reason for the choice of qualitative research mode is the researcher epistemology. The relevance of researcher epistemology in the choice of research mode has been reported in many studies on research method classifications in IS research (Fitzgerald and Howcroft 1998; Mingers 2003b; Myers 1997, Trauth 2001). As discussed in the previous section on research paradigm, this researcher epistemology, which is an interpretivist stance, aims to explore, explain and understand factors and why they influence the adoption of OSS. This epistemology is consistent with a qualitative research mode because qualitative research modes also help to explain and understand complex and subjective contexts of a research phenomenon through interaction with their natural settings (Hoepfl 1997; Ivankova *et al.* 2006; Minchiello *et al.* 1990; Myers 1997; Rouse and Dick 1994; Sale *et al.* 2002). On the other hand, this interpretivist epistemological stance is not consistent with a quantitative research mode because it is more focused on predictions by measuring predefined variables or testing particular hypotheses across a stated population (Hoepfl 1997; Ivankova *et al.* 2006; Myers 1997).

The third reason is that the qualitative research mode is suitable for the discovery of regularities, which is to identify and categorise the relevant elements of the phenomenon, leading to the formation of concepts and their interrelation into a set of generalisable propositions (Glaser and Strauss 1965; Tesch 1990). Therefore, it is argued that a discovery of regularity in this study is relevant because it may be the outcome of exploring factors, explaining and understanding why such factors influence the adoption of OSS by IT SMEs. Furthermore, concepts and interrelations that emerge from such discovery of regularities will help to develop empirically validated frameworks which help to explain and understand OSS adoption. This is in contrast to a quantitative research mode, which is more concerned with the discovery of facts about the phenomenon (Minchiello *et al.* 1990; Rouse and Dick 1994) and testing hypotheses across a sample population to achieve statistical generalisation (Hoepfl 1997; Meredith 1998; Strauss and Corbin 1990).

The fourth reason for the choice of qualitative research mode is the degree of uncertainty about factors influencing OSS adoption, which is relevant because studies suggest that research in OSS adoption is still in its infancy (Agerfalk *et al.* 2006; Dedrick and West 2003; Fitzgerald and Kenny 2003; Holck *et al.* 2005; Larsen *et al.* 2004; Overby *et al.* 2006). The literature analysis in Chapter 2 also suggests that there are knowledge gaps due to the lack of explanatory theories on the adoption of OSS. Therefore, as an exploratory study, this qualitative research mode will help to explore, explain, and better understand the factors and why they influence the adoption of OSS by IT SMEs. This argument is consistent with Strauss and Corbin (1990) who suggest that qualitative research can be used to better understand any phenomenon about which little is known. Hoepfl (1997) also suggests that qualitative methods are appropriate in situations where one needs to first identify the variables that might later be tested quantitatively. From this perspective, a quantitative research mode is not applicable because this focuses on confirming, testing or refuting existing theories or hypotheses about a stated population (Fitzgerald and Howcroft 1998; Mingers 2003b).

4.2.3 Justification for a Case Study Strategy

Many qualitative research strategies have been reported in the literature. For example, action research which enables the researcher to observe and to make objective changes to the phenomenon under investigation (Avison *et al.* 1999; Baskerville 1999), ethnography which enables the researcher to get immersed in the study phenomenon focused on people and culture (Myers 1999), grounded theory which emphasises that theory emerges from the empirical observations and interpretations (Corbin and Strauss 1990; Rouse and Dick 1994), and the case study strategy, which aims to investigate and understand a contemporary phenomenon within its natural context, especially when boundaries between the phenomenon and its context are not clearly evident (Eisenhardt 1989; Miles and Huberman 1994; Myers 1997; Yin 1993,1994).

Although the qualitative research modes mentioned above are applicable for investigating a phenomenon within its natural setting, Figure 4.1 shows that a case study strategy was chosen as a most suitable approach for this study for four reasons: (1) the research problem; (2) the degree of focus on contemporary events; (3) the extent of control over the phenomenon; and (4) the generalisation of findings (Eisenhardt 1989; Miles and Huberman 1994; Yin 1993, 1994). These reasons are discussed below.

The first reason is about the research question, aim and objectives (see section 1.4) which fits with the selection of case study strategy investigating OSS adoption because the strategy is suitable for exploring and explaining a contemporary phenomenon (Eisenhardt 1989; Miles and Huberman 1994; Yin 2003).

The second reason is the degree of focus on contemporary events in OSS adoption. This issue relevant here because the contemporary nature of OSS adoption, as a modern alternative software platform, and the fact that OSS adoption research is still in its infancy (Agerfalk *et al.* 2006; Dedrick and West 2003; Fitzgerald and Kenny 2003; Holck *et al.* 2005; Larsen *et al.* 2004; Overby *et al.* 2006) makes this IS research more appropriately investigated using the case study strategy since this is suitable for investigating a contemporary phenomenon where boundaries between phenomenon and context are not clearly evident (Eisenhardt 1989; Miles and Huberman 1994; Yin 2003).

On the other hand, the contemporary nature of OSS adoption and research in this field suggests that an ethnography strategy will not be appropriate here because this is more suitable for investigating people and cultures, and emphasises that the researcher immerses him/herself in to the research phenomenon (Myers 1999). Such immersion into the research phenomenon during the investigation has the potential to cause changes or conflicts, and hence influence the investigation. This leads to the third reason for the selection of case study strategy in this study.

The third reason is the extent of control over the phenomenon. As discussed above, ethnography suggests that the researcher has control over the phenomenon (Myers 1999). Similarly, an action research strategy emphasises that the researcher observes, but also manipulates the phenomenon being investigated (Avison *et al.* 1999; Baskerville 1999). While these strategies suggest control over the research phenomenon, the emphasis in this study is on understanding the complexity and subjectivity of OSS adoption within its natural context and and settings, and therefore with no researcher interference with OSS adoption in their natural context. Hence, the researcher will exert no control over contemporary events in this study.

The fourth reason is generalisation of findings, which enhances the development of a common understanding of OSS adoption. This is relevant because of the complexity and subjectivity of factors influencing OSS adoption (see sections 2.5.1 and 2.5.2) and which suggests that there are different perspectives to OSS adoption. This leads to the argument

that investigating the multiple perspectives of OSS adoption by a logical replication of its natural settings (Tellis 1997; Yin 1994, 2002) will provide a better understanding of OSS adoption. This logical replication can lead to a discovery of regularities or theories (Creswell *et al.* 2007; Tellis 1997; Eisenhardt 1989; Yin 1994) about OSS adoption, which means common explanations and understanding of OSS adoption, and thus theoretic generalisation (Eisenhardt 1989; Meredith 1998; Yin 1993, 1994) of explanations and understanding of OSS adoption. The use of logical replication to investigate multiple perspectives or settings of OSS adoption is consistent with a multiple-cases study strategy (Creswell *et al.* 2007; Yin 2003). Therefore this study adopts a multiple-case study strategy to investigate OSS adoption within multiple natural settings - across a sample of IT SMEs.

4.3 Case Study Strategy

This section presents the case study strategy, which acts as a blueprint that guides the field research processes involved in data collection and analysis, and the reporting of study findings (Gable 1994). Although field research issues such as a plan of the logistics during data collection, including scheduling and budgeting (Lincoln and Guba 1985) were considered prior to the empirical inquiry, such issues were not specifically determined because these issues were subject to circumstances around the researcher and the research participants. However, adequate financial arrangements, timing of appointments, and contact with participants were considered.

Studies of case study design (see, for example, Eisenhardt 1989; Gable 1994; Lincoln and Guba 1985; Yin 1994) suggest there are seven key design issues: (1) the focus of the inquiry; (2) the fit of the research paradigm to the research focus; (3) the sources of empirical data; (4) the instruments, plan, and recording modes of data collection including lines of inquiry, and measures for ensuring validity of data; (5) the phases of the inquiry; (6) the plan of data analysis procedures; and (7) the plan of techniques to determine case study quality and rigour. These issues were considered in this study and form the basis for the design of the field research for this case study strategy (see Figure 4.1).

4.3.1 Focus of the Inquiry

The first issue relevant to this multiple-cases research design is the focus of this inquiry. As shown in Figure 4.1, the literature research (encompassing Chapters 1, 2, and 3) is the background to the focus of this inquiry, and encompasses three important components

including the study question, research propositions, and unit of analysis (Yin 1994, 2003). These components will now be discussed in turn.

The first component of the focus of this inquiry is the research question (see section 1.4), which focuses on exploring factors that influence the adoption of OSS by IT SMEs, and is relevant here because it sets the same focus for this inquiry – to explore factors influencing OSS adoption by SMEs.

The second component is the unit of analysis in this study. We define the unit of analysis in this research study as *a factor that influences the adoption of OSS by an IT SME*. That unit of analysis is based on the research question (in section 1.4), and consistent with Yin (2003) who suggests that the unit of analysis is an event or entity that is likely to be at the level of the research questions. This unit of analysis is also evident from three different contexts. The first context is the identification and classification of factors in the literature analysis in sections 2.2, 2.3 and 2.4. The second context is the development of a theoretical framework suitable for exploring factors that influence OSS adoption by SMEs and explaining their influence. The third context is the centrality of the theoretical categories of factors in the design of data collection instrument, and data analysis and reporting methods and techniques for the empirical research.

The unit of analysis established in this study is important for two reasons. First, it helps to narrow the data collection within the limits that best meet the research aim and objectives (Yin 2003), and therefore, helps to focus the data collection on factors that influence OSS adoption by SMEs. Second, it serves as a criterion for comparing empirical findings in cross-case analysis, and across longitudinal studies (Yin 2003), and therefore allows us to use empirical factors and their categories as the basis for the analysis of empirical findings.

The third component is the research propositions developed in this study (see section 3.3) and is related to the conceptual model as shown in the literature research part of Figure 4.1. It follows that as an interpretivist study, the research propositions which were defined in section 3.3, help to focus the inquiry on the unit of analysis. Thus, there were no objectivist propositions or hypotheses defined with the intention of testing, confirming, or refuting such propositions or hypotheses, as is common with positivist studies (Ivankova *et al.* 2006; Myers 1997; Sale *et al.* 2002). However, as discussed in section 3.3, exploratory research propositions were developed and form the analytical framework that guides the design of qualitative data collection instrument and analysis techniques and procedures. In this study,

the research propositions developed in section 3.3 are exploratory in nature, and are not tested as would have been the case in a positivist research (Fitzgerald and Howcroft 1998; Hoepfl 1997; Myers 1997).

4.3.2 Fit of the Research Paradigm to the Research Focus

The fit of the research paradigm to the research focus is established for this study. The research question, research aim and objectives (both established in section 1.4) are associated with the research focus and allowed us to establish the fit of the research paradigm to the research focus. The research focus was also discussed in terms of the focus of this inquiry, where the research question (in section 1.4) was, again, argued to be an important issue for the focus of this inquiry (see, section 4.3.1). The research question, research aim and objectives were also the key justifications for the choice of the research paradigm (in section 4.2). Therefore, the research question, research aim and objectives are important links between the research paradigm established and the research focus.

4.3.3 Data Sampling

In the case study strategy, case sampling was applied to clarify the domain of this investigation on cases that are relevant to understanding OSS adoption by IT SMEs (Eisenhardt 1989; Mayring 2007; Miles and Huberman 1994; Yin 2003). Thus, logical replication (Coyne 1997; Eisenhardt 1989; Miles and Huberman 1994) was applied in selecting 10 UK SMEs in the IT industry. A case sampling boundary of 10 was set to help manage limited time, means, and the number of cases, which can be between four and 10 cases for a multiple-cases study research (Eisenhardt 1989; Miles and Huberman 1994). The 10 SMEs are then case subjects, and help to extend the discovery of factors that influence the OSS adoption.

The selection of the 10 IT SMEs as case subjects follows an application of a sampling frame (Miles and Huberman 1994), including purposeful, theoretical (analytical), opportunistic, phenomenal, deviant case, and maximum variation sampling (Eisenhardt 1989; Meredith 1998; Miles and Huberman 1994; Patton 1990; Sandelowski 1995). For explicitly justifying the selection of sample cases in this study, three sampling strategies were applied.

The first sampling strategy was a purposeful sampling, described as a flexible sampling technique (Coyne 1997; Miles and Huberman 1994; Patton 1990) applied to extend the richness of information for this exploratory study. It was applied as an initial sampling technique, to identify diverse UK IT SMEs willing to participate, as case subjects, in this

research study. Setting UK SMEs as a boundary for the purposeful sampling provided a general basis arguing for the analytical generalisation (Meredith 1998; Miles and Huberman 1994; Yin 2003), of the emergent factors influencing OSS adoption in this study.

Within the initial purposeful sampling of UK SMEs, further purposeful sampling was applied to select cases that have potential for rich information (Miles and Huberman 1994) and also focused on two issues related to the conceptual framework (Miles and Huberman 1994). The first was an organisational issue and the preference of an SME manager/owner as a potential rich source of information because such a person is a focal-point for all information and activities (Gelinas and Bigras 2004; Martin 2005; Taylor and Murphy 2004) and therefore able to contribute both as a participant and as an informant. The second issue was a technological issue, concerned with a preference of the OSS server technology platforms because there appears to be a higher adoption of OSS server platforms compared to a low, but rising adoption of OSS desktop platforms (Giera 2004). Therefore, this research is more likely to generate rich information by sampling case organisations that adopt OSS server platforms.

A second sampling strategy applied in this study was a maximum variation sampling (Patton 1990), which helps to justify the selection of a non-OSS adoption case. This sampling allows us to extend the variation of issues such as barriers or constraints to OSS adoption by IT SMEs.

The third sampling strategy applied was as emergent or theoretical (analytical) sampling (Meredith 1998; Miles and Huberman 1994; Patton 1990; Sandelowski 1995). This strategy allow us to pursue new cases based on insights from existing data. This sampling strategy allows us to justify the inclusion of cases where OSS applications are a core part of an embedded systems platform.

4.4 Data Collection Methods

Figure 4.1 shows that data collection was the first stage of field research that focuses on data gathering. The selection of a data gathering tool was influenced by the types of information necessary to explore, explain and understand the research phenomenon (Lincoln 2002) by representing the complex and subjective nature of context and meanings of the factors that influence OSS adoption. The complexity and subjectivity suggests a qualitative data source or qualitative evidence (Lincoln 2002). The literature suggests that there is a variety of qualitative data sources including documents, archival records, interviews, direct observation,

participant observation and physical artefacts that may be used (see, for example, Eisenhardt 1989; Miles and Huberman 1994; Yin 2003).

4.4.1 Interviews

As shown in Figure 4.1, the interview was the primary data gathering tool in this qualitative research study. It was undertaken as an interactive conversation with the participants and allowed us to pursue a guided and focused line of inquiry (Eisenhardt 1989; Miles ad Huberman 1994; Yin 2003). Interviews also provide opportunities to identify corroboratory or contradictory sources of evidence such as other respondents or data sources (Yin 2003). This is especially important because it reduces the risk of being overly dependent on a key informant (Yin 2003).

This study used the research propositions developed in section 3.3 as a framework for the initial or Open-ended interview questions (see Appendix A.3 – Interview Questions). Doing so focused the initial stages of the interview sessions towards exploring the key areas of OSS adoption suggested in the research propositions. Subsequently, other questions that arose from information obtained during the interview were also presented to the participant. This led to the use of open-ended, focused and structured interviews for capturing data from research participants. Their use is explained in the discussion on phases of the field inquiry, in section 4.7.

In this study, interview sessions were recorded and transcripts were developed from the audio recordings. The use of a digital audio recording device provided a more accurate form of storage of the conversations from the interviews. Transcriber (http://trans.sourceforge.net/en/presentation.php), which is an Open Source Software for audio transcription, was used for developing the transcripts. This transcription software provides standard text output with audio timing information and segmentation, which can be used to validate the transcript against its related audio segments. The signal noise management features in Transcriber allowed us to better improve the audio quality in some of the audio recordings which, in some instances, were poor.

The electronic storage media and use of Transcriber on the audio recording adds to the consistency in the data collection and analysis processes, and makes the methods easier to validate by other researchers. The audio recording and transcripts developed are important components of the case study database, which helps to establish data credibility and reliability of this multiple-cases research (Yin 1994, 2003; Eisenhardt 1989).

4.4.2 Phases of the Empirical Inquiry

In this qualitative research, data collection and data analysis processes overlaped (Eisenhardt 1989). This overlap is important for three reasons. First, it allows the research to take advantage of flexible data collection, which corresponds to a theoretical (analytical) sampling frame (see data sampling in section 4.3.3). This reveals helpful adjustments to data collection (Eisenhardt 1989). Second, it helps to speed up data analysis because data analysis starts when the initial or first batch of data is available, without waiting for a full set of case data. Third, it helps in the transition between any of the three phases of interviews (Yin 1994), which will now be discussed.

The first phase of interview was the open-ended interviews (see Appendix A.3 – Interview Questions). This was applied in the initial questioning sessions, to explore the core research problems based on the research propositions developed in section 3.3, and to identify other respondents and sources of evidence. Findings from the analysis of data may subsequently lead to new, interview questions and sources of evidence.

The second phase was the focused interview. This was applied to explore better understanding of particular issues identified from previously undertaken interview questions. The findings from such interviews may also lead to new interview questions.

The third phase was structured interview. This was undertaken to gather confirmatory data that would corroborate other evidence sources. Data collected from structured interviews may be quantitative and/or qualitative in nature, and thus is used for gathering organisational/demographic information. The analysis of such data may also form the basis for subsequent interview questions.

4.5 Data Analysis Techniques

Figure 4.1 shows the data analysis stage of field research, an important stage which processes data gathered and outputs the findings. The data analysis techniques discussed here are systematic procedures for analysing empirical data. The systematic procedures are important because they enhance credibility and dependability of the analysis process and the findings (Eisenhardt 1989; Miles and Huberman 1994; Yin 1994, 2003).

The analysis strategy applied in this study provides a guide for exploring meaning and understanding from the field data, logically presenting the empirical findings, and reporting

conclusions drawn from these findings. This analysis strategy is based on three concurrent flows of data analysis activities to achieve analytical generalisation (Benbasat *et al.* 1987; Miles and Huberman 1994; Yin, 1994). The data analysis activities are data reduction, data display, and conclusions drawing and verification (Miles and Huberman 1994; Yin 2003), and are discussed in turn below.

4.5.1 Data Reduction

Data reduction refers to the process of exploring meaning and understanding from qualitative data sources, and includes various iterative processes: data examination, sharpening, rearranging, focusing, categorisation, recombination, and selection (Baskerville 1999; Corbin and Strauss 1990; Hyde 2000; Miles and Huberman 1994; Myers 1999; Roberts and Wilson 2002; Tellis 1997; Thomas 2006; Yin 1994, 2003). These processes are applied in developing a data analysis procedure as shown in Figure 4.3, and consisting of five stages: initial set-up, data interpretation, categorisation, analytical generalisation, and factor definition. The initial three stages form the within-case analysis processes. The fourth stage forms the cross-case analysis processes. The fifth stage is a definition of emerged factors. These five stages are now described in detail.

The first stage of data reduction in Figure 4.3 is initial set-up and prepares the within-case analysis processes by specifying the case study objective and a definition of initial theoretical categories. Declaring the case study objective helps to focus the data analysis towards identifying units of analysis. The definitions of initial theoretical categories (see Appendix A.4 – Definition of Theoretical Constructs) provides a guide for interpreting units of analysis in the next stage.

The second stage in Figure 4.3 is data interpretation and focuses on identifying evidence within the data, using two processes. The first process is a close reading of a case transcript, involving reading and reflecting on the data and providing an in-depth understanding of the data as a stand-alone entity, allowing the researcher to become familiar with its complexity and contexts (Eisenhardt 1989). The second process is an identification of relevant text segments, focusing on deriving themes by identifying units of analysis in particular text segments. This process is guided by the researcher's knowledge and intimate familiarity (Bryman 2001; Roberts and Wilson 2002) with the unit of analysis (see, for example, sections 2.2, 2.3 and 2.4), and the understanding of the theoretical concepts (in section 3.3).

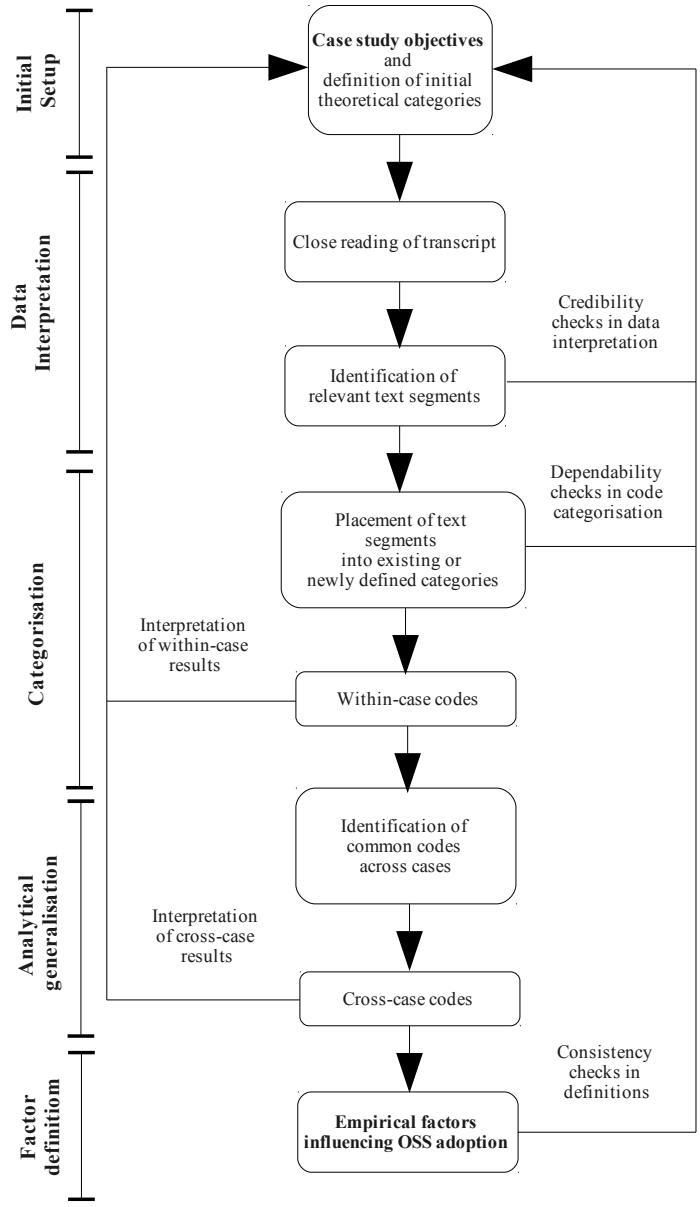

Figure 4.3 Data Analysis Procedure

Figure 4.3 shows that a credibility check is performed when relevant text segments are identified. In this context, credibility is a technique used for ensuring research quality and rigour and will be discussed in greater detail in section 4.6.1. Therefore, this check ensures credibility of the themes that are identified and used in creating codes and categories. The credibility check is performed by cross-checking the meaning of a text segment with meanings in similar themes or definitions of theoretical categories in the case-study database.

The third stage of data reduction in Figure 4.3 is categorisation. This focuses on using codes and categories for categorising segments of data identified in the previous stage. The codes and categories help to systematically organise themes that are identified. A theme is coded by linking a unique code to its related segment of data. Thus, each code is a unique identifier for a particular segment of data that represents a unit of analysis.

To develop a code for a theme by categorising it, the meaning in a segment of data representing the theme is compared to definitions of theoretical concepts in the case-study database. A match between the two will establish a theme, which is then coded in the next stage. A theme can also be identified by pattern-matching (Gable 1994; Mayring 2000; Tellis 1997; Yin 1994, 2003) between a segment of data and a previously coded theme. If a match is not established in the two approaches above, this will suggest the emergence of a new category of themes. In such a situation, the segment of data is coded and a new category is also created. This approach is consistent with an inductive analysis process (Hoepfl 1997; Mayring 2000; Thomas 2006), and is particularly important for developing categories based on new themes that emerge from the data. Codes are also created for theoretical concepts in the initial set-up stage, and these are used for categorising themes that match with the definition of a theoretical concept. Codes for the theoretical constructs have the same name as their theoretical constructs. Codes are also created for the new themes and their categories. The names for new categories are based on the first theme placed into the category.

Figure 4.3 shows that a dependability check is performed after codes are placed in relevant categories. In this context, dependability is a technique for ensuring research quality and rigour, and will be discussed in greater detail in section 4.6.3. Therefore, this check enhances quality and therefore confidence in the categories created and used for sorting the codes developed. The dependability check is performed by cross-checking that a code is placed in its correct category and that duplication of a category is avoided.

The third stage is categorisation, which is the last stage of within-case analysis, and allows us to organise text segments, codes and categories according to the cases. An iteration through the previous stages and processes extracts themes and develops related codes from all of the case study dataset. The tabulation of segments of text linked to themes, codes and categories enables quick search through a within-case analysis data set. Thus, all codes, categories and related segments of text are organised in flat files in the case study database, an approach that is particularly important for the next stage of analysis which focuses on identifying analytical generalisation (Benbasat *et al.* 1987; Yin 1994, 2003) across all cases.

The fourth stage of data reduction in Figure 4.3 is the analytical generalisation, which identifies common codes across cases, leading to a logical replication of the codes. Identifying analytical generalisation is important because it leads to the formation of strong evidence, from the triangulation of multiple sources of data (Guion 2002; Mayring 2007; Meredith 1998; Patton 1999), to support the definition of factors in subsequent stages of the data analysis. To achieve analytical generalisation, common codes and categories across all cases are identified and their frequency is noted in a cross-case frequency table. From that cross-case frequency, codes with high logical replication are selected since these show analytical generalisably of the theme represented by the codes. Furthermore, the selected codes provide strong evidence that can lead to definition of factors in the next stage of analysis.

The fifth stage in Figure 4.3 is the definition of factors, and develops theoretical definitions of the identified factors, which form components of this research's empirical theory of OSS adoption by SMEs. A definition for a factor is developed by creating a theoretical description of the theme represented by the codes, using the explanation of the theoretical category associated with the code. Thus, the theoretical categories provide a strong generalisable description in the definition, and the meanings from the text segments associated with the code provide the context for the emerged definition. The definition is enriched, repeatedly, using the data from similar codes and also checked for consistency with the definition of theoretical category associated with the factor. The emergence of the definition of factors ends the data reduction process.

4.5.2 Data Display

The second data analysis activity in this study is data display, which is an organised and compressed assembly of empirical evidence that leads to conclusion drawing (Miles and Huberman 1994). Data displays in this study provide a collective view of the empirical data, and this is important in order to conduct cross-case analysis that identifies trends across the multiple cases evidence.

Studies suggest that qualitative research studies use tables, extended text, matrices, graphs, charts, and networks (Eisenhardt 1989; Miles and Huberman 1994; Yin 1994) for data display. However, for this study, tabular displays were mainly used for the within-case and cross-case analysis, and matrix frameworks were also used for organising field data, factor codes, and category codes in the cross-case analysis.

4.5.3 Conclusions Drawing

This study uses an analytic strategy (Tellis 1997), which includes data reduction and data displays as discussed in the sections 4.5.1-2, and leads to conclusions drawing. The analytical strategy also relies on the theoretical framework (Yin 1994) developed in section 3.3, which provide a structure for the reporting of the research findings and conclusions drawing in this study. Thus, the conclusions drawing presents the factors identified from the cross-case analysis, using the theoretical framework to explain the factors and their influence on OSS adoption in this study. The empirical factors are displayed within the theoretical framework and ultimately represented in a diagram as the empirical model of OSS adoption by IT SMEs.

4.6 Research Quality and Rigour

Research quality and rigour in the design of this research is important and establishes the coherence, plausibility, sturdiness or instrumental utility, and consensus (Hoepfl 1997; Miles and Huberman 1994; Patton 1999) of research methods, and the conclusions that may be drawn from the field data and this study as a whole.

Studies have discussed different approaches for establishing research quality and rigour in terms of reliability (see, for example, Eisenhardt 1989; Yin 1994), and validity (see, for example, Guion 2002; Lincoln and Guba 1985; Tellis 1997). However, many of these studies use different perspectives, suggesting that quality issues in qualitative research are mainly subjective. Therefore, an augmentation of research quality and rigour issues were considered from an interpretivist and multiple-cases study research perspectives, leading to a framework for establishing research quality and rigour in this study. The framework consists of four elements of quality in qualitative research (Hoepfl 1997; Patton 1999) – credibility, transferability, dependability and confirmability. Although these elements are related to the domain of qualitative research, some studies suggests that some of these elements share meanings with quality issues such as internal validity, external validity, reliability and objectivity (Hoepfl 1997; Yin 1994), which are more common in the positivist or quantitative research literature. Thus, the quality elements that are to be discussed in this study should stand criticism from a positivist perspective.

4.6.1 Credibility

Credibility is the extent to which the realities from the multiple-cases are represented in this study (Hoepfl 1997; Patton 1999), and shows that the analysis and conclusions drawn in this

study relied on all the relevant evidence (Yin 1994). Credibility can be established by allowing public access to field data for inspection and criticism, and seeking corroboration of research findings from participants (Lincoln and Guba 1985). Various triangulation methods are discussed in the literature (see, for example, Guion 2002; Hoepfl 1997; Mayring 2007; Patton 1999), and the ones applied in this study are now discussed.

The first triangulation method is data triangulation, and involves the use of multiple sources of evidence (Guion 2002; Mayring 2007; Meredith 1998; Patton 1999). This study uses data sets from multiple IT SMEs to achieve analytical generalisation of factors. This study also applies multiple sources of knowledge from multi-disciplinary literature and theories on ICT adoption and diffusion to guide the analysis of data from different settings. Thus, there is a data triangulation in the data sampling (see section 4.3) and data analysis processes (see section 4.5) of this study.

The second method is investigator triangulation, which required multiple investigators/evaluators in the evaluation of the project. This method was problematic in this study owing to the limited size of the research team (a single researcher). However, design and progress of the empirical research were always monitored by an academic supervisor, final reports are published to the research community, and the project report is examined by another academic evaluator. Thus, it may be argued that investigator triangulation is established in this study.

The third method is methodological triangulation, involving the use of multiple research methods in this study. Although this is primarily an interpretivist qualitative study, the use of an initial theoretical framework for the design of the interview questions (see, Appendix A3 – Interview Questions), and an initial data analysis framework (in section 5.3), suggests a positivist approach to developing data collection instruments, and a deductive approach (Mayring 2000) to data analysis (in sections 5.4, 5.5, 6.3, 6.4, and 6.5). Thus, it is argued that multiple research methodologies were applied in this study, suggesting an application of methodological triangulation (Fitzgerald and Howcroft 1998; Hannabuss 1996; Myers 1997; Trauth 2001).

The fourth triangulation method is environmental triangulation (Guion 2002). This method involves the use of different participant environments, locations, and settings in which the study takes place. This is particularly relevant because, in addition to issues about the OSS, various other issues such as environmental factors (see, for example, section 2.4) and

subjective norms (see for example, section 3.3.2) were identified as influencing OSS adoption. Thus, a variation in the SME location was considered in sampling the study cases.

4.6.2 Transferability

Transferability refers to the generalisability of research findings across different settings, even beyond the immediate cases of a study (Hoepfl 1997; Malterud 2001; Metcalf 2005; Rowlands 2003). This is of particular relevance in this multiple-cases study which seeks to establish analytical generalisability across the cases. Thus, an initial indicator for transferability can be observed in the application of logical replication in the data sampling frame, as discussed in section 4.3.3.

Within the context of analytical generalisation, the conceptual model (see Chapter 3) plays an important role as an analytical tool for generalising findings from the different cases. Thus, the conceptual model also helps to establish transferability of findings within this study. Also, the publication of research findings, and an acknowledgement of generalisability of such findings within the research community, will ultimately be a better testimony of the transferability of this study to other studies of OSS adoption, or even other areas of technology adoption.

4.6.3 Dependability

Hoepfl (1997) suggests that dependability in qualitative research equals reliability. That view is consistent with Eisenhardt (1989) and Yin (1994) who suggest that both dependability and reliability aim to enable reviewers to examine the consistency of both the procedures and the conclusions of the research. In establishing dependability or reliability, Lincoln and Guba (1985) discuss the need for an inquiry, and Eisenhardt (1989) and Yin (1994) suggest the use of a case study protocol and a case study database. For this reason, a case study protocol was developed for this study and that will be discussed after a brief discussion about the case study database that was also developed for this study.

Case Study Database

The case study database provides an inquiry audit (Hoepfl 1997; Lincoln and Guba 1985; Yin 1994), which consists of raw data, analysis notes, data segmentation and coding products, process and personal notes, and preliminary developmental information. The case study database was implemented using a flat-file system that includes the use of the OpenOffice.org word processor and spreadsheet, to develop tables, matrices and figures. Original transcripts

were developed using transcription software – 'Transcriber' (http://trans.sourceforge.net/en/presentation.php). For compatibility with the transcription software, audio recording from case interviews were converted from 'wav' to 'ogg' audio format using the 'XMMS' (http://www.xmms.org/about.php) audio decoded/encoder. Both formats of the original recordings were retained as part of the case database.

Initially, the data analysis part of the case-study database was implemented using Nvivo (http://www.qsrinternational.com/products_nvivo.aspx), a computer aided qualitative data analysis system (CAQDAS). However, due to computer failure, and restrictions in portability of the proprietary software license, the use of this software was discontinued. Although Open Source alternatives including Weft QDA (http://www.pressure.to/qda/) and TAMS (http://sourceforge.net/projects/tamsys/) were identified, the lack of adequate software documentation, software complexity, and lack of time for the research to become familiar with the new software led to the use of flat file systems for the case study database.

Case Study Protocol

The case study protocol for this study is important because, first, it keeps the field work focused on the subject of the case study and the research methodology that is set out (Yin 2003). Second, it helps in anticipating several problems such as initial data management and the need to consider the audience for the research prior to report writing. Yin (2003) recommends that the case-study protocol of a carefully designed research project should have four important elements. These elements are implemented in this study and are discussed below.

The first element was an overview of this study, and includes project objectives and case study issues. Project objectives were first discussed in section 1.4, and also in sections 4.2.2 and 4.2.3, in the justification of qualitative research approach and the choice of a multiple-cases study strategy, respectively. Thus, a formal overview of the study has been established.

The second element was to establish field procedures, which give a guideline for conducting field work and dealing with constraints that are associated with the process of data collection (Yin 2003). By considering various field work issues and constraints (Yin 2003), a field procedure for dealing with such constraints is developed as follows.

The first issue was gaining access to key organisations or informants. For this, three documents were created: an information sheet (see, Appendix A.1 – Participant Information

Sheet); consent form (see, Appendix A.2 – Consent Form); and a statement of research ethics approval from the 'Brunel University Research Ethics Committee'. The information sheet was sent to various IT SMEs identified as potential sources of rich information. The IT SMEs were identified mainly through internet directories and by site visits within the local city centre. Other documents were presented to interview participants for their acknowledgement of research participation.

The second issue was having adequate resources while in the field. Various resources including recording devices, blank tapes, spare batteries, note pad and pen, and logistics arrangements, were organised prior to visiting case sites or arranging interview sessions. The interview participants were also notified of the interview sessions. A digital voice recorder was acquired as a replacement for the tape recorder due to poor quality of audio recording. The replacement proved effective with clearer recording and better recording editing functions and timing information.

The third issue involved developing a procedure for calling for assistance and guidance. For this, various methods including telephone conversations and email were applied to communicate potential problems to participants or a study supervisor, who could provide assistance, and also discuss progress of the field work.

The fourth issue was providing for unanticipated events, including changes in the availability of interviewees as well as changes in the conditions of the researcher. The scheduling of interviews were made flexible to accommodate changing situations with participants. The research supervisor was also consulted in the event of any constraint or circumstance that hindered the progress of the field work. These issues represent measures for dealing with issues that may constrain the progress of the field work. Therefore, these ensure that adequate contingency plans were considered.

The four issues discussed above establish the field procedures applied in this case study inquiry. Arguably, the procedure established provides a guide for conducting the field work and dealing with constraints, therefore enhancing the validity of the case study design (Yin 2003).

The third element of this case study protocol was to specify field questions which the investigator must keep in mind during data collection. Yin (1994) suggests that case studies need to consider important questions at five different levels. Level one is concerned with

questions asked of interviewees (see, for details, Appendix A3 – Interview Questions), which explore information regarding participants' reactions and feeling; changes in attitudes, perceptions or knowledge; changes in skills, and effectiveness of their use of OSS). Level two is concerned with questions asked of an individual case study (see, research question in section 1.4) and provides an analytical view of OSS adoption within individual case organisations. Level three is concerned with questions asked across multiple-case enquiries (see, also, research question in section 1.4), and provides a cross-case view of OSS adoption by the participant IT SMEs. Level four is concerned with questions asked of this entire study and provides an answer to the research question, research aim and objectives (in section 1.4). Level five is concerned with questions asked that lead to research recommendations and conclusions beyond the scope of the study, which will be addressed during discussions about the research findings in Chapter 6 and conclusions drawing in Chapter 7.

The fourth element of this case-study protocol was a guide for the case study. The guide developed for this study includes an outline and format for the case study narrative. This element is addressed in section 4.5.2 and 4.5.3 in the discussions on data displays and conclusions drawing.

4.6.4 Confirmability

Confirmability refers to the degree to which the researcher can demonstrate neutrality of the research interpretations through a confirmability audit, which is an audit trail of various research elements including raw data, analysis notes, data segmentation and coding products, analysis process notes, personal notes and preliminary developmental information. These research elements are contained in a case study database, which was discussed sections 4.6.3, as a component for establishing research dependability. Thus, the confirmability of this study is already established because various research elements in the case study database demonstrate neutrality of the research interpretations.

4.7 Summary

This chapter has established the empirical research methodology that will guide the field exploration of factors influencing the adoption of OSS by IT SMEs. The methodology established is an interpretivist, qualitative research and applies a multiple-case study strategy.

The interpretivist stance was taken based on arguments made about the research question, an understanding of the complex and subjective nature of OSS adoption from the analysis of the

literature (in Chapter 2) and the exploratory nature of the research propositions and conceptual model (both in section 3.3). The interpretivist stance taken and the research question and research aim and objectives, also influenced the choice of qualitative research mode in this study.

As a qualitative research and an interpretivist exploratory study, a case study strategy was argued to be fit for this research study. In particular, the multiple-cases study strategy was applied, to enable the development of a theory, by identifying analytically generalisable set of factors influencing OSS adoption by SMEs. In selecting the cases for this strategy, a purposeful and the theoretical (analytical) sampling techniques were applied, leading to the selection of information rich cases that provided the logical replication of factors in this study.

The interview was selected as the primary data source for the empirical inquiry. The concepts of the conceptual model were applied in developing the initial interview questions. This ensures that the field inquiry will focus on the most relevant aspects of OSS adoption. Field procedures were also developed to mitigate difficult situations or take opportunity of favourable situations that may develop during the filed inquiry.

The analysis of empirical data used a procedure that supports both a within-case and cross-case analysis, and encompasses three stages, namely initial set-up, interpretation, and categorisation. These stages allow us to set-up the empirical research objective and theoretical concepts that guide the inductive or theory-based interpretation of raw data, and the categorisation of emergent themes.

The theoretical concepts defined in the set-up stage facilitate a cross-case comparison that will lead to the identification of common themes and categories. This is an important process of analytical generalisation of findings from the multiple cases, and thus offers the potential to generate related theory of factors that influence the adoption of OSS by IT SMEs.

The conceptual model will also be applied as the basis for an analytical sequence for reporting the research findings from both the within-case and cross-case analysis. Thus, the report format will focus on presenting attitudinal, normative, perceived control, and other emergent categories of factors.

For this study, various issues regarding the quality of research design, field instruments and procedures, and ensuring validity of research findings were considered. This led to

establishing measures for research credibility and dependability. Measures established to ensure credibility included data, theory, and methodological triangulations. However, the applicable forms of triangulation were limited by a one-man research team. Measures established to ensure credibility include the development of a case-study research protocol and a case-study database.

Although theories on qualitative research methodologies are still developing, the instruments and procedures for this field inquiry were developed based on systematic and proven techniques. Thus, there is a strong argument for the credibility and dependability of the results that will emerge from this study. Now, the research instruments and procedures have been introduced, the next chapter will discuss the findings following their application in the field inquiry.

5

Data Analysis

5.1 Introduction

Chapter 4 presented the empirical research methodology that was applied in gathering qualitative data for this study. This chapter now presents the analysis of that empirical data, leading to the identification of factors influencing the adoption of Open Source Software (OSS) by the IT Small to Medium sized Enterprises (SMEs) sampled in this study. The identification of factors represents the first part of the research findings and fulfils the first objective of this study, which was stated in section 1.4.

In this chapter, there are four key issues related to the analysis of the empirical data. The first issue is the preparation of the empirical data and this focuses on the rich and diverse sampled cases and the development of quality interview transcripts. The second issue is establishing a theoretical framework for the analysis of the empirical data. The Third issue is the use of within-case analysis to initially interpret the empirical data and identify factors within each of the 10 case transcripts in this study. The fourth issue is the use of cross-case analysis processes to collate similar factors leading to the identification of analytically generalisable factors which form important components of the research empirical model of OSS adoption in this study. These issues lead to the four key sections of this chapter which are explained as follows.

Section 5.2 presents the sampled cases in this study and the development of transcripts from the interview sessions associated with each sampled case. This is important for two reasons. First, it shows that the sampled cases provided rich and diverse but comparative information

relevant to factors that influenced the adoption of OSS by the case participants. Second, the transcripts developed provided a structured form of the empirical data which is a key input to the data analysis processes in this chapter.

In section 5.3, the theoretical framework applied in the data analysis processes in this chapter is discussed. The framework is used in this chapter as an analysis tool for the identification and classification of evidence identified in the empirical data. The use of the framework is argued to enhance rigour in the analysis of the empirical data, increasing the credibility of the research findings.

Section 5.4 presents the within-case analysis of the qualitative data. The within-case analysis stage aims to identify and categorise factors that influence the adoption of OSS in each of the 10 case organisations. In doing so, this analysis stage extracts evidence about factors from the case transcripts. This is guided by the use of an analysis tool, which is the conceptual model that was developed in Chapter 3. This model is used here because it provides a theoretical approach to the interpretation of the evidence in the case transcripts. By using this model as an analysis tool, a corresponding framework of emerged factors is developed for each of the 10 cases in this study.

In section 5.5, the cross-case analysis stage of this qualitative data analysis is presented. The cross-case analysis brings together the factors that emerged from the within-case analysis of all 10 cases in this study, leading to the development of analytically generalisable theories that represent the factors that influence the adoption of OSS in this study.

5.2 About the Empirical Data

This section will discuss the sampled cases in this study. The discussion presents the sampled SMEs and discusses the similarities and variations in the empirical data. It also discusses the approach used to ensure high quality in preparing the qualitative data used in this study. This will show that a rich and diverse set of sources of information is applied in this study, which is important in establishing the credibility of the research data and the research findings that emerge from the analysis of the data.

5.2.1 Selection of Study Cases

The research findings that are presented in this chapter are based on 10 sampled cases and are summarised in Table 5.1. Although 15 cases were observed in the entire study, a

maximum of 10 cases were selected because these provided the richest and adequate data for this study and allowed us to be consistent with a recommended maximum number of cases for a multiple cases research study (Eisenhardt 1989; Mayring 2007; Miles and Huberman 1994; Yin 2003).

***Table 5.1** Summary of Research Cases*

Case	Business Area	Server Apps	Enterprise Apps and API	Databases	Email and Web Apps	Workstations	Business Location
C01	Consultant		OpenOffice.org, SugarCRM, and Vim editor	PostgreSQL	Firefox and Thunderbird	Debian	London
C02	Server and embedded systems consultancy	Web server	Compiler tool chains	Database servers			East Sussex
C03	Support services, initial consultancy and configuration	Apache, Exim, and Tomcat	OpenOffice.org, PhP, and Ruby		Thunderbird	Ubuntu (Mac)	Manchester
C04	Developers	Apache	PhP5	MySQL		Debian, Gnome, and Slackware	Wakefield
C05	Developers of ARM chip software	Apache	OpenOffice.org and embedded systems			Debian and Ubuntu	Cambridge
C06	Consultants and service providers	LAMP and Samba	Easy-CMS, IPTables, SugarCRM, and system security				North Yorkshire
C07	MS partner, developers, and IT training	(MS Exchange) and (MS IIS)	(Visual Studio)	(MS SQL)	(Outlook)	(MS Win OS)	Uxbridge
C08	Developers, community contributors, IT consultancy, and support services	Apache, Courier, Racoon, and Zope	C, LTPNS, OpenSSL, OpenVPN, PhP, and Python	MySQL, PostgreSQL, and SQLite	Evolution, KMail, and Thunderbird	Linux	Manchester
C09	Software systems development and support	Apache, Debian, Tomcat, and (Lotus Domino)	OpenOffice.org	PostgresSQL	KMail	Suse	Bucking-hamshire
C10	Web services and software developers	Solaris-OpenSolaris	OpenOffice.org and PhP	MySQL	Firefox	Linux	Scotland

Key:
(Application) – All applications in parenthesis are non-OSS
Apps – Applications
API – Application Programming Interface

In the initial stage of searching for case participants, local small businesses were approached on-site for participation in this study. However, non of those approached responded that they actually used OSS. To extend the search, local small business directories were used to identify candidate small businesses. The small businesses identified in the local directories were contacted through telephone calls and invited to participate in the study. Again, non of the small businesses contacted responded that they used OSS for their business.

To improve the chances of finding enterprises using OSS, it was decided to focus on IT companies because (I) they are more likely to use diverse software systems and (ii) this extended the search beyond the local county. This initiative led to a search for IT companies listed in telephone directories and on-line small business directories. Although many businesses were identified, a consideration of costs (where site visits would be necessary) led to a short-list of IT companies around the local area including the city of London.

An attempt was made to contact these businesses by telephone and invite the short-listed IT companies in the nearby counties to participant in the study. Difficulties were encountered as many of the phone numbers were no longer valid and some numbers had changed ownership. In other situations, the company was no longer in business but had retained the telephone number. However, two organisations proved to be useful for this study as they responded positively and were able to participate fully in the study.

Following a very low success-rate with the short-list of IT companies in the nearby counties, it was decided to consider using a telephone media for the interview rather than relying on site visits as the only mode of contact. This led to further consideration of other IT companies outside the local and nearby counties, as illustrated in the diversity of business locations in Table 5.1. Based on this sampling approach, many IT companies using OSS were identified.

Some of this tranche of companies were again also no longer in business, but many others were successfully contacted. However, a high proportion of the companies contacted turned down the invitation to participate on the grounds that they had limited staff and time to accommodate research surveys and interviews, and some responded that they had a company policy to not participate in student research or survey. For companies that responded that they were busy or had limited time, efforts were made to negotiate appropriate times to contact them and a maximum time limit for the interview was also suggested. This initiative proved useful as some of the contacts were able to use the flexible arrangement and participate in the study. The participants were mainly key figures in the organisations including general managers/owners and IT manager or IT team-leaders. The majority of the interviews lasted for around one hour with the participant responding to all questions of the inquiry. A few interviews ran for up to two hours because the participant was happy to provide broad contexts and their personal experiences of issues related to the interview questions. Another interview also ran into a two hour period owing to long pauses during the interview as the participant attended to other issues in their environment, while the researcher waited patiently. All cases featured had a single participant, often an organisational figure head such

as the general manger/owner, or the IT manager. Owing to limited availability of participants and the need to manage the volume of qualitative data, a single participant case was deemed to suffice. This was also on the understanding that the initial participant responded to all the interview questions.

As discussed in Chapter 4, a theoretical sampling strategy (Eisenhardt 1989; Meredith 1998; Yin 1994) was applied for selecting the cases in this study. The use of a theoretical sampling strategy has allowed us to compare factors identified across the study cases. This comparison is important because it is central to the cross-case analysis processes which, as discussed later in this chapter, involves the comparison of factors across all cases to establish their analytical generalisability (Eisenhardt 1989) and thus support theorisation in this study. The use of a theoretical sampling strategy has also allowed us to select cases that provide rich information, in terms of maximum variation in technological, organisational and environmental issues (see, for example, Chapter 2).

Another important point on the use of theoretical sampling was the targeting of IT managers or the small business mangers/owners for participation as interviewees. Such figures were targeted because they were seen as the key decision makers and change agents in the adoption of OSS in the organisation and, they could provide a diverse and rich sources of information as participants providing answers to specific interview questions and also as informants providing access or information that leads to other sources of information. The scope of comparison and the variation of the selected cases will now be discussed.

The summary of selected cases, as shown in Table 5.1, shows a variation in SME profiles including software in use, business area and geographical location of the IT SMEs. The variations across the selected cases allow us to explore a variety of technological, organisational and environmental issues that influence the adoption of OSS by the IT SMEs. As explained below, the cases contribute differently to the variation of the factors identified in this study.

Various selected cases allowed the capture of the influences of variation in SMEs' IT environments. For example, cases C01, C04, C05, C06 and C08 used OSS-only platforms; cases C02, C03, C09 and C10 used mixed software platforms; and case C07 used a non-OSS platform. As shown in Table 5.1, the non-OSS applications recorded in this study are shown in brackets. The relevance of case 07 in this study is explained later in this section. The

variations in IT environment also allow us to explore a variety of technological issues that influence the adoption of OSS by the selected IT SMEs.

The selected cases also allowed the capture of variations in business speciality within the IT industry. For example, cases C04, C05, C07, C08, C09 and C10 are software developers of business applications; cases C01, C03, C06 and C08 are IT consultants; and cases C02 and C05 operate in software development for embedded systems. The variations in business area allow us to explore a variety of organisational issues that influence the adoption of OSS by the IT SMEs.

As shown in Table 5.1, the selected cases also allow us to capture data from geographically dispersed locations: cases C01, C02, C03, C04, C05, C07 and C08 are SMEs based in England; case C10 is based in Scotland; and case C06 is based in Wales. These variations in business location provide an, albeit limited, opportunity to explore the organisational and environmental issues that influence the IT SMEs in this study.

The variations in the selected cases provided rich information in this study. However, the cases were also selected because they satisfy the condition for unit of analysis for this study. Thus, with the exception of case 07, as explained below, all cases are IT SMEs using OSS (see Table 5.1). The business area in Table 5.1 shows that all the selected cases operate in the IT industry in the UK. The variation in the technological, organisational, and environmental factors across the cases also provides a profile for comparison of the factors that emerge from the selected cases. This comparison is particularly important in the cross-case analysis stage, reported in section 5.5.

Case C07 is an exception to the rule for unit of analysis, as mentioned above. As shown in Table 5.1, case C07 is a non-OSS adopter. This case provided alternative views to some factors identified in the study, and thus enhances the understanding of such issues. This case was selected as an opportunistic and negative instance sampling (Coyne 1997; Patton 1990; Sandelowski 1995; Yin 1994).

Although the variation in the selected cases provides an opportunity to explore rich information, the variations in the SMEs, their technologies and their business environment also manifest during the interview sessions and this was noticed during the transcription of the interview recordings. In order to manage the variations in the interview dialogues with

different participants, a standard for developing high-quality interview transcripts for all 10 cases was applied, and this is discussed in the next section.

5.2.2 Development of Case Transcripts

The strategy used in developing a quality transcript (see, for example, the sample transcripts in Appendix B.1 – Transcript of Case C01) focused on organising and representing what was heard during the interview and in the audio recording of the interview. To this end, some principles of Conversation Analysis (CA) (Bryan *et al.* 1998; Drew *et al.* 2001; Maynard and Heritage 2005; Negretti 1999; Schegloff *et al.* 2002) were applied and this allowed us to better represent and organise various interview dialogues, which include utterances such as different types of pauses within speakers' turn-taking, repair and word selection (Negretti 1999; Schegloff 1999; Schegloff *et al.* 2002), and also the documentation of inaudible segments of the interview recording.

The development of the transcripts of the interviews focused on representing what was said and heard in the audio recording. The dialogue recorded in the interview runs as turns for the researcher and interview participant, with some multiple turns separated by a short pause. The dialogue includes utterances such as 'Hm', 'um', 'eh', 'uh', (.) to represent pauses, and (inaudible) to represent inaudible sections of the audio recording. Some actions by the researcher or participants were represented using the notation '#action#'. This notation was also used to mark the end of interview question and answer sessions, especially for the recording of multiple interview sessions. These Conversation Analysis conventions helped to better represent and interpret the organisation of meanings in the dialogue from the interview sessions and also from the audio recording. This was important in reducing the ambiguity that is often common in the social activities of everyday human interaction (Maynard and Heritage 2005).

The interview recording times varied, averaging about an hour, with a few interview sessions lasting up to one and a half hours. It emerged that interviews in the earlier stages of the empirical study were longer. But as researcher experience increased, interview sessions became shorter. This was also as a result of better focus on discussions that yielded new information on the adoption of OSS, or provided support for information that had been captured in previous interview sessions.

5.3 Theoretical Framework for the Data Analysis

Following the development of transcripts as discussed in section 5.2, this section presents the theoretical framework applied in the data analysis. The theoretical framework is an important analysis tools for classification of factors that emerge from the empirical data. The framework is based on the same concepts from the research propositions developed in section 3.3. The continued use of concepts from the research propositions is also important in this study because they are applied in many stages of analysis, from the formation of initial categories to reporting the findings of the case study analysis. Yin (1994) suggests that the use of a theoretical framework in the data analysis enhances the rigour and validity of analysis processes and therefore increases the credibility of research findings. Tellis (1997) also suggests that the use of theoretical propositions in data analysis helps to establish links between data and empirical findings, and therefore enhances the validity of research findings.

The theoretical framework, developed in Chapter 3, consists of three belief components – attitude (section 3.3.1), subjective norms (section 3.3.2) and perceived behavioural control (section 3.3.3). These belief components were decomposed into eight categories: relative advantage (section 3.3.1); complexity (section 3.3.1); compatibility (section 3.3.1); superior influences (section 3.3.2); peer influences (section 3.3.2); self-efficacy (section 3.3.3); resource facilitating conditions (section 3.3.3); and technology facilitating conditions (section 3.3.3). The key features of these categories, which are uniquely-numbered 1 to 8, will be applied in identifying factors in the empirical data. The features of each category will now be presented in turn, according to the categories in each belief component.

The first belief component is the 'attitude' and contains categories: (1) relative advantage; (2) complexity; and (3) compatibility. The features of relative advantage include: economic benefits; image enhancement; convenience; and satisfaction. The features of complexity include: difficulty in understanding; and difficulty in learning or using an OSS. The features of compatibility include: the fit of OSS with existing values; the fit of OSS with previous experiences; and the fit of OSS with current needs.

'Subjective norms' is the second belief component and includes the categories: (4) peer influences and (5) superior influences. The features of these categories are: peer influences – the influences by friends, and influences by colleagues; superior influences – influences of the information from secondary sources such as Internet, TV media, and newspapers or other printed media.

The third belief component is the 'perceived behavioural control' and has the categories: (6) self-efficacy; (7) resource facilitating condition; and (8) technology facilitating condition. The features of self-efficacy include: ability for the successful use of an OSS; and confidence for the successful use of an OSS. The features of resource facilitating condition include time and money, as supporting resources. The features of technology facilitating condition include the technology compatibility resources or other technical or technological infrastructure to facilitate the use of OSS.

5.4 Within-Case Analysis of Transcripts

Having presented, in section 5.3, the theoretical concepts representing the initial categories for the data analysis, this section presents the within-case stage of qualitative data analysis in this multiple-case study research (Eisenhardt 1989; Miles and Huberman 1994; Tellis 1997; Yin 1994). This within-case analysis stage allows us to interpret the transcripts for each case organisation, which leads to identifying and categorising factors that influence the adoption of OSS in each case organisation. Thus, the outcome of this stage of analysis is a framework of factors for each case organisation.

Literature suggests that the within-case analysis stage is the most difficult, least developed and least published part of the case study research (Eisenhardt 1989; Tellis 1997). Therefore, the initial data analysis approaches applied in this study were based on a general inductive approach (Thomas 2006). This allowed us to deal with the challenges of initial interpretation of the qualitative data, enabling the researcher to use common logic to derive initial insights into the meanings of the data as a whole. This soft technique is recognised in the literature as one of the advantages of the case study approach, which exhibits an openness in the selection of techniques, and is greatly influenced by the experiences and discretion of the researcher (Lillis 1999; Myers 1997; Roberts and Wilson 2002).

5.4.1 Processes of Within-Case Analysis

The within-case analysis in this study used three iterative processes: close reading of text; developing memos; and data pattern-matching. These processes that led to the identification of factors will now be discussed in greater detail. The first process has a close reading of a case transcripts which are documented in Appendix B – Transcripts. The reading of transcripts enhanced familiarity with the case text as a whole (Eisenhardt 1989; Thomas 2006). Doing so also enabled the identification of key facts which are relevant to the case study questions in this study. Thus, reading the case transcripts informs us of the unique facts which are

associated with a particular factor that influences the adoption of OSS by the case organisation. The related text-segment was tagged and also copied to a within-case analysis table (see, for example, case C01 in Table 5.2). Similar tables for all of the cases are documented in Appendix C – Within-Case Analysis.

***Table 5.2** Sample Memoing in Within-Case Analysis*

Relative advantage		
Factors	**Related Data Extracts**	**Memos**
License cost-saving	if I need a program to do something, I can just do a quick search, download it, and install it in (.) a matter of seconds [...] I don't have to worry about licenses [...] Its free for those who are prepared to make the effort to understand it to use it properly [...] I think the license is obviously an advantage. No licensing cost [...] if you are not careful, you could be using a software that you don't know you are using [...] in your organisation. And you could fall down on the licensing restriction law. In OSS, its just not an issue. It doesn't arise – C01	suggests that there is license cost-saving because there are no fees for OSS licenses. This suggests a cost advantage over most proprietary software, which require purchase of a license.
License-audit cost-saving	you don't have the cost of keeping track of licenses, which is probably more expensive than actually having the licenses cost [...] in a large organisation, actually tracking that you got valid copies of the core software, proprietary software, is quite an overhead – C01.	suggests that there is a cost saving in the cost of license auditing because adopter does not have additional costs in keeping track of OSS licenses (cost of license-audit). There is a cost advantage over the use audit of proprietary software licenses.
Notations: (.) – represents a pause in dialogue. [...] – represents omitted segments of the dialogue, or a combination of related segments of the dialogue.		

The second process was the development of memos about important facts that were identified in the case text. This was simply note-taking, as shown in the sample in Table 5.2. Making memos of the facts from the text segments is important because this links the data back to the case study questions (Eisenhardt 1989; Howe and Eisenhardt 1990), which focus on what factor were identified and why the factor influences the adoption of OSS by the case organisation. The facts are also important because they were used in forming a unique and meaningful word or phrase which, as shown in Table 5.2, represents the emerged factor.

The third process was a patten-matching of text segment and theoretical concepts to determine the category of an identified factor. This process identified the links between the data and the theoretical framework, leading to a theoretical classification of the factor represented by the data. This involved the use of a pattern-matching technique (Tellis 1997b; Yin 1994) to identify and compare features between the segment of text and categories that were discussed in section 5.3. As shown in the sample in Table 5.2 (represented in the column of related data extracts), the features in the segment of text were compared to the

characteristics of the categories. A match in that comparison confirmed that a factor was identified and that the factor fits with a theoretical category in this study. Table 5.2 shows that memos were used to record the logical justification for the relevance of the text segment as evidence and, therefore, a link between the text segment and the emerged factor.

The use of the pattern-matching technique to compare text-segments and theory-based categories enhances the validity of an emerged factor because the theoretical concepts, which represents the categories, provide a validated framework for the description of the factor (Howe and Eisenhardt 1990; Tellis 1997). As discussed in section 4.9, the validity of factors identified in this study is important because it is a feature of high-quality in case study research, and also represents rigour in the data analysis procedures (Yin 1994).

5.4.2 Factors Emerging from the Within-Case Analysis

The processes of the within-case analysis discussed above were applied to the transcripts of the 10 cases in this study. This allowed us to capture a framework of factors from each case. Although factors captured from all of the cases are documented in Appendix C – Within-Case Analysis, a framework of factors for each case is discussed in this section. This allows us to highlight the case study findings from each case organisation, thus presenting a summary of findings from the within-case analysis for each of the 10 cases in this study.

The first case is C01. Table 5.1 shows that this case was a London based OSS consulting firm which used an OSS-only software platform. The interview recording with the participant in this case was transcribed (see Appendix B.1 – Transcript of Case C01). The data collected from this case were very useful as a sample that represents a diverse use of OSS by an IT consultant in a major city such as London.

The within-case analysis in this case led to the identification of various factors (see Appendix C.1 – Data Analysis of Case C01) which are summarised as follows. The relative advantage factors identified were: license cost-saving; license-audit cost-saving; extend use of hardware; maintenance cost; extensibility; and reliability. The complexity factors identified were: lack of drivers and lack of applications. The compatibility factors identified were: server platform; interoperability; functionality; and supports legacy-hardware. The peer influences factors identified were: support community; growing OSS-community; lack of government support; and software monopoly. The self efficacy factors identified were: core IT-skills; resistance to change; lack of awareness; and management support. Finally, the resource facilitating

condition factor identified was capital investment. No superior influences and technology facilitating conditions factors were identified in case C01.

The second case is C02. Table 5.1 shows that this case was an East Sussex based consultancy firm which used a mixed software platform. The interview recording with the participant in this case was transcribed (see Appendix B.2 – Transcript of Case C02). The data collected from this case were very useful as a sample that represents a mixed software environment of OSS and non-OSS platforms for the firm's diverse IT applications, including web database software and embedded systems development and consulting.

The within-case analysis in this case led to the identification of various factors (see Appendix C.2 – Data Analysis of Case C02) which are summarised as follows. The relative advantage factors identified were license cost-saving, environmental cost, energy cost, costs of complex IT-needs, ease of use, positive image, flexible support, ease of modification, total cost of ownership, and extensibility. The complexity factors identified were lower quality of interfaces, poor interoperability, scalability, desktop maturity, lack of drivers, and lack of applications. The compatibility factors identified were multi-platform applications, functionality, and supports legacy-hardware. The peer influences factors identified were social-interaction issues, lack of government support, software monopoly, and loss of OSS-developers. Finally, the self efficacy factors identified were innovativeness, IT support, and management support. No superior influences, resource facilitating conditions and technology facilitating conditions factors were identified in case C02.

The third case is C03. Table 5.1 shows that this case was an OSS support services, consultation and configuration firm based in Manchester. The interview recording with the participant in this case was transcribed (see Appendix B.3 – Transcript of Case C03). The data collected from this case were very useful as a sample that represents a mixed software and hardware computing environment of OSS and non-OSS platforms. These environments allowed the staff to use flexible applications and servers for their office IT-needs such as Internet communication, document processing and web development, even using flexible choice of underlying computing hardware, including Macs and commodity PC hardware.

The within-case analysis in this case led to the identification of various factors (see Appendix C.3 – Data Analysis of Case C03) which are summarised as follows. The relative advantage factors that were identified are license-audit cost-saving, extensibility, reliability, server hardware support, training aid, diverse documentation, and flexible support. The complexity

factor identified is lack of drivers. The compatibility factors identified were functionality and software maturity. The peer influences factor identified was lack of government support. The superior influences factors identified were print media and Web media. The self efficacy factors identified were: lack of awareness; core IT-skills; and resistance to change. The resource facilitation condition factor identified was capital investment. Finally, the technology facilitation condition factors identified were hardware-infrastructure and Internet connectivity.

The fourth case is Case 04. Table 5.1 shows that this case was a software development firm based in Wakefield. The interview recording with the participant in this case was transcribed (see Appendix B.4 – Transcript of Case C04). The data collected from this case were very useful as a sample that can support information gathered from firms that use only OSS platforms. This firm used an OSS-only platform for its business functions which centred around web and database systems development.

The within-case analysis in this case led to the identification of various factors (see Appendix C.4 – Data Analysis of Case C04) which are summarised as follows. The relative advantage factors that were identified are license cost-saving, security, ease of maintenance, ease of use, flexible IT-solutions, flexible support, and trialability. The compatibility factors identified were functionality, server platform, and hardware compatibility. The peer influences factor identified is support community. Finally, the self efficacy factors identified were core IT-skills, management support, and IT support. No complexity, superior influences, resource facilitating conditions and technology facilitating conditions factors were identified in case C04.

The fifth case is C05. Table 5.1 shows that this case was a Cambridge based firm that specialised in the development of software for embedded systems and in doing so, this firm used OSS-only platform. The interview recording with the participant in this case was transcribed (see Appendix B.5 – Transcript of Case C05). The data collected from this case were very useful as a sample that showed the diverse application of OSS not just as an office software, but, also as a software platform that is widely recognised in the embedded systems industry.

The within-case analysis in this case led to the identification of various factors (see Appendix C.5 – Data Analysis of Case C05) which are summarised as follows. The relative advantage factors identified were license cost-saving, ease of maintenance, flexible support, extensibility, and trialability. The compatibility factors identified were hardware compatibility and

functionality. The peer influences factors identified were support community and national IT-security. The superior influences factor identified was Web media. The self efficacy factors identified were: IT support, core IT-skills, lack of skilled IT-staff, and innovativeness. The resource facilitation condition factor identified was capital investment. Finally, the technology facilitation condition factor identified was Internet connectivity. No complexity and technology facilitating conditions factor were identified in case C05.

The sixth case is C06. Table 5.1 shows that this case was a firm that used OSS-only platform to provide OSS consultancy and services in North Yorkshire. The interview recording with the participant in this case was transcribed (see Appendix B.6 – Transcript of Case C06). The data collected from this case were very useful as a sample that can support information gathered from other firms that use only OSS platforms but also present a geographical diversity to the use of OSS among the IT SMEs.

The within-case analysis in this case led to the identification of various factors (see Appendix C.6 – Data Analysis of Case C06) which are summarised as follows. The relative advantage factors identified were flexible support, no license cost, reliability, and extend use of hardware. The complexity factors identified were lack of documentation and lack of drivers. The compatibility factor identified was hardware compatibility. The peer influences factors identified were support community and government IT-policies. The superior influences factor identified was Web media. Finally, the self efficacy factors identified were innovativeness and core IT-skills. No superior influences, resource facilitating conditions and technology facilitating conditions factors were identified in case C06.

The seventh case is C07. Table 5.1 shows that this case was a Microsoft partner company that is based in Uxbridge. This firm used non-OSS platform and therefore is an interesting variation from all other cases in this study. The interview recording with the participant in this case was transcribed (see Appendix B.7 – Transcript of Case C07). The data collected from this case were very useful as a sample that allowed us to see some difference in factors related to OSS and non-OSS adoption by the IT SMEs. However, this case also allowed us to see some factors that were common among IT SMEs that used OSS or non-OSS platforms. Thus, this case provided the opportunity to begin to identify some theoretically generalisable factors influencing the adoption of OSS by IT SMEs.

The within-case analysis in this case led to the identification of various factors (see Appendix C.7 – Data Analysis of Case C07) which are summarised as follows. The relative advantage

factors identified were limited cost-saving, limited free-support, reliability, flexible IT-choice, and basic modifications. The complexity factors identified were software defect and legal restrictions. The compatibility factors identified was hardware compatibility. The peer influences factor identified was good vendor-relationship. The superior influences factor identified was Web media. The self efficacy factors identified were core IT-skills and IT support. The resource facilitation condition factor identified was capital investment. Finally, the technology facilitation condition factor identified was IT hardware.

The eighth case is C08. Table 5.1 shows that this case was an IT consulting, support services and development firm that is based in Manchester. The interview recording with the participant in this case was transcribed (see Appendix B.8 – Transcript of Case C08). The data collected from this case were very useful as a sample case which not only used an OSS-only platform but also claimed to have made software contributions back to the OSS community. This makes this case a rare example of contributing SMEs. However, this can be expected from the variety of advanced programming OSS packages which they used for their business.

The within-case analysis in this case led to the identification of various factors (see Appendix C.8 – Data Analysis of Case C08) which are summarised as follows. The relative advantage factors identified were license cost-saving, extensibility, and reliability. The complexity factors identified were complex to deploy and lack of drivers. The compatibility factors identified were hardware compatibility and server platform. The peer influences factor identified was government IT-policies. The self efficacy factors identified were core IT-skills, resistance to change, IT support, and management support. The resource facilitation condition factor identified was capital investment. Finally, the technology facilitation condition factor identified was Ethernet technologies. No superior influences factor were identified in case C08.

The ninth case is C09. Table 5.1 shows that this case was a software systems development and support firm based in Buckinghamshire. The interview recording with the participant in this case was transcribed (see Appendix B.9 – Transcript of Case C09). The data collected from this case were very useful as a sample that can support information gathered from firms that used a mixed software platform.

The within-case analysis in this case led to the identification of various factors (see Appendix C.9 – Data Analysis of Case C09) which are summarised as follows. The relative advantage factors identified were license-audit cost-saving, extensibility, flexible support, backward

compatibility, flexible IT-solutions; and trialability. The complexity factors identified were lack of local-support and lack of drivers. The compatibility factors identified were functionality, standard user-interface, hardware compatibility, and multi-platform applications. The peer influences factors identified were support community, social interaction issues, multi-language support, and lack of government support. The superior influences factor identified was Web media. The self efficacy factors identified were core IT-skills, IT support, management support, and innovativeness. The resource facilitation condition factor identified is capital investment. Finally, the technology facilitation condition factor identified was Internet connectivity.

The tenth case is C10. Table 5.1 shows that this case was a web services and software development firm based in Scotland. The interview recording with the participant in this case was transcribed (see Appendix B.10 – Transcript of Case C10). The data collected from this case were very useful as a sample that provided geographical diversity to the selection of IT SMEs in this study and also support information gathered from firms that used a mixed software platform.

The within-case analysis in this case led to the identification of various factors (see Appendix C.10 – Data Analysis of Case C10) which are summarised as follows. The relative advantage factors identified were license cost-saving, security, extensibility, independent verification, and flexible support. The compatibility factors identified were functionality and supports legacy-hardware. The peer influences factors identified were peer initiation and lack of government support. The superior influences factor identified were print media and Web media. The self efficacy factor identified was lack of awareness. Finally, the technology facilitation condition factor identified was Internet connectivity. No complexity and resource facilitating conditions factor were identified in case C10.

Following the presentation of factors identified in each case organisation, the next stage of the data analysis explores the logical replication (Creswell *et al.* 2007; Tellis 1997; Yin 1994) of factors across all cases. This leads to the triangulation of sources of evidence and determines the extent of analytical generalisability of the factors identified in the within-case analysis in this study.

5.5 Cross-Case Analysis of Factors

This section presents the cross-case analysis stage of this multiple cases study research. The cross-case analysis stage allows us to compare factors across all cases and then to select the most logically replicated and generalisable factors, which then form theory-building factors (Eisenhardt 1989; Miles and Huberman 1994; Tellis 1997; Yin 1994). Thus, this stage leads to the development of theories that are supported by evidence from multiple sources. This is an important feature for the analytical generalisability of the theories that emerge from this stage of data analysis.

This cross-case analysis stage is made up of four processes that lead to the formation of theories in this study. The first process is the convergence of factors from similar categories across all cases. This leads to the development of a summary table of the factors within the same category. The second process is the recording of the replication frequency of all factors by category. This leads to the development of a frequency table for each category that shows the replication of each factor. The third process is the selection of generalisable factors from each of the frequency tables. This leads to the development of a set of generalisable factors that is used in supporting the development of theories. The fourth process is the development of theories using the generalisable factors. This last process results in analytically generalisable theories that are supported by multiple sources of evidence in this study. These processes will now be discussed in greater detail.

5.5.1 Collation of Factors

The first process is the development of a summary of factors, which are organised according to their categories. As an example, Table 5.3 shows the summary of factors for the category of relative advantage, as a collation of factors from the results of all the within-case analysis in this study. The use of matrices simplified the selection of similar factors across all cases (Eisenhardt 1989) and these are documented in Appendix D – Cross-Case Analysis. The selection of similar factors is important in the next step which leads to developing a table of frequency of all the factors.

5.5.2 Frequency Analysis of Factors

The second process is the tabulation of the frequency of all of the factors according to their category (Miles and Huberman 1994; Tellis 1997b). The example in Table 5.4 shows a frequency analysis table which shows all the factors of relative advantage, their replication

frequency and related cases. The frequency analysis tables for each category of factors are documented in Appendix E – Frequency Analysis of Factors.

In this study, the replication frequency is the number of the cases that have that particular factor. Because C07 is a case of non-OSS adoption, it is not included as a count in replication frequency. For simplicity of this analysis, the table for each category is sorted first, in descending order, by the frequency column and then, in ascending order, by the factor column. This approach allows us to filter to the top of the table factors with the highest frequency or logical replication. Doing so makes it easy to identify factors relevant to the next stage which selects factors with multiple replication for triangulation, identifies key features and develops descriptions of the factors.

***Table 5.3** A Sample Summary of Factors – Relative Advantage*

Case	C01	C02	C03	C04
Factors	License cost-saving License-audit cost-saving Extended use of hardware Maintenance cost Extensibility Reliability	License cost-saving Environmental cost-saving Energy cost-saving Costs of complex IT-needs Ease of use Positive image Flexible support Ease of modification Total cost of ownership Extensibility	License-audit cost-saving Software control Reliability Server hardware support Training aid Diverse documentation Flexible support	License cost-saving security Ease of maintenance Ease of use Flexible IT-solutions Flexible support Trialability
Case	C05	C06	C07 – NON-OSS	C08
Factors	License cost-saving Ease of maintenance Flexible support Extensibility Trialability	Flexible support License cost-saving Reliability Extended use of hardware	Limited cost-saving Limited free-support Reliability Flexible IT-choice Basic modifications	License cost-saving Extensibility Reliability
Case	C09	C10		
Factors	License-audit cost-saving Extensibility Flexible support Backward compatibility Flexible IT-solutions Trialability	License cost-saving Security Extensibility Independent verification Flexible support		

5.5.3 Selection of Generalisable Factors

The third process is a selection of factors with a minimum frequency of four. Table 5.4 shows a sample frequency analysis of factors for 'relative advantage' in descending order of frequency. The use of contrast in the text background easily separates the generalisable factors with at least a frequency of four appearing at the top of the table, and the factors with

a frequency of less than four which are shown in the text background contrast of the lower part of the table.

Although an arbitrary number of sources of evidence can be chosen as the threshold to support theory-building in case study research, a frequency of four is chosen in this study. This choice is based on a theory that there should be at least four cases in a multiple-cases study research (Eisenhardt 1989) and the use of four cases in this study also allows triangulation of evidence from multiple sources (Patton 1999; Thurmond 2001), which helps to establish the analytical generalisability (Meredith 1998; Yin 1994) of the emergent theory. This suggests that the emergent theory is consistent in multiple case settings in this study. This also demonstrates that multiple sources of evidence were used in establishing the internal validity (Eisenhardt 1989; Miles and Huberman 1994; Meredith 1998; Yin 1994) of the emergent theories in this study. Furthermore, the use of multiple sources of evidence to support the emergent theories is consistent with procedures for enhancing the credibility of emergent theories and this has been reported to be a good practice for high-quality data analysis (Eisenhardt 1989; Yin 1994).

Based on the selection process described above, factors with a frequency of at least four were selected in all of the categories. This led to the development of a framework of selected factors in eight categories. A summary of the selected factors in each category (see Appendix E – Frequency Analysis of Factors) will now be presented. Case C07 was not counted because it is a case of non-adoption of OSS.

Table 5.4 shows that four relative advantage factors were selected: flexible support, license cost-saving, extensibility, and reliability. These factors are were identified in multiple cases as follows: flexible support was identified in cases C02, C03, C04, C05, C06, C09 and C10; license cost-saving was identified in cases C01, C02, C04, C05, C06, C08 and C10; extensibility was identified in cases C01, C02, C03, C05, C08, C09 and C10; and reliability was identified in cases C01, C03, C06, and C08 (and in case C07).

Table 5.4 *Frequency Analysis – Relative Advantage*

Factor	Sources	Frequency
Extensibility	C01, C02, C03, C05, C08, C09, C10	7
Flexible support	C02, C03, C04, C05, C06, C09, C10	7
License cost-saving	C01, C02, C04, C05, C06, C08, C10	7
Reliability	C01, C03, C06, C08, (C07)	4
License-audit cost-saving	C01, C03, C09	3
Security standard	C01, C04, C10	3
Trialability	C04, C05, C09	3
Extend use of hardware	C01, C06	2
Flexible IT-solutions	C04, C09	2
Backward compatibility	C09	1
Costs of complex IT-needs	C02	1
Diverse documentation	C03	1
Ease of maintenance	C04	1
Ease of modification	C02	1
Ease of use	C02	1
Energy cost	C02	1
Environmental cost	C02	1
Independent verification	C10	1
Positive image	C02	1
Server hardware-support	C03	1
Total cost-of-ownership	C02	1
Training aid	C03	1

Table 5.5 *Frequency Analysis – Complexity*

Factor	Sources	Frequency
Lack of drivers	C01, C02, C03, C06, C08, C09	6
Complex to deploy	C08	1
Desktop maturity	C02	1
Lack of applications	C01	1
Lack of documentation	C06	1
Lack of local support	C09	1
Lower quality of interfaces	C02	1
Poor interoperability	C02	1
Scalability	C02	1

Table 5.5 shows that the single complexity factor selected is lack of drivers. This factor was identified in cases C01, C02, C03, C06, C08 and C09. In Table 5.6, we show that two

compatibility factors were selected: functionality, and hardware compatibility. Functionality was identified in cases C01, C02, C03, C04, C05, C09 and C10. Hardware compatibility was identified in cases C04, C05, C06, C08 and C09 (and in case C07). Table 5.7 shows that two peer influences factors were selected: support community; and lack of government support. Support community was identified in cases C01, C04, C05, C06 and C09. Lack of government support, was identified in cases C01, C02, C03, C09 and C10. The next table is Table 5.8 and it shows that the single superior influences factor selected was Web media. This factor was identified in cases C03, C05, C06, C09 and C10.

***Table 5.6** Frequency Analysis – Compatibility*

Factor	Sources	Frequency
Functionality	C01, C02, C03, C04, C05, C09, C10	7
Hardware compatibility	C04, C05, C06, C08, C09, (C07)	5
Server applications	C01, C04, C08	3
Supports legacy-hardware	C01, C02, C10	3
Multi-platform applications	C02, C09	2
Interoperability	C01	1
Software maturity	C03	1
Standard user-interface	C09	1

***Table 5.7** Frequency Analysis – Peer Influences*

Factor	Sources	Frequency
Lack of government support	C01, C02, C03, C09, C10	5
Support community	C01, C04, C05, C06, C09	5
Government IT-policies	C06, C08	2
Social-interaction issues	C02, C09	2
Software monopoly	C01, C02	2
Growing OSS-community	C01	1
Loss of OSS-developers	C02	1
Multi-language support	C09	1
National IT-security	C05	1
Peer initiation	C10	1

Table 5.8 *Frequency Analysis – Superior Influences*

Factor	Sources	Frequency
Web media	C03, C05, C06, C09, C10, (C07)	5
Print media	C03, C10	2

Table 5.9 *Frequency Analysis – Self Efficacy*

Factor	Sources	Frequency
Core IT-skills	C01, C03, C04, C05, C06, C08, C09, (C07)	7
IT support	C02, C04, C05, C08, C09, (C07)	5
Management support	C01, C02, C04, C08, C09	5
Innovativeness	C02, C05, C06, C09	4
Lack of awareness	C01, C03, C10	3
Resistance to change	C01, C03, C08	3
Lack of skilled IT staff	C05	1

Table 5.9 shows that four generalisable self-efficacy factors were selected: core IT-skills, IT support, management support, and innovativeness. Core IT-skills was identified in cases C01, C03, C04, C05, C06, C08 and C09 (and in case C07). IT support was identified in cases C02, C04, C05, C08 and C09 (and in case C07). Management support was identified in cases C01, C02, C04, C08 and C09. Innovativeness was identified in cases C02, C05, C06 and C09. In Table 5.10, we show that the single resource facilitating conditions factor selected was capital investment. This factor was identified in cases C01, C03, C05, C08 and C09 (and in case C07). The next table is Table 5.11 and it shows that the single technology facilitating conditions factor selected was Internet connectivity. This factor was identified in cases C03, C05, C09 and C10 (and also in case C07).

Table 5.10 *Frequency Analysis – Resource Facilitation Conditions*

Factor	Sources	Frequency
Capital investment	C01, C03, C05, C08, C09 (C07)	5

Table 5.11 *Frequency Analysis – Technology Facilitation Conditions*

Factor	Sources	Frequency
Internet connectivity	C03, C05, C09, C10, (C07)	4
Hardware infrastructure	C03, (C07)	1
Ethernet technologies	C08, (C07)	1

5.5.4 Triangulation of Evidence

The fourth process is the triangulation of evidence that supports the factors selected in the frequency analysis in section 5.5.3. This process triangulates data from multiple sources (Meredith 1998; Patton 1999) to identify key features that best describe the factors selected in section 5.5.3. The process involves the iterative use of an explanation-building strategy (Tellis 1997b; Yin 1994) to test and fit the features and description of a factor against new supporting data, leading to an extension of the features and description.

***Table 5.12** Flexible Support*

Supporting Evidence	If you've got an obscure problem, you can normally find, you know, the person that has been working on that aspect (.) of the code, and you can speak to them. And that would, in most cases, get the problem sorted for you, or at least point you in the right direction. Um whereas, you've got no hope of that with commercial software. Um you know, em actually, OSS, it has a massive advantage in that aspect – C03 there has been occasions where we've been in direct contact with the programming teams of some software, um where um we needed to either clarify stuff or find out if something that we were seeing was actually bug, or was intended to work that way. And, I just don't think you can get that kind of response from a large organisation [...] We had a problem resolved in probably, a couple of days. And, where realistically, I think, if we haven't have had that kind of support available, um it could have run on into months [...] I think if it was a commercial equity that we were dealing with, um in the time that we actually reported the problem and have it resolved, with a Open Source, we would probably, have been asked for our credit card number and told that we would be called back – C04 if you have a problem with Windows application, you are only going to get help from a Windows appointed support system, person, or organisation, or supplier. The virtue with an Open Source system is that there is no limit to the people who can join in and throw their weight into tackling the problem [...] proprietary operating systems are (.) are very private, and sequestered, and exclusive, and you have to pay for access. Um In Open source, in principle, any body can play, and they probably won't need to pay – C05 if it doesn't do what I want, I can fix it [...] If you are using OSS, even if you don't have the skills yourself, you can find somebody who does, that can solve the problem in your time scale, not somebody else's, with your sets of priorities, not somebody else [...] It does ninety percent of what I want. I can build the other or find the other from somebody else. Which means, I am solving the problem I wanted to solve, not the problem that I am being allowed to solve [...] the problem with the closed-source stuff, especially when you buy a machine on which it has been preloaded [...] um is that you don't know what you are getting until it arrives [...] If you are installing it yourself, then you know what you are installing. Then you are in good order. And it is much easier to plan for – C09
Features	help to resolve issues in the use of OSS; customised support; free of fee payment; mutual benefit to user and developers; Open, public access; from any entity willing to provide it
Description	refers to the perception of convenience of using OSS and incorporates different features such as free-support, public-access support, customised support, and cooperative support.

Table 5.12 shows that the testing and fitting of features is also a convergence of relevant features from each of the four or more supporting cases. The convergence of supporting evidence from multiple sources was achieved in two processes. First, the pattern-matching technique (Tellis 1997b; Yin 1994) is applied in comparing evidence from two supporting cases and then merging the features identified from their data segments. The new set of features then represents the composite features of the factor (see, for example, in 'Features' in

Table 5.12). The second process uses the composite features to iterate the first process, in another application of the pattern-matching technique through the evidence in the remaining supporting cases. Again, any new features from this pattern-matching are added as an extension of the composite features. This allows the fitting any new features from other supporting sources of evidence into an evolving set of composite features (Eisenhardt 1989; Meredith 1998). This process of testing and amending refines the set of features that forms the description of a factor by sharpening or enriching its features, yielding a more empirically-valid and analytically generalisable description of the factor (Eisenhardt 1989). The triangulation processes have led to the development of a framework of triangulated factors and their sources of evidence. The factors and their categories are summarised according to the theoretical framework discussed in section 5.3.

The factors in relative advantage, complexity, and compatibility form the attitudinal factors. The factors are also referred to as technological factors because they represent the innovation characteristics and qualities specific to OSS. The factors and their supporting sources of evidence are now presented in turn according to their categories.

The first category is relative advantage and consists of four factors: flexible support; license cost-saving; extensibility; and reliability. As shown in the example in Table 5.12, the description of flexible support is supported by evidence from cases C03, C04, C05 and C09 (see Table 5.12 Flexible Support); license cost-saving is supported by cases C01, C02, C04 and C05 (see Table 5.13 License Cost-Saving); extensibility is supported by cases C03, C05, C08 and C09 (see Table 5.14 Software Control); and reliability is supported by cases C01, C03, C06 and C08 (see Table 5.15 Reliability).

Table 5.13 *License Cost-Saving*

Supporting Evidence	if I need a program to do something, I can just do a quick search, download it, and install it in (.) a matter of seconds [...] I don't have to worry about licenses [...] Its free for those who are prepared to make the effort to understand it to use it properly [...] I think the license is obviously an advantage. No licensing cost [...] if you are not careful, you could be using a software that you don't know you are using [...] in your organisation. And you could fall down on the licensing restriction law. In OSS, its just not an issue. It doesn't arise – C01
	licensing cost are a big issue, depending on the Open Software you are talking about [...] there's definitely a cost advantage [...] that generally occurs when you have an unusual situation where you have um for some reason, you need to deploy many (.) many copies of a piece of software. Um and eh and the pricing structure of the closed-source competition aren't really good for that particular application – C02
	huge benefit from a licensing point of view. Um but probably not as big as most people would think [...] I am not having to pay for licenses for each and every test server that I am setting up – C04
	I don't (.) I've never paid for Linux [...] its free. That's a distinction feature. Having registered with Ubuntu for the desktop um (.) with Debian, um it just happens, a little icon comes up when there is a new upgrade [...] This happens with Windows as well. But with Windows, you have to have paid MS first [...] proprietary operating systems are (.) are very private, and sequestered, and exclusive, and you have to pay for access – C05
Features	free OSS licenses; no licensing restriction law; cost advantage; public access
Description	refers to the perception of economic benefits in using OSS due to the cost-free licenses, liberal licensing-laws and public access.

Table 5.14 *Extensibility*

Supporting Evidence	we've got the source code. So, you know, if there's anything we need to change, we can do [...] With other software, you don't get the source code [...] the fact that we have access to the source code of all software, means that we can modify it to be suitable for the non-standard problems [...] if it was not OSS, you wont be able to do it at all. Because if you don't have access to the source, you can't modify the software [...] it makes something feasible. Um it makes it possible. I mean, you know, you wont be able to solve these problems if it weren't for OSS – C03 There are a lot of people around who don't want to be tied to Windows. And that disposition, that preference, not to be tied to MS, is one of the several drivers for using Linux [...] there's up-teen million people out there that want to do things nobody else has ever done before, and therefore, need the flexibility [...] In general, the barriers and restrictions and inhibitions to uh developing application under MS, as a freelance rather than as a captured member under MS development (inaudible) are very considerable. And you will not get (.) well if you sign up as a MS developer, you ll probably get quite a lot of support. But what you develop is only going to work on MS operating system. And of course you will have to upgrade all your development tools when they change the operating system. And that is going to cost you. In the Open Source world, these barriers are non existing, or much much lower – C05 For example, for high availability and high security. Um you can't book out at (.) evaluate the systems, test it, test it, test it. Find out where all the possible pitfalls are, then deploy something that your are very confident of. Its very difficult to do that with a commercial package because I think it s a black box [...] we got the source code. We can see the source. We can change the source. We can look through it, find out how software works, find out where the bugs are. And we do do that when we encounter problems, we do go back to the source code, and we say, well this is where is it going wrong – C08 I am not locked-in to doing things when the manufacturer tells me to. So, if I want to upgrade, I can. If I want to use an old version of something, I can. Um I can mix and match as I want [...] If you don't like KDE, you can try Gnome [...] there are lots of alternative ways of solving the same problem. So, it is much easier to find something that is going to suit. The fact of the point is that the technology should be there to help the user. Shouldn't be there to force them to do things. And um giving the user choice, while not swamping them with it [...] I tell you, because you are being forced to do things by the manufacturing, you have no knowledge of what is being done on your behalf – C09
Features	modifiable/adapt to suit needs; access to source code; independence; not tied to MS; enable innovativeness; barriers are non-existent; freedom to explore the technology; no restrictions; choice
Description	refers to the perception of conveniences in using OSS due to public access to source code, freedom to modify OSS, and freedom of choice.

Table 5.15 *Reliability*

Supporting Evidence	I think it is very high quality [...] as a result of the collaborative approach [...] the many pairs of eyes looking at code [...] They run until some (.) very important involvements with the odd security upgrades [...] I knew that Firefox is a much better browser, sufficient than Internet Explorer. So, um OSS could be a major beneficiary of that. And also the client (.) the server-client model that Linux is built on is much more attuned to that sort of environment than Windows, which is not natural a client-server architecture – C01 if you are trying to run a large highly available, very scalable website, you haven't really got any option other than to use OSS. And, you know, expand upon it. Um People have, you know, come across problems, they've added patches to Apache. And you know, other various pieces of software [..] what I am more interested in is the fact that it is extremely stable and reliable [...] I think for non technical users, the primary reason to use it, is because of their stability and reliability [...] I mean, I suppose, really, stability and reliability, I am using as synonyms here. Its one and the same – C03 we've got service here that (.) that runs literary four years without being switched off. You know, normally it gives a fast, efficient (.) it just do the job. It fits the server in the background [...] What you find is (.) that it is so reliable, um it just (.) it never needs attention. It just sits there – C06 the fact that Linux is very good at the high availability and high security side, is one example of where it is easy to sell that. To be able to say, but look, you know, if you compare how stable a Linux server is compared to say a Windows server, there is no competition um that on Linux servers that we run, that has been running for well in excess of four hundred days. Without shut down, without reboot, without anything – C08
Features	high quality; innovative and proven architecture; highly available; very scalable; extremely stable very long uptime; continuous operation; minimal attention/maintenance; high availability; high security
Description	refers to perception of satisfactions in using OSS due to high availability and scalability, high security, and low maintenance.

***Table 5.16** Lack of Drivers*

Supporting Evidence	the one area that Linux has a disadvantages in the area of hardware drivers [...] for instance, I've a screen (.) I've a screen (.) eh graphics cards client. So she buys a spanking new kit. The likelihood of finding proprietary drivers that will run is quite low [...] So, generally, you are better off buying hardware which is (.) has been older [...] you know, to a year or so. So, its (.) people had time to write registered drivers because a lot of the manufacturers won't release specifications to the OSS community to write proper drivers. So a lot of it had to be reverse engineered – C01 you did used to have um in certain (.) certainly on (.) in (.) on server space, where you have hardware vendors not supporting OSS by releasing specifications. And, um that has been an issue (.) a big issue on the desktop [...] the fact that the major PC hardware suppliers, AMD and Intel, have been worked (.) have very good relationship with Open Source community for a long time helps things a lot – C02 It used to be an issue five years ago, you know, ten years ago, yeah, it was a big problem [...] Obviously, yeah, its something that one needs to check, but its not (.) its not a large worry [...] Yeah, I mean (.) that does exist and it does happen. But, generally, its not for issues (.) certainly not for server side issues [...] On the desktops, there are, you know, there are problems that graphics cards manufacturers don't (.) tend to not want to give out data, and the same for wireless networking, um drivers. But on the server side, its not really a problem. You know, I mean, this is very much server focused rather than desktop focused – C03 you got to be a wee bit careful when you buy a new piece of kit that they are not using some (.) As I said, there are a couple of manufacturers, you tend to find them more in laptops than you do in um um general systems. For instance, some of the wireless chips [...] um are badly supported in Linux because the manufacturers won't tell anybody how to drive them and therefore how to write a driver. and they won't do it themselves. Um Broadcom are a bad example of this – C09
Features	hardware drivers; new computing hardware; no proprietary drivers or software specification (from manufacturers); no support from hardware vendor; an issue with desktop platforms; problems with graphics card manufacturers; wireless networking devices; mostly modern hardware such as laptops, home-PCs, graphics cards and wireless network devices
Description	refers to the perception of difficulty in understanding, learning and using OSS due to the lack of software specifications and poor support from manufacturers.

The second category is complexity and consists of a single factor – lack of drivers, and its descriptions is supported by evidence from cases C01, C02, C03, and C09 (see Table 5.16 Lack of Drivers).

***Table 5.17** Functionality*

Supporting Evidence	For most offices, for most functions, you need to browse the web, read emails, and create documents and spreadsheets, if you like. So, between Firefox, Thunderbird and OpenOffice, all of which run on MS eh, as well as Linux, you can port your organisation onto those three fairly painlessly over time [...] If I am giving a Linux distribution to somebody else, I will give them Ubuntu [...] Ubuntu, you can use out of the box, just like Windows [...] those people who try and say Ubuntu is the alternative, find that XP is not dissimilar to use, in some respects. Uh Its obvious there is a difference. But that's not (.) not a huge problem – C01
	We've used it in a lot of different scenarios. We've deployed it in (.) for a lot of different companies and we've seen how it can work for us [...] You know, we've seen (.) empirically, you know, we've observed it working – C03
	Linux is a popular operating system for embedded applications [...] ARM therefore needs to develop the tools available to developers, to allow them, to develop applications for ARM processors, using Linux software [...] ARM processors don't normally run eh Windows or any MS applications or Mac OS [...] you can develop for a staggering variety of applications using Linux [...] So, there are people making for example, surveying equipment using GPS to define positions and space on (.) on the surface of the earth [...] We wanted a web browser, a very good email handling package, and a good office suite. And they existed. Um Most of them were probably being upgraded since we started using it, but they continue to be perfectly satisfactory for our purposes – C05
	Its the standard thing I use. Netwise, it does everything I need, and I feel comfortable working with Linux [...] OSS is popping up all over the place. I mean, it appears in almost all the little um ADSL routers you get out of, you know, the little wireless routers, they (.) all of those run Linux these days. Um the um a lot of the new appliances, the new little sub mini (.) sub laptop that Asus has produced - the Eee PC [...] that runs Linux. Um set-top boxes, all that sort of stuff runs Linux [...] there is almost nothing you can't do with them these days, by way of computing – C09
Features	office applications; alternative solution; similar software; different work scenarios; proven business software solutions; variety of embedded applications; satisfactory for purposes
Description	refers to the perception of fit of using OSS for different IT needs such as office information processing; software development; and embedded systems.

The third category is compatibility and consists of two factors: functionality and hardware compatibility. The description of functionality is supported by cases C01, C03, C05 and C09 (see Table 5.17 Functionality) and hardware compatibility is supported by cases C04, C06, C08 and C09 (see Table 5.18 Hardware Compatibility).

Table 5.18 *Hardware Compatibility*

	nothing out of the ordinary really. Um they all (.) they all run on just commodity PC hardware [...] It basically comes down to availability. Whatever is widely available is going to be better supported, um from a drivers point of view, than any locked down stuff that they don't want you playing with, which would be the case with Apple [...] there is support for a huge array of hardware. So, if for example, a network card dies in one of our machines, I could grab a spare from a shelf, and go and drop it in. And if it wasn't the same as what I've just taken out, there is a very very good chance that its just going to be a drop in replacement [...] Which isn't the case on certain operating systems from em (.) 'Raymond'. Change hardware on that, and eh you could be in for a whole world of pain – C04
Supporting Evidence	because that software interfaces into any number of different devices, ranging from small tape drives through to um million pound robotic (inaudible) Amanda has got a huge long list of drivers that they produced to support their software – C06
	we have a mix between Dell, HP, Compaq, and own built systems as well [...] on the hardware side, it doesn't really matter. So long it is supported. and that just comes down to drivers, at the end of the day [...] one can have compatibility problems. But all those three manufacturers, IBM, Dell, and HP are committed to Linux on their servers. So drivers are made available by them – C08
	most hardware work off the shelf these days, even laptops. Um And I mean, I've been using Linux desktop as my only operating system since the month before September the eleventh 2001 [...] the um hardware selection generally isn't a problem for an office desktop. Its going to work – C09
Features	commodity PC hardware; availability of hardware drivers; easy replacement; new computing devices major manufacturers; support hardware; need drivers; support for drivers on servers; hardware including laptops; work off the shelf; no problem for office desktops
Description	refers to the perception of the fit of using OSS with existing hardware platforms from different manufacturers and classes such as legacy and modern hardware.

The fourth and fifth categories are peer influences and superior influences, respectively. The factors in these categories form the normative beliefs. The factors are also referred to as socio-environmental factors because they represent the social interaction issues and environmental agents that influence SMEs to decisions to adopt and use OSS in this study. The factors and their supporting sources of evidence are now presented in turn according to their categories.

Table 5.19 *Support Community*

Supporting Evidence	I think OSS is quite a democratising force. Because everybody can (.) everybody can participate to the level that they choose. And the only hierarchy, particularly in Debian, is based on technical expertise. You know, you come to respect those that know what they are talking about [...] the impression I get of the ethos is (.) is quite egalitarian [...] But everybody is working towards the same end, which is it to create the best software of all [...] Because theres more people who use it, more people are looking at it, the features will become rich (.) richer. Um All the bugs get squashed out [...] More usage brings in uh better software, better software brings in more users – C01 we did have one very strange problem with ARP protocol using an older Linux Kernel. And, we actually ended up speaking directly with one of the Kernel developers. Um which very rapidly got that sorted out [...] they are very interested in ensuring that the software that they produce is, em there's bug free and useful as possible. Generally, if you find something very strange in there, um they will be interested in getting as much detail from you as possible, and sorting the problem out – C04 It is very popular because it is (.) uh very powerfully supported by a great many people during the developments stage [...] it is characteristics of the Linux users of the world, that they help each other out. That they read newsgroups about problems somebody is having, getting a driver for a specially exotic piece of kit. And they advice each other where to look. Um And, this supportive behaviour from the user community [..] is something that MS cannot, and of course will not develop [...] On the other-hand, it is very very important components of the Unix class of operating systems, of which Unix (.) Linux is a particular case [...] You depend upon your ability to connect to a community that will help you if you get stuck [...] you need to be able to connect to a community of like-minded users who will help you out when you get stuck [...] I am saying that intellectual curiosity and caring about what goes on behind the system are a characteristics of Open Source people – C05 there is a very very active development community out there. So if you are using one of these products and you think there is something wrong with it, then so long as you are supported through um forums like source forge, you can post your problems back, and they will get it fixed [...] you always find that if you (.) if you are trying to use something, and you've got difficulties, then the authors of the software are usually very proud to be asked a question [...] because somebody out there has taken an interest. And more than happy to answer the questions – C06
Features	users help developers to improve software; users help other users to use software; developers help users to use software; developers help other developers to improve software; vendors to distribute OSS; manufacturers to provide supporting resources; sponsors to provide supporting resources; free and active support communities, mutual support within large OSS communities, collaborative efforts among users and developers; open and cooperative community; egalitarian; common cause; solving users problems; rapid response; improve quality of OSS; large community; self-support groups; intellectual curiosity and care about OSS community; active community; support forums; keen to help users; contributive roles such as users, developers, sponsors, vendors, manufacturers and intellectuals; open participation and shared support in the development, use and spread of OSS.
Description	refers to the perception that peers influence the development, use and spread of OSS.

The fourth category is peer influences and consists of two factors: support community – which is supported by evidence from cases C01, C04, C05, and C06 (see Table 5.19 Support Community); and lack of government support – which is supported by cases C01, C02, C03 and C10 (see Table 5.20 Lack of Government Support).

Table 5.20 *Lack of Government Support*

Supporting Evidence	in this country in the (.) amongst the public sector, there is very little use of OSS, in reality [...] There are areas in Spain, a whole districts that have gone Open Source, and have rolled out computing across the public sector, at a fraction of the cost of what it would have cost for proprietary installation. So, there is a (.) there is a roller-coaster of activity, particularly on the continent, and we in the UK are just quite a long way behind on that – C01 I think the involvement of the UK government is very low [...] people doing the procurement comparative services think that Open Source is new. And they don't want any risks. So, they are not ready to try something new [...] Um So, the EU seems more um enthusiastic. And countries like Germany and Spain have a lot more the use of public system Open Source than the UK – C02 the government tend to be very much behind the curb on IT anyway. And, um they have been traditionally, and still are, very much tied into MS-based solutions. Um I think, certainly in this country anyway, there is a very low level of government take up of OSS [...] Um potentially, they could be very useful, but in practice, they are completely 'use-less' – C03 the government (.) the British government, they just (.) they just don't give out any information on Open source, or very little. they tend to be (.) they tend to go more for um eh promoting companies like MS and Sun Microsystems [...] I don't think that is fair. I think the government is being biased towards eh the non Open Source companies. That's probably because some of these companies donate large sums to political parties, they donate large sums to um academic institutions – C10
Features	little use in public sector; comparatively behind in use; low involvement of government; lack of understanding in the government; poor enthusiasm; government is far behind in the use of OSS; government is tied to MS-based solutions; very low level of government take up; government department don't give out information; government is biased towards non Open Source companies
Description	refers to the perception that government agencies influence the use of OSS in the public sector.

***Table 5.21** Web Media*

Supporting Evidence	With OSS, you know, there might be a Wiki. There might be a mailing list. There might be a web-based forum. There is many sources of documentation [...] You know, I think that (.) as with anything these days, you use Google and you search the Internet [...] The Internet is key. Um Realistically [...] Internet based information is where most eh most information is going to come from [...] most people that are interested in OSS get most of their information from the Internet [...] I would never have started using it actively if it wasn't for the Internet because I won't have been able to get a copy of it [...] So, really, I think, the Internet is the only distribution medium of any consequence, with respect to OSS – C03
	license entails the obligation, to disclose the source code, of applications that run, using ah any GPL code (.) any GPL application. #software-reference# is a GPL application. So, people who take our software from our web site and use it, can play with them as much as they like, try it out, eh test it in service [...] If you are able to connect to such a community, they don't have to be local. In fact, so much of the communication now is via the Internet um including chat and email. But they don't need to be local at all [...] I am very pleased that um (.) that when we bought a new HP scanner, copier, fax machine, we were able to get a driver from it (.) for it, um free, from HP web site – C05
	you will tend to find that a distribution like Ubuntu, or Kubuntu, there (.) there is two different flavours I think, um are (.) their help-desk, their forums are designed with end-users in mind. And the system then tries to be helpful to them [...] the bigger projects like KDE or Oracle or whatever, do support a lot of languages. And uh both in terms of being able to have the program talk to you [...] But also in terms of the mailing lists and forums and things, happening in your language – C09
	Because you can (.) for example, if (.) if there was a problem using eh OSS such as OpenOffice, um there is a web site for OpenOffice and you log on to that um there is a (.) in the forum (.) help forum [...] Eh you can log on there and leave a message [...] Eh about the details of your problem. And usually within a day, somebody will get back to you – C10
Features	Wiki, mailing-list, web-based forum, Internet-based information, and Internet distribution medium web site information, chat, and email; multi-lingual help-desks and forums, and mailing-lists; web site, and help forum; incorporates Internet channels such as Wiki, mailing-lists, forums, email, and chat.
Description	refers to the perception that web-based information influences the development, use and spread of OSS.

The fifth category is superior influences and consists of a single factor – Web media – which is supported by evidence from cases C03, C05, C09 and C10 (see Table 5.21 Web Media).

The sixth, seventh and eighth categories are self-efficacy, resource facilitating conditions, and technology facilitating conditions, respectively. The factors in these categories form the perceived control beliefs. The factors are also referred to as organisational factors because they represent characteristics that are particular to SMEs which influence their adoption of OSS in this study.

***Table 5.22** Core IT–Skills*

Supporting Evidence	I think you need a good understanding of the principles behind what's happening. For example, if you are using networking stuff where you need to probably understand TCP-IP [...] a good understanding of computer science is really necessary to support the software. Not necessary to use it. But, to be able to support the software, well, you need to have a good understanding of general computer science principles [...] you don't necessarily need to be a computer programmer, but you need to have at least a basic a understanding of programming concept, to be able to take full advantage of that – C03 from a development point of view, we need programmer skills in the language that we are using [...] from my point of view, as it happens, I won't pick out anything in particular. Its more a good overall knowledge of how the system hangs together. Um obviously, on the programming side, you need someone who is well versed in the languages that you are using [...] there are a lot off-the-shelf sort of set-ups, that you can throw at a machine and it will do the job. But if you want to get the most performance out of it, like anything else, you need to understand how it works. And you need to be able to tune it to your specific needs – C04 we are involved in development work, and need capabilities that other people don't automatically need [...] I won't have embarked on this at all, unless we had skills in-house that allowed us to get the best out of Linux [...] I have um learned to use OpenOffice and make it do everything I want [...] server users are more highly trained. And, um more fluent in more than one type of server. They have broader knowledge. They are (.) they are perhaps more like multi-lingual people, than like people trained only in English – C05 Using Linux systems from an operational point of view or from an installation and commission point of view, you are talking about just the same skill-set as you need to install Unix [...] you know, or the same or similar skill-set that you will need to deal with any multi-tasking operating system [...] it is a general knowledge of IT, what these things do, uh, how infrastructure works [...] you talking about general network knowledge that (.) it gives (.) well, you have to be the equivalent of an MCSC in (.) in Unix/Linux world [...] I think you just got to be relatively technical and pretty determined. You know, because it is difficult um if you are not trained as a network infrastructure engineer, its difficult to discern from the outside, what do all of these components do, and how it (.) how it fits together – C06
Features	good understanding of principles; good understanding of computer science; ability to support the software; understanding of programming concepts; good overall knowledge; understand how system works; need capabilities; broad knowledge; skill-set; general knowledge of IT
Description	refers to the perception of ability to use OSS successfully in the given situation, and requires capabilities such as a good understanding of OSS principles and a general knowledge of IT.

The sixth category is self efficacy and consists of four factors: core IT-skills – which is supported by evidence from cases C03, C04, C05 and C06 (see Table 5.22 Core IT-skills); IT support – which is supported by cases C02, C05, C08 and C09 (see Table 5.23 IT support), management support – which is supported by cases C01, C02, C08 and C09 (see Table 5.24 Management Support); and innovativeness – which is supported by cases C02, C05, C06 and C09 (see Table 5.25 Innovativeness).

***Table 5.23** IT Support*

Supporting Evidence	when changing from a closed-source to an Open Source, you always have a learning curve. Um but same as when changing from one piece of software to another [...] majority of our customers, they already taken the decision to use Open Source. So, you know, we are really ah (.) we are just helping them with it – C02 It is probably necessary to have somebody around, who is fluent in using Linux [...] The most of all thing, is to have somebody available to you, who has the capacity to get (.) the staff who will be using Open Source um familiar enough with it to get confident, and then help them if they get stuck [...] you need to have somebody around to have recourse if you get stuck. Otherwise you are (.) you are getting frustrated that you are unproductive [...] just as no complicated system, digital or strictly mechanical, um can be operated without support (inaudible), you need somebody around you who is capable of supporting them when they (.) challenge you [...] what made it valuable to have this person around was his capacity to solve problems that popped up in Linux applications, um in the same way that technical support or desk cooperation would solve problems that pop up in Windows applications – C05 I've seen huge numbers of staff supporting IT systems. And it doesn't matter how much a software cost, it cost a million pounds or it cost nothing, you've still got to (.) um you got a (.) you got staff that you got to support it. You've got to have a help-desk. You've got to have people fixings servers – C08 heaving techies want access to you know, detailed information that means all sort of things. Um End-users just want to get back up running again. Um And their (.) their need is much simpler in that respect. But the help-desk system you need, or help support system you need for the two are different – C09
Features	Change; IT consultants; getting through learning-curve; help-desk; fix systems; helping users; technical staff; in-house help; solving problems; IT systems; help-desk; fixing servers; access to detailed/technical information, software vendors, getting systems running; Given the support of technical and informational assistance from internal or external sources such as in-house skilled staff, external help-desk, software vendors, IT consultants and OSS community.
Description	refers to the perception of confidence to use OSS in a given situation given the support of technical and informational assistance from internal or external sources.

Table 5.24 *Management Support*

Supporting Evidence	lets say you've got an IT department which has a director and manager, and say ten people. Um There may be two or three within there who understand Linux. And they might (.) they might use um products (.) projects, almost on a quite using Linux. And then they show the idea to their management. And over time, that's how it changes [...] the key to changing an organisation is to go to the top. So, basically, its selling the benefits to the finance directors and the chief executive is where you need to go – C01 a company has to decide weighing up on licensing, cost of ownership, skills of personnel. These are all factors in their decision making process. But its really a big decision for them – C02 I think one of the biggest problems that I have encountered is, the mentality of senior managers or executives, which is nobody has got fired for buying MS, or for buying Oracle, or for buying SAP or whatever. There is a mentality 'well, everybody else uses MS, so why don't we?' [...] that (.) that can often be difficult to sell. It can be very difficult to convince some people that are (.) are in that mindset. And, normally because they are being very defensive. They (.) they are trying to minimise on that risks to themselves – C08 I think the appreciation of IT and its ramifications (.) and again you can go back to the (.) this mess with the HMRC and their twenty-five million records. The problem was, I believe, that the senior management didn't understand the consequences of the decision they were being asked to make – C09
Features	Directors; managers; executives; present ideas to management; change in the organisation; factors in decision making process - decide weighing up on license; cost of ownership; skills of personnel; assisting mindset; defensive mindset; management want to minimise own risks; appreciation of IT; appreciation of the ramifications of decisions; understand consequences of decisions
Description	refers to the perception of confidence to use OSS given the involvement of management and the appreciation of decisions about IT.

Table 5.25 *Innovativeness*

Supporting Evidence	they are generally seen as more flexible, forward looking companies, most conservative. Um um usually it is companies with the great eh (.) which do have in-house knowledge and are prepared to use their in-house knowledge to reduce their cost [...] I would say that the skill level is (.) required is generally a bit higher for OSS [...] you have to have technically able people. Um but once you got those creative people, they can do a lot more work than they can do with closed-source software – C02 we try and keep an Open mind, and a broad view um and to use the resources that we find are around us [...] central to it were two things. First of all, a wish formulated long ago, not to get tied to MS. And second, having somebody around who was already fluent in Linux [...] And therefore, was able to provide the support on site – C05 From a personal point of view, initially it was curiosity. I've heard and read all this claims about this software, and what it could do, and it didn't cost me anything. Well, and so, I thought OK, we'll give it a go. See if it lives up to its claims [...] So, over a period of about twelve months, uh, I personally built all the things that we've been talking about with it – C06 you've got to learn to navigate your way round to finding the right person. Now that takes a little bit of doing, but once you get used to doing it, its not that difficult [...] The major skill is (.) is the ability to go out and find things that solve your problem. One of the things you get used to in the Open Source world, is the idea that very probably, somebody has already solved this problem. So, I'll go out and look for that, rather than trying to solve the problem [...] its an attitude of mine that says lets assume that somebody has already done this or something very like this. Lets go and look for it and see if its useful to us [...] And what more, you can do it as an (.) apart from your time in evaluating it, at almost no cost operation – C09
Features	flexible mindset; in-house knowledge; objective use of OSS; creative staff; open mindedness; use of available OSS resources; need for freedom of choice; have in-house capability; curiosity; explore claims; trials; navigating to a support community; ability to explore existing solutions
Description	refers to the perception of confidence to explore OSS resources and the OSS support-community, enabled by internal qualities such as open mindedness, creative staff, and in-house IT capability.

Table 5.26 *Capital Investment*

Supporting Evidence	If you don't have best expertise yourself or the time to develop that expertise, then you need to hire-in. Um In hiring-in, it may possibly be more expensive than hiring-in corresponding MS certified engineers – C01 one of the main issues is training of staff. Um Making sure that the staff are aware how to use the new software [...] what you gain, um in not having to pay licenses, obviously, you have to spend in training – C03 big organisation who use Windows have a problem when they um switch to a new version of the operating system. And they have to get a call centre to back their front-line IT core people. And it (.) its a painful process and this is what keeps the IT support people in business. The need for their services is always there. What I am saying here is that, there is not a fundamental qualitative difference between Windows um MS on one hand and OSS on the other hand, in terms of the amount of resources needed to deploy it in real life companies – C05 really the cost of a software in any project is actually quite small. But depending on the project, but often, the software cost is quite small compared to the support, maintenance, training [...] the other challenge is staffing [...] Often there is a little bit more involved on a Linux side in understanding what goes on [...] it is a bit more difficult to (.) to for example set-up a web server on Linux, to administer firewall or whatever. I mean, there are things that would to make it easier, but its (.) its not (.) its a more difficult um it s a more difficult task in some respect, and fewer people have those skills – C08
Features	hiring-in expenses; staff training expenses; external call centres; external IT support services; needed resources; costs in of support; maintenance; and training
Description	refers to the perception of need for resources to aid the development of IT capabilities and incorporates resources such as time and money.

The seventh category is resource facilitating conditions and consists of one factor – capital investment – which is supported by evidence from case C01, C03,C05 and C08 (see Table 5.26 Capital Investment).

Table 5.27 *Internet Connectivity*

Supporting Evidence	The Internet is key. Um Realistically, if you have a software that is implementing that, you are obviously using computers. And, Internet based information is where most eh most information is going to come from [...] there are Wiki, there are blogs, there are various articles on the Internet about how to use specific pieces of software, and how to use specific pieces of software for a particular a task [...] I would never have started using it actively if it wasn't for the Internet because I won't have been able to get a copy of it. Um so yeah, without the Internet, I don't think OSS could exist in its current form [...] the very first thing you do when you install Linux distribution is connect it to the Internet and download the updates – C03 you need to be able to connect to a community of like-minded users who will help you out when you get stuck. And I have to admit it, when you get stuck, not if you get stuck [...] If you are able to connect to such a community, they don't have to be local. In fact, so much of the communication now is via the Internet um including chat and email. But they don't need to be local at all – C05 increasingly, most of that sort of material is on-line material. Um And you (.) now, you are getting people like universities putting their courses off on-line. So, um there are generally quite a lot of tutorials and things on-line. um Obviously, you need to be shown how to get yourself on-line. Um But once you are connected with a browser, uh generally that's pretty straight forward, Um then, um finding your way is the same way to, is the usual sources like Google, um which gets you to the right thing – C09 if there is a serious problem, you have to go to the Internet, and um log on to one of the (.) sort of self-help groups [...] the Internet is far more useful than magazines [...] Yes, much more useful [...] you've got instant communication [...] Because you can (.) for example, if (.) if there was a problem using eh OSS such as OpenOffice, um there is a web site for OpenOffice and you log on to that um there is a (.) in the forum (.) help forum [...] Eh you can log on there and leave a message [...] Eh about the details of your problem. And usually within a day, somebody will get back to you – C10
Features	Google; Internet; Internet based information; Wiki; Blogs; Internet publication; connect to community; chat; email; on-line material; tutorials; self-help groups; instant communication; web site; help forum
Description	refers to the perception of the need for Internet-based connectivity to enable low-bandwidth and high-bandwidth network tasks through Internet channels such as web sites, email, Wiki, help forums, and download services.

The eighth category is technology facilitating conditions and also consists of one factor – Internet connectivity – which is supported by cases C03, C05, C09 and C10 (see Table 5.27 Internet Connectivity).

5.6 Summary

This chapter presented the analysis of empirical data which led to the identification of 16 factors influencing the adoption of OSS by the SMEs in this study. In doing so, this chapter has fulfilled the first research objective set out in section 1.4. The 16 factors were identified from the interview data collected across 10 IT SMEs and formed theory-building factors in this study. The identification and description of the factors follows the field research processes undertaken, including the selection of sample cases, the development of case transcripts, and the use of relevant analysis techniques to identify, classify and triangulate supporting evidence. A summary of these analysis processes will now be presented.

The sampling of 10 cases in this study was discussed in section 5.2.1, which argued that the selected cases provided rich and diverse information for this study. The discussion also argued that the sampling of the cases allowed for a comparison of factors across all cases, aiding the cross-case analysis of the factors. Following that, the use of conventions from Conversation Analysis (CA) in the development of interview transcripts was discussed in section 5.2.2. This approach enabled us to better organise the qualitative data gathered and recorded in the interview transcripts. The use of Conversation Analysis conventions also enabled us to format the transcripts to a common standard which was important owing to the variation in the interactions with the different participants.

The theoretical framework used in the data analysis was discussed in section 5.3, showing the theoretical concepts and related categories applied in the identification and classification of factors influencing the adoption of OSS by the SMEs in this study. The use of the theoretical concepts also showed the link between the research theoretical framework developed in section 3.3 and the data analysis processes.

The within-case analysis stage of the qualitative data analysis was discussed in section 5.4. This analysis stage led to the identification of qualitative evidence and the categorisation of the evidence using the theoretical concepts derived from relevant text segments, which provided evidence of a factor that influenced the adoption of OSS by the case SME. Thus, the within-case analysis was used to explore factors in individual cases.

The cross-case analysis stage of the qualitative data analysis was discussed in section 5.5. This analysis stage brought together similar factors from all cases into a frequency analysis table. The table was used in selecting factors with a minimum frequency of 4four thus establishing the scale of evidence for supporting theory-building factors and a high analytical generalisability of the theory-building factors in this study. Then, the selected factors and their supporting evidence were used in an initial description of the factors based on the definitions of the theoretical concepts presented in section 5.3.

Having identified theory-building factors in this chapter, the factors and their influence on the adoption of OSS in this study will be discussed in the next chapter which also presents an emergent theory of OSS adoption by SMEs in this study.

6

Research Findings

6.1 Introduction

The previous chapter presented the analysis of case study data which led to the identification of factors influencing the adoption of OSS by SMEs in this study. This chapter presents an emergent theory of OSS adoption and discusses the implications of the research findings, including the empirical factors and theory in general, from research and practice perspectives. The theory provides an explanation of factors and their influences on the adoption of OSS in this study. Thus, the theory fulfils the second research objective and presents an answer to the research question (both set out in section 1.4).

The aim of this chapter as presented above has two key strands. First, the emergent theory will be discussed, explaining the empirical factors and their influence using the theoretical framework of OSS adoption developed in section 3.3, using the Decomposed Theory of Planned Behaviour (DTPB) as the underlying theory of adoption. Second, the implications of the emergent theory will be discussed, focusing on the relevance of the theory in relation to OSS adoption in research and practice. These issues lead to the five sections of this chapter, and then, a chapter summary at the end. The five sections will now be introduced.

Section 6.2 presents an emergent theory of OSS adoption for this study, which is represented as the empirical model for explaining the factors identified and their influence on the adoption of OSS by SMEs in this study. Thus, this section will present the structure of the empirical model, showing the empirical factors and concepts from the theoretical framework developed in section 3.3.

In section 6.3, the attitudinal factors in the empirical model presented in section 6.2 will be discussed. The discussion will present the definition of the factors and explain their influence on the adoption of OSS by SMEs in this study. In doing so, the technological factors discussed in chapter 2 will be used for a comparison and validation of the factors.

Section 6.4 discusses the normative factors presented in the empirical model in section 6.2, presenting the definition of the factors and an explanation of their influence. The definition of the factors will be supported by a comparison and validation with the socio-environmental factors discussed in chapter 2.

The perceived behavioural control factors in the empirical model will be discussed in section 6.5, presenting a definition of the factors and an explanation of their influence on the adoption of OSS by SMEs in this study. In doing so, the organisational factors discussed in chapter 2 will be used to compare and validate the factors.

Section 6.6 discusses the implications of the empirical factors from sections 6.3 to 6.5 and the theory as a whole, from research and practice perspectives. Initially, the discussion argues for the generalisability of factors and the emergent theory developed in this study. Then, arguments are presented about the relevance of the emergent theory which can be used by IT SME owner-mangers, other policy-makers and practitioners as a reference framework for understanding the adoption of OSS.

6.2 An Emergent Theory of Open Source Software Adoption

This section presents a theory of OSS adoption developed in this study. The theory comprises of the factors from the analysis in section 5.5 and uses the research theoretical framework (see, sections 5.3 and 3.3) to explain the factors and their influence on the adoption of OSS in this study. The theory is represented as a graphical empirical model in Figure 6.1, showing the empirical factors and the theoretical concepts from the theoretical framework used in this study. This discussion will now continue with an overview of the empirical model.

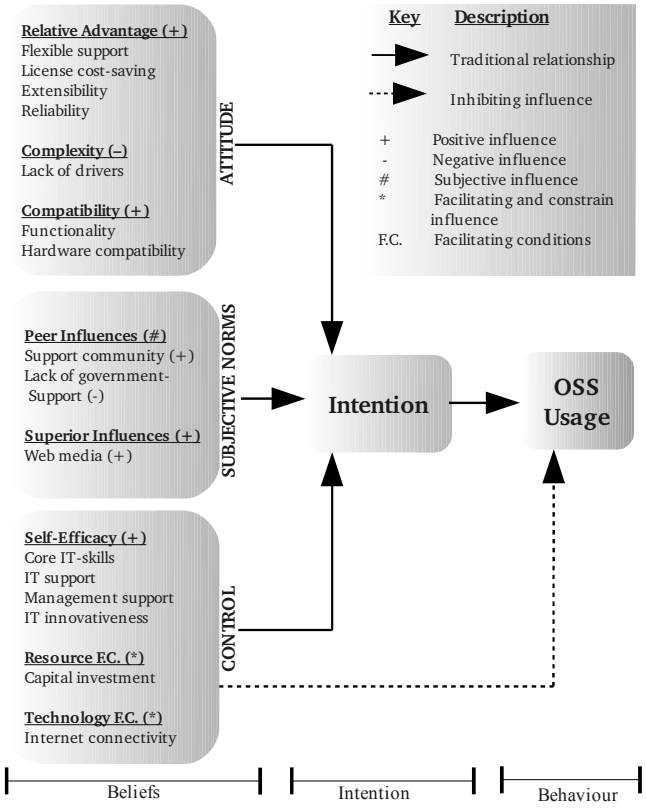

Figure 6.1 An Empirical Model of Open Source Software Adoption by IT SMEs

The empirical model presented in Figure 6.1 shows that OSS adoption, as defined in section 3.3, is a complex process of multiple decision making, consisting of four stages – factors and belief structures; belief components; intention; and behaviour – which represent the chain of interrelationships between the theoretical concepts and explain the influence of factors on the adoption of OSS in this study. These theoretical concepts were defined in section 3.3 and their role in the empirical model will now be discussed.

Figure 6.1 shows that the first stage of adoption consists of factors and belief structures. It also shows that the belief structures used in this study are relative advantage, complexity and compatibility (see definition in section 3.3.1), peer influences and superior influences (see definition in section 3.3.2), self efficacy, resource facilitating conditions and technology facilitating conditions (see definition in section 3.3.3). These belief structures were used as categories (see section 5.3) for the identification and classification of factors during the empirical data analysis stages of this study (see sections 5.4 and 5.5). These belief structures provide the theoretical concepts used in defining the empirical factors in this chapter.

Therefore, the definitions of the factors developed in this chapter will show the link between the empirical data and the theoretical framework used throughout this study. The factors within each belief structure, as shown in Figure 6.1, are now introduced.

As shown in Figure 6.1, the first belief structure is relative advantage, consisting of four factors: flexible support, license cost-saving, extensibility, and reliability. The second belief structure is complexity, and consists of a single factor – lack of drivers. The third belief structure is complexity, which consists of two factors: functionality and hardware compatibility. The fourth belief structure is peer influences, consisting of two factors: flexible OSS-community and lack of government support. The fifth belief structure is superior influences, and consists of a single factor – Web media. The sixth belief structure is self-efficacy, which consists of four factors: core IT-skills, IT support, management support, and innovativeness. The seventh belief structure is resource facilitating conditions, consisting of a single factor – capital investment. The eighth belief structure is technology facilitating conditions, and consists of a single factor – adequate Internet connectivity.

Figure 6.1 shows that the second stage of adoption consists of three belief components: attitude (see definition in section 3.3.1); subjective norms (see definition in section 3.3.2); and perceived behavioural control (see definition in section 3.3.3). The relationships between these belief components and their belief structures were explained in section 3.3. These relationships extend the explanations of the influence of factors because they allow us to explain their influence on the belief components. Therefore, the discussions will include an explanation of the influence of factors on the belief components.

The third stage of adoption is intention, as shown in Figure 6.1 and defined in section 3.3. This concept is related to the three belief components – attitude, subjective norms, and perceived behavioural control – and the relationships were explained in section 3.3. These relationships also extend the explanations of the influence of factors because they allow us to explain the influence of factors on intention. Therefore, the explanation of factors will include their influence on intention.

It is also shown in Figure 6.1 that intention has a direct influence on OSS usage, which is also defined in section 3.3. This relationship, also explained in section 3.3, extends the explanations of the influence of the factors because it allows us to explain the influence on OSS usage. Therefore, the explanation of factors will include their influence on OSS usage.

Having briefly introduced the empirical factors and theoretical concepts in the empirical model in Figure 6.1, and given a guide to their use in explaining the adoption of OSS, the factors will now be discussed in greater detail. The discussion will explain the theory of OSS adoption developed in this study. In doing so, two key points will be discussed.

First, the definition of each factor is presented and justified using the support of relevant empirical evidence and literature. The justification will show that each factor is defined based on the fit of the empirical evidence with the theoretical framework used in the data analysis (see section 5.3). The justification will also show the links between the empirical evidence and the theoretical framework used in this study. The definition of each factor will be supported by evidence from multiple cases, in a triangulation process that enhances the theoretic and analytical generalisability of the empirical factors (see section 5.5.4 and Mayring 2007; Meredith 1998; Patton 1999), and will provide alternative contexts for the factors. The alternative contexts provide important insights into the diverse contexts and a profile for better identifying and understanding the factors. The use of multiple contexts will show that the explanations of the factors in this study are based on research rigour in the use of multiple sources of evidence, and this enhances the validity of the factors and emergent theory of OSS adoption in this study (see discussion in section 4.9.1).

In further enhancing the validity of factors, and where there is adequate information to do so, the factors will be compared to relevant literature. This process of comparative literature analysis (Mayring 2007) will allow us to support our research findings with evidence from the literature, leading to stronger arguments about the analytical generalisability or transferability (Malterud 2001; Metcalf 2005; Rowlands 2003) in the empirical factors that will be discussed.

The second point is the application of the empirical model in Figure 6.1 to explain the influence of the factors on the 'belief components', 'intention' and the 'actual use of OSS'. The explanations provide an understanding of the factors and why they influence the adoption of OSS by SMEs and will test the consistency of the factors' influences on OSS adoption against the research propositions discussed in section 3.3. The test of consistency of factors with the research propositions allows us to establish the external validity of the empirical factors, which also enhances their theoretic and analytical generalisability (Meredith 1998; Yin 2003) to other studies or settings of OSS adoption by IT SMEs.

6.3 Attitudinal Factors Influencing OSS Adoption

The discussion will now explain the attitudinal factors and their influence on OSS adoption as shown in Figure 6.1. The factors will be explained according to their belief structures: relative advantage (section 6.3.1), complexity (section 6.3.2), and compatibility (section 6.3.3).

6.3.1 Relative Advantage Factors

Figure 6.1 shows that relative advantage (see details in sections 3.3 and 5.3) contains four factors: flexible support, license cost-saving, extensibility, and reliability, which will now be discussed in detail. The discussion will examine these factors in terms of the economic benefits, image enhancement, convenience and satisfaction benefits in using OSS and, therefore, as motivations or drivers in the adoption of OSS. Afterwards, the influences of these factors on the adoption of OSS will be explained.

Flexible Support

The first factor is flexible support. Based on the triangulation of related data (see Appendix F.1 – Flexible IT-Support), this factor is defined as a perception of the convenience of using OSS over a predecessor system and incorporates features such as access to free-support, public-access support, customised support, and cooperative support. The justification for this definition is that evidence from multiple cases fit with the feature 'convenience benefit' in using OSS and, therefore, suggests that the evidence are contexts of 'relative advantage' (see section 5.3) and forms of flexible support. To support this argument, three forms of flexible support will now be discussed.

The first form is access to free-support. The participant in case C04 observed that free-support makes OSS convenient to use because it allows OSS users the benefit of direct interaction with developers when resolving problems (see case C04, Appendix F.1 – Flexible IT-Support). The participant in case C03 observed that access to direct help from the OSS projects community is an advantage over commercial software where one is unlikely to have access to such help (see case C03, Appendix F.1 – Flexible IT-Support).

The second form is public-access support. The empirical evidence suggests that there is openness and therefore convenience of access to support in using OSS because of the public-access to, and provision of, support (see case C05, Appendix F.1 – Flexible IT-Support). The participant in case C05 also observed that there is no limit to who can participate in resolving problems with the software (see case C05, Appendix F.1 – Flexible IT-Support), suggesting

that cooperative and collaborative efforts in OSS communities enhance the convenience of providing public support.

The third form is customised support. The participant in case C09 observed that customised support enabled OSS users to get help on a one-to-one basis, more focused on individual user needs and problems with using OSS (see case C09, Appendix F.1 – Flexible IT-Support), thus suggesting that users get the convenience of personalised help and support services that are focused on individual/user problems.

While the above forms of flexible support suggest that there are diverse forms of support for the use of OSS, the discussions in the literature analysis (see section 2.4.2 and Dedrick and West 2004; Geira 2004; Wang and Wang 2001) suggest that there is lack of support for OSS. Some studies have argued that access to support is difficult due to limited IT staff with skills necessary to support complex OSS requirements (Dedrick and West 2004; Geira 2004) and that technical support for OSS from commercial entities was scare but comprehensive (Wang and Wang 2001). However, the increasing popularity of OSS appears to be changing these views. For example, the factor 'flexible support' identified in this study and recent literature (see, for example, Fitzgerald 2006; Geira 2004; Lakhani and von Hippel 2003; Overby *et al.* 2006), suggests that OSS support is accessible from diverse sources, including in-house IT staff or commercial entities who provide customised support, and the OSS community which provides free and public access support. Thus, while there appear to be varying views on access to support in OSS adoption, the diverse arguments and forms of flexible support identified in this study show that this is an important factor that influences the adoption of OSS.

License Cost-Saving

The second factor is license cost-saving. Based on the triangulation of related data (see Appendix F.2 – License Cost-Saving), this factor is defined as a perception of economic benefit in using OSS and incorporates features such as cost-free licenses, liberal licensing-laws, and public access. This definition was developed based on the fit of evidence from multiple cases with the feature 'economic benefit' in using OSS, thus suggesting that the evidence are contexts of 'relative advantage' (see section 5.3) and forms of license cost-saving. Three forms of license cost-saving will now be discussed in support of this argument.

The first form is cost-free licenses. The empirical evidence from the participant in case C01 suggests that free OSS licenses eliminate software license acquisition costs, and this was an

economic benefit to them (see case C01, Appendix F.2 – License Cost-Saving). This view of economic benefit is also supported by some characteristics of OSS: the license is free; the software is distributed through publicly open channels thus reducing costs for access; and licenses do not expire, therefore eliminating the need and costs associated with license auditing (Open Source Definition – OSD Version 1.9).

The second form is liberal licensing-laws. The participant in case C02 observed that liberal licensing-laws on OSS creates more cost-savings per license because an OSS license allows use of multiple copies of the software (see case C02, Appendix F.2 – License Cost-Saving). The participant in case C04 also observed that not having to pay for licenses for each and every test server that is set up is a huge benefit (see Appendix F.2 – License Cost-Saving), suggesting an accumulative benefit in per server license cost saving.

The third form is public access. The evidence in this study suggests that OSS licenses offer a fair license cost-saving to all regardless of individual or corporate status. The participant in case C05 observed that this is because OSS is free to the general public regardless of firm size, business sector, geographical location or organisational IT-capacity, unlike most proprietary software which are traditionally private, sequestered and exclusive (see case C05, Appendix F.2 – License Cost-Saving).

Cost saving was discussed in the literature analysis (see section 2.2.1 and Dedrick and West 2003; Fitzgerald and Kenny 2003; Forrester Consulting 2007; Geira 2004; Holck *et al.* 2004; Larsen *et al.* 2004; Valimaki *et al.* 2005). Some studies acknowledge that there is a zero acquisition cost in the procurement of OSS licenses because they are 'free' to access and re-distribute (Fitzgerald 2004; Geira 2004; Holck *et al.* 2004; Kumar and Krishnan 2005). The context of cost saving in the literature supports the context of 'cost-free licenses' identified in this study and therefore extends the analytical generalisability of license cost-saving as defined in this study. However, the diverse contexts of financial savings-related factors identified in this study suggests that there is limited understanding of cost and cost savings related issues in the adoption of OSS. The issue of cost saving is expected to be of importance to SMEs who are characterised as having scarce resources including money and human resources (Houghton *et al.* 2001; Martin 2005; Martin and Matlay 2003; Poon and Swatman 1999; Simpson and Docherty 2004).

Extensibility

The third factor is extensibility. Based on the triangulation of related data (see Appendix F.3 – Extensibility), this factor is defined as a perception of convenience in using OSS and incorporates features such as: public access to source code, freedom to modify OSS, and freedom of choice. The justification for this definition is that evidence from multiple cases fits with the feature 'convenience benefit' in using OSS and therefore suggests that the evidence are contexts of 'relative advantage' (see section 5.3) and forms of extensibility. This argument will now be supported using three forms of the factor.

The first form is access to source code. The empirical evidence suggests that there is a convenience in being able to access source code which allows the customisation of OSS to an organisation's own needs, and the use of source code to develop or extend a new innovation. The participant in case C03 observed that access to source code enables users to independently modify the source code to adapt it to their needs (see case C03, Appendix F.3 – Extensibility). The participant in case C05 also observed that many users want to do innovative things that are not available from their vendors and therefore need the convenience of independent software development (see case C05, Appendix F.3 – Extensibility).

The second form is freedom of choice. The participant in case C05 observed that many software users want the freedom of choice of software that suits their needs rather than being tied to particular software from particular vendors (see case C05, Appendix F.3 – Extensibility). The participant in case C09 also observed that freedom of choice provides users with the convenience to independently select, upgrade and replace OSS according to the needs of the user rather than the mandated directions of the vendor and that this enable users to explore alternative software solutions or find more appropriate solutions (see case C09, Appendix F.3 – Extensibility). The freedom of choice gained from unrestricted access and choice is a particular characteristic of OSS licenses (see, Open Source Definition: OSD version 1.9 – www.opensource.org/docs/definition.php), suggesting that the freedom of choice in these views allows user the flexibility of selection and application of OSS.

The third form is freedom to modify software. The freedom to modify OSS is important and allows users the convenience to adapt OSS to their needs. The participant in case C08 observed that freedom to modify OSS allows users the convenience to independently develop software solutions that meet their demands for high-quality or high-specification software

(see case C08, Appendix F.3 – Extensibility). This is consistent with the open access to OSS source code which is a characteristic of OSS licenses (see OSD version 1.9).

The extensibility of OSS is one of the quality characteristics that was discussed in the literature analysis (see section 2.2.4 and Fitzgerald 2004; Overby *et al.* 2006; Raja and Barry 2005; Wang and Wang 2001). The extensibility of OSS has also been discussed in terms of customisability, robustness and reusability (Fitzgerald and Kenny 2003; Mannaert and Ven 2005; Valimaki *et al.* 2005). Although there is little help with the theoretical definition of this factor in the literature, its identification in diverse forms in this study, and its general discussion in the existing literature, suggests that it is an important characteristic and a factor that influences OSS adoption. In particular, the extensibility of OSS, which is enabled by access to the source code, was identified to be important to SMEs in the software development industry. Other forms of extensibility identified in this study (see above, 'freedom of choice' and 'freedom to modify software') also provide useful contexts for understanding this factor, more so we would argue than from the existing literature.

Reliability

The fourth factor is reliability. Based on the triangulation of related data (see Appendix F.4 – Reliability), this factor is defined as a perception of satisfaction in using OSS and incorporates features such as: high availability and scalability, high security, and low maintenance. This definition was developed based on the fit of evidence from multiple cases with the feature 'satisfaction benefit' in using OSS and therefore representing contexts of 'relative advantage' (see section 5.3) and forms of reliability. To support this argument, three forms of reliability will now be discussed.

The first form is high availability and scalability. The evidence suggests that the users were satisfied with the high quality of the OSS. The participants of case C03 and case C08 observed that OSS, such as the Linux operating system satisfies users needs for computing systems capable of high availability and scalability (see cases C03 and C08, Appendix F.4 – Reliability). The participant in case C01 also observed that there is high quality in OSS as a result of the collaborative approach in the development community (see case C01, Appendix F.4 – Reliability).

The second form is low maintenance. The participant in case C06 observed that little or no maintenance was required in their undisrupted use of services based on OSS over a long

period (see Appendix F.4 – Reliability). This view suggests that the user was fulfilled and gratified by the little effort required for service continuity using the OSS.

The third form is high security. There appears to be user satisfaction with the high security of some OSS, such as the Linux operating system. The participant in case C08 observed that Linux is highly secure, leading the competition in this respect (see Appendix F.4 – Reliability). This view about the quality of OSS has the support of the participant in case C01 who observed that the collaborative approach in the development community leads to high quality in OSS (see case C01, Appendix F.4 – Reliability).

Reliability in OSS is another quality characteristic that was discussed in the literature analysis (see section 2.2.4 and Glynn *et al.* 2005; Holck *et al.* 2004; Kumar and Krishnan 2005; Overby *et al.* 2006; Raja and Barry 2005). The views from some of these studies suggest that high reliability in OSS reduces IT expenditure (Holck *et al.* 2004; Kumar and Krishnan 2005) and this is consistent with the 'low maintenance' form of reliability identified in this study. Fitzgerald (2004) has also argued that high standards, configurability and robustness are some of the quality characteristics that make OSS such as Apache, Bind and the Linux operating system now seen as leading competitive products. These qualities fit with the 'high availability and scalability' features identified in this study and also suggest that while the quality characteristics of OSS are diverse and the knowledge about them is still emerging, there are key quality characteristics that drive the popularity of some OSS, such as those mentioned in this discussion.

Influence of Relative Advantages on OSS Adoption

The four factors of relative advantage – flexible support, license cost-saving, extensibility, and reliability – have a positive influence on attitude towards the use of OSS. The justification for this relationship is that each factor, as discussed in section 6.3.1, is a form of 'relative advantage' which itself has a positive influence on 'attitude' (see Figure 6.1). This justification is consistent with proposition 1a which suggests that relative advantages have a positive influence on attitude toward the use of an OSS (see section 3.3.1). Based on the relationship and the definition of attitude (see section 3.3.1), we argue that the factors lead to the perceptions that using the particular OSS is good or favourable for the organisations.

The four factors also have a positive influence on the intention to use OSS, owing to their positive influence on 'attitude', which itself has a direct influence on intention (see Figure 6.1). This relationship is consistent with proposition 1 (see section 3.3.1), which suggests that

attitude towards the use of OSS has a direct influence on intention. The relationship and the definition of intention (see section 3.3.4) leads us to the explanation that the factors have a positive influence on the evaluation of all beliefs related to the use of the particular OSS.

There is a positive influence by the factors on the actual usage of OSS. This relationship stems from the factors' positive influence on 'intention' which itself is the immediate determinant of 'usage' (see Figure 6.1). The 'intention'–'usage' direct-relationship is consistent with proposition 5 (see section 3.3.4), which suggests that intention to use an OSS has a direct influence on actual usage. Therefore, based on this relation and the definition of 'usage' (see section 3.3.4), we suggest that the factors have a positive influence on the confirmation of use or implementation of the OSS.

6.3.2 Complexity Factor

The second belief structure in Figure 6.1 is complexity (see details in sections 3.3 and 5.3). This belief structure contains a single factor – lack of drivers – which will now be examined in terms of the difficulty in understanding, learning and using OSS and, therefore, as a barrier to the adoption of OSS. Afterwards, the influences of this factor on the adoption of OSS will be explained.

Lack of Drivers

Based on the triangulation of related data (see Appendix F.5 – Lack of drivers), 'lack of drivers' is defined as the perception of difficulty in understanding, learning and using OSS due to the lack of software specifications and poor support from manufacturers. The justification for this definition is that evidence from multiple cases fits with the feature 'difficulty' in using OSS and therefore, suggests that the evidence are contexts of 'complexity' (see section 5.3) and forms of lack of drivers. Two forms of this factor will now be discussed in support of this argument.

The first form of the factor is lack of software specifications. The participant in case C01 observed that some hardware manufacturers do not release software specifications that allow the OSS community to develop drivers, leading to poor support for the related hardware (see case C01, Appendix F.5 – Lack of Drivers). This suggests that the lack of the hardware drivers makes it difficult to use OSS.

The second form is poor support from hardware manufacturers. The empirical evidence suggests that it is difficult to use modern hardware under an OSS platform because some

proprietary hardware manufacturers do not provide the OSS community with support for drivers of modern hardware such as laptops, home-PCs, graphics cards and wireless network devices (see case C02, Appendix F.5 – Lack of Drivers).

The importance of support for OSS adoption was discussed in the literature analysis (see section 2.4.2 and Fitzgerald and Kenny 2003; Geira 2004; Dedrick and West 2004; Wang and Wang 2001). While there appears to be little focus on the lack of proprietary hardware driver support under OSS platforms, the identification of forms of 'lack of drivers' in this study enhances knowledge of the potential challenges in the use of OSS and therefore this factor is relevant to the adoption of OSS. However, the increasing popularity of OSS and the increasing participation of proprietary hardware manufacturers in delivering OSS bundled hardware infrastructure (for example, Asus Eee PC, HP Mini 2133, Intel OLPC, and Toshiba Protege, Accton VM3228T and Google Android), may be changing the views related to a lack of drivers for OSS platforms.

Influence of Complexity on OSS Adoption

The single complexity factor – lack of drivers – has a negative influence on attitude towards the use of OSS. The justification for this relationship is that lack of drivers, as discussed in section 6.3.2, is a form of 'complexity' which itself has a negative influence on 'attitude' (see Figurer 6.1 and proposition 1b in section 3.3.1 – complexity will have a negative influence on attitude towards the use of an OSS). This relationship and the definition of 'attitude' (see section 3.3.1) allows us to explain that a lack of drivers leads to the perceptions that using the particular OSS is bad or unfavourable for the organisation.

Lack of drivers also has a negative influence on intention to use OSS. The justification for this relationship is that the factor has a negative influence on 'attitude' which itself has a direct influence on intention (see Figure 6.1). This relationship, albeit a negative influence, is also consistent with, again, proposition 1 (see section 3.3.1). The relationship and the definition of intention (see section 3.3.4) lead us to the explanation that a lack of drivers has a negative influence on the evaluation of all beliefs related to the use of the OSS.

Finally, the actual usage of OSS is negatively influenced by a lack of drivers – owing to the factor's negative influence on 'intention' which itself is the immediate determinant of OSS Usage (see Figure 6.1). This relationship is consistent with, again, proposition 5 (see section 3.3.4). Based on the relationship and the definition of 'usage' (see section 3.3.4), we argue

that a lack of drivers has a negative influence on organisations' confirmations of use or implementation of the particular OSS.

6.3.3 Compatibility Factors

Figure 6.1 shows that compatibility (see details in sections 3.3 and 5.3) contains two factors: functionality and hardware compatibility, which will now be discussed in detail. The discussion allows us to examine these factors in terms of the fit of OSS to IT needs. Afterwards, the influence of these factors on the adoption of OSS will be explained.

Functionality

The first factor is functionality. Based on the triangulation of related data (see Appendix F.6 – Functionality), this factor is defined as the perception of fit of using OSS for different IT needs such as office information processing, software development and embedded systems. The justification for this definition is that evidence from multiple cases fits with the feature 'IT needs' and therefore suggests contexts of 'compatibility' and forms of functionality. To support this argument, two forms of functionality will now be discussed.

The first form is office information processing. The empirical evidence suggests that OSS is fit for IT needs in the area of office information processing. The participant of case C01 observed that common OSS applications for most office functions are similar to their non-OSS counterparts and therefore provide fairly easy replacements (see case C01, Appendix F.6 – Functionality). The participant in case C03 also observed that OSS have been used in different work scenarios and for different organisations (see case C03, Appendix F.6 – Functionality). The participant in case C05 also observed that OSS satisfactorily fits their need for office information processing technologies such as web browser, email handling package and a good office suite (see case C05, Appendix F.6 – Functionality).

The second form is software development and embedded systems. The participant in case C05 observed that OSS such as Linux are a popular platform for embedded applications (see case C05, Appendix F.6 – Functionality). The participant in case C09 also observed that Linux appears in embedded systems such as ADSL routers and domestic set-top boxes (see case C09, Appendix F.6 – Functionality), suggesting that OSS fits with IT-needs in the area of embedded systems. The participant in case C05 also observed that Linux allows the development of a variety of applications, such as surveying equipment using GPS on ARM processors, which do not normally run under major closed-source alternatives (see case C05, Appendix F.6 –

Functionality), suggesting that Linux and other OSS can provide a significant platform for software development in an area such as embedded systems.

While this study has identified that functionality influences the decision to use OSS, this factor has also been discussed in the literature analysis on ICT adoption (see section 2.2.2 and Mehrtens *et al.* 2001; Poon and Swatman 1999; Sadowski *et al.* 2002; Schillewaert *et al.* 2005; Sillince *et al.* 1998; Stockdale and Standing 2004). Some studies acknowledge the fit of OSS with general information system needs (Dedrick and West 2004; Glynn *et al.* 2005; Kshetri 2004) and office data processing (Fitzgerald and Kenny 2003; Forrester Consulting 2007; Overby *et al.* 2006). The 'office information processing' form of functionality discussed above agrees with these views. This suggests that the usefulness of OSS in satisfying general information systems needs and office data processing needs is an important factor in the adoption of OSS. The 'software development and embedded systems' form of functionality was also discussed in the literature in terms of a flexible software development base (Donnellan *et al.* 2005; Fitzgerald 2004; Krishnamurthy 2003). This suggests an important usefulness of OSS in the software development industry and is consistent with the views of the participants in this study who are SMEs in the IT industry.

Hardware Compatibility

The second factor is hardware compatibility. Based on the triangulation of related data (See Appendix F.7 – Hardware Compatibility), this factor is defined as the perception of the fit of using OSS with existing hardware platforms from different manufacturers and classes, such as legacy, old, new, and modern hardware. The justification for this definition is that evidence from multiple cases fits with the feature 'existing values' in using OSS and therefore suggests contexts of 'compatibility' and forms of hardware compatibility. Two forms of the factor will now be discussed in support of this argument.

The first form is compatibility from a manufacturer's perspective. The evidence suggests that some proprietary hardware manufacturers do not provide hardware-driver support under OSS platforms and this reduces hardware functionality when operating under OSS platforms. The participant in case C08 observed that OSS fits with hardware from a variety of different hardware manufacturers including major manufacturers (see case C08, Appendix F.7 – Hardware Compatibility). The participant of case C04 also observed that OSS runs on most commodity hardware, more so than on proprietary standards hardware (see case C04, Appendix F.7 – Hardware Compatibility). These observations suggests that the support of hardware manufacturers is key to the fit of OSS with existing hardware platforms. From a

different perspective, the importance of manufacturer support is also evident in the factor 'lack of drivers' (see section 6.3.2).

The second form is backward-compatibility. The participant in case C04 observed that OSS platforms such as Linux are compatible with alternative classes of hardware such as legacy, old and new hardware, which can be a drop-in replacements under Linux, but can be problematic or not at all compatible with some proprietary standard hardware (see case C04, Appendix F.7 – Hardware Compatibility), such as Macintosh or SPARC.

Various studies identified in the literature analysis have discussed the Open-Standards compatibility and supportability of OSS (see section 2.2.4 and Raja and Barry 2005; Fitzgerald 2004; Fitzgerald and Kenny 2003; Overby *et al.* 2006; Valimaki *et al.* 2005). Arguably, these quality characteristics are related to hardware compatibility because Open-Standards is a framework that enables operation of OSS across on different computing hardware (Dalziel 2003; Kajan 2004; West and Dedrick 2001b). Fitzgerald and Kenny (2003) and Valimaki *et al.* (2005) also suggest that hardware compatibility, such as 'cross-manufacturer compatibility' and 'backward compatibility', as identified in this study, is an important factor that allows SMEs to leverage existing IT infrastructure in their adoption of OSS. Although there appears to be limited understanding of this factor in the literature, there is support from the findings in this research study that hardware compatibility is an important factor in the adoption of OSS.

Influence of Compatibilities on OSS Adoption

The compatibility factors – functionality and hardware compatibility – positively influence attitude towards the use of OSS. This relationship stems from the fact that each factor is a form of 'compatibility' which itself has a positive influence on 'attitude' (see Figure 6.1). This relationship supports proposition 1c (see section 3.3.1 – compatibility has a positive influence on attitude towards the use of an OSS). The relationship and the definition of 'attitude' (see section 3.3.1) allows us to explain that the factors lead to the perceptions that using the OSS is good or favourable for the organisations.

The two factors have a positive influence on intention to use OSS, owing to their positive influence on 'attitude' which itself has a direct influence on intention (see Figure 6.1). This relationship is consistent with, again, proposition 1 (see section 3.3.1). The relationship and the definition of intention (see section 3.3.4) allows us to explain that the factors have a positive influence on the evaluation of all beliefs related to the use of the particular OSS.

The factors also have a positive influence on the actual usage of OSS. This relationship is owed to their positive influence on 'intention' which itself is the immediate determinant of 'usage' (see Figure 6.1). The relationship is supported by, again, proposition 5 (see section 3.3.4). Based on the relationship and the definition of 'usage' (see section 3.3.4), we argue that the factors of compatibility positively influence the organisations' confirmation of use or implementation of the OSS.

6.4 Normative Factors Influencing OSS Adoption

The discussion will now explain the subjective norms factors and their influence on OSS adoption as shown in Figure 6.1. The factors will be explained according to their belief structures – peer influences (section 6.4.1) and superior influences (section 6.4.2).

6.4.1 Peer Influences Factors

Figure 6.1 shows that peer influences (see details in sections 3.3.2 and 5.3) contains the two factors – support community and lack of government support – which will now be discussed in detail. The discussion will examine these factors in terms of the influence of subjective moderation by external parties in the adoption of OSS. Afterwards, the influences of these factors will be explained.

Support Community

The first factor is support community. Based on the triangulation of related data (see Appendix F.8 – Support Community), this factor is defined as a perception that peers influence the development, use and spread of OSS. The justification for this definition is that evidence from multiple cases fits with the feature 'peer moderation' in using OSS and therefore suggests contexts of 'peer influences' (see section 5.3) and forms of support community. To support this argument, two forms of support community will now be discussed.

The first form is open participation in the OSS community. The empirical evidence suggests that there is a positively-moderated influence on members to participate in the OSS community, especially between technical experts, basic users and potential adopters. The participant in case C01 observed that OSS communities are open to all participants and the elite contributors or technical experts are the most recognised members who strive to improve

the community software, which attracts more users to the community (see case C01, Appendix F.8 – Support Community).

The second form is shared-support. The participant in case C05 observed that users within an OSS community are keen to help each other and such shared-support enhances the quality and popularity of the software produced in the OSS community (see case C05, Appendix F.8 – Support Community). The participant in case C06 also observed that there are very active OSS development communities and the participants are able to get support by interacting with OSS authors who are usually very keen to help users in the community (see case C06, Appendix F.8 – Support Community). These views suggest that there is a positively-moderated influence on OSS community members to support one another and promote the growth of their software, which may draw more interest from potential users outside the community.

The lack of support as a factor that influences the adoption of ICT was debated in the literature analysis (see section 2.4.2 and Chester and Skok 2000; Simpson and Docherty 2004; Stansfield and Grant 2003; Stockdale and Standing 2004). Some studies also see it as an important issue in OSS adoption and acknowledge that OSS communities are important sources of technical and information support, in terms of both free and commercial support services (Dedrick and West 2003; Fitzgerald 2006; Geira 2004; Overby *et al.* 2006; Wang and Wang 2001). The forms of support, 'open participant' and 'shared support' as identified in this research study, support these views and therefore suggests that support from members in OSS communities are important in the adoption of OSS because these provide essential informational and technical support that enables the use of OSS.

Lack of Government Support

The second factor is lack of government support. Based on the triangulation of related data (see Appendix F.9 – Lack of Government Support), this factor is defined as the perception that government agencies influence the use of OSS in the public sector. The justification for this definition is that evidence from multiple cases fits with the feature 'peer moderation' in using OSS and therefore suggests contexts of 'peer influences' and forms of lack of government support. Two forms of this factor will now be discussed in support of this argument.

The first form is poor involvement and lack of enthusiasm. Evidence from this study suggests that there is a negatively-moderated influence of government agencies in the use of OSS in the public sector. The participant in case C01 observed that while there is more government enthusiasm and involvement in the use of OSS in the public sector in EU countries such as

Germany and Spain, there is very little such involvement in OSS by the UK government (see case C01, Appendix F.9 – Lack of Government Support). The participant in case C02 also observed that there is more enthusiasm about the use of OSS in such EU countries, whereas involvement is low due the lack of such enthusiasm by procurement comparative services or government agencies (see case C02, Appendix F.9 – Lack of Government Support).

The second form is inadequate initiatives, creating a negatively-moderated influence of government agencies in the use of OSS in the public sector. This view is based on the observation that there are inadequate initiatives to use OSS in the public sector partly because government agencies responsible for procurement services lack understanding of OSS and hence see its use as risky (see case C02, Appendix F.9 – Lack of Government Support). The participant in case C03 also observed that, while the government often lacks initiatives in IT, traditionally, government are very much tied into proprietary software solutions, leading to a very low level of their take up of OSS (see case C03, Appendix F.9 – Lack of Government Support). The participant in case C10 also observed that the government lacked initiatives to give out information on Open Source, but tend to go for proprietary alternatives (see case C10, Appendix F.9 – Lack of Government Support).

The literature analysis suggests that government intervention enhances the adoption of ICT (see section 2.4.1 and Darch and Lucas 2002; Lawson *et al.* 2003; Martin and Matlay 2003; Simpson and Docherty 2004). Many studies on OSS adoption acknowledge that government initiatives and policies, especially in areas such as central Europe, have had a positive influence on OSS adoption (Benssen 2002; Kshetri 2004; Mindel *et al.* 2007; Schmidt and Schnitzer 2003; Valimaki *et al.* 2005; Wheeler 2007). In contrast, the responses from the participants across the various UK SMEs in this study suggest that there is limited government support for OSS adoption in the UK public sector, cast in terms of 'poor involvement', 'lack of enthusiasm' and 'inadequate initiatives'. These forms of 'lack of government support' show that this factor is geographically subjective and extends knowledge of socio-environmental challenges in OSS adoption in the UK.

Influence of Peer Influences on OSS Adoption

The two factors of peer influences – support community and lack of government support – have a subjective influence on 'subjective norms' about the use of OSS. This relationship stems from the positively moderating influence of 'support community' and the negatively moderating influence of 'lack of government support', which together, leads to a subjective moderating influence on the norms related to the use of OSS. This relationship is supported

by proposition 2a (see section 3.3.2) which suggests that peer influences have a subjective influence on normative beliefs about the use of OSS. Based on the relationship and the definition of 'subjective norms' (see section 3.3.2), the factors – support community and lack of government support – respectively have a subjective influence on the perception of social pressures to use, and not use an OSS.

The two factors also have a subjective influence on intention, owing to their subjective influence on 'subjective norms' which itself has a direct influence on intention (see Figure 6.1). This relationship is consistent with proposition 2 (see section 3.3.2 – subjective norms around the use of OSS have a direct influence on intention). This relationship and the definition of intention (see section 3.3.4), leads us to the explanation that the factors have a subjective influence on the evaluation of all beliefs related to the use of OSS.

The factors also have a subjective influence on the actual use of OSS. This relationship is based on the factors' subjective influence on 'intention' which itself is the immediate determinant of 'usage' (see Figure 6.1). The relationship is also supported by proposition 5 (see section 3.3.4 – intention to use an OSS has a direct influence on actual usage). Based on the relationship and the definition of 'usage' (see section 3.3.4), we argue that the factors have a subjective influence on the confirmation of use or implementation of OSS in the organisation.

6.4.2 Superior Influences Factor

Figure 6.1 shows that superior influences (see details in sections 3.3.2 and 5.3.5) contains a single factor – Web media – which will now be discussed in detail. The discussion will examine this factor in terms of the influence of secondary sources of information on the adoption of OSS. Afterwards, the influences of this factor will be explained.

Web Media

Following the triangulation of related data (see Appendix F.10 – Web media), this factor is defined as the perception that web-based information influences the development, use and spread of OSS. The justification for this definition is that evidence from multiple cases fits with the features of 'web-based information' on OSS and therefore suggests contexts of 'superior influences and forms of Web media. Two forms of this factor will be discussed in support of this argument.

The first form is software distribution. The empirical evidence suggests that the information exchange over Web media is a key enabler for the distribution of OSS information and support services and is therefore a positive moderation to use OSS. The participants in cases C03 and C05 observed that information including Internet-based documentation and the interactions between users and developers via Internet channels (such as Wiki, mailing list, forums, web sites, chat, and email) are useful resources that enable or enhance the use of OSS (see cases C03 and C05, Appendix F.10 – Web Media). The participant in case C10 also observed that users and help-desks in OSS communities exchange information about OSS and also provide interactive support information using Internet channels such as web sites and forums (see case C10, Appendix F.10 – Web Media).

The second form is software development. The participant in case C03 observed that Internet-based information on OSS is important for most people, such as developers, users, sponsors and testers, who have different interests in OSS development (see case C03, Appendix F.10 – Web Media). The participant in case C05 also observed that information available over the Internet enables remote users and developers to participate and make contributions to their OSS community by trying, testing, providing feedback on and debugging the OSS (see case C05, Appendix F.10 – Web Media). These views suggest that information exchange over Web media is important to the development of OSS and therefore has a positive moderation on the use of OSS.

The importance of web and Internet technology as a major IT infrastructure has been discussed in the literature (see, for example, Dedrick and West 2004; Holck *et al.* 2004; Houghton *et al.* 2001; Larsen *et al.* 2004; Martin 2005; Mehrtens *et al.* 2001; Sadowski *et al.* 2002; West and Dedrick 2001). This study has also identified that the 'Web' is an important IT infrastructure and an essential OSS adoption enabler because it is a key source of, and channel for, the distribution of OSS products, informational and technical support and other services that facilitate the use of OSS. Consistent with the forms of Web media discussed above, many studies agree that the 'Web' represents a primary domain for OSS products, supporting information and services which are provided by OSS projects and communities (Dedrick and West 2003; Geira 2004; Overby *et al.* 2006; Wang and Wang2001). As a key source of the OSS innovation, the importance of Web media in terms of contents and services cannot be overlooked and therefore it is an important factor in the adoption of OSS.

Influence of Superior Influences on OSS Adoption

The single factor of superior influences – Web media – has a positive moderating influence on the 'subjective norms' related to the use of OSS. This relationship, also shown in Figure 6.1, stems from the positive effect of the Web media, as an information-based form of 'normative influences' (Taylor and Todd 1995a, 1995b), on the norms related to the use of the OSS. This relationships is supported by proposition 2b (see section 3.3.2 – superior influences have a subjective influence on normative beliefs about the use of OSS). Based on the relationship and the definition of 'subjective norms' (see section 3.3.2), Web media have a positively moderating influence on the organisations' perception of social pressures to use OSS.

Based on their relationship with 'subjective norms', Web media also have a positively moderating influence on intention, owing to the direct influence of 'subjective norms' (see Figure 6.1). This relationship is also supported by proposition 2 (see section 3.3.2). Based on the relationship and the definition of intention (see section 3.3.4), Web media has a positively moderating influence on the evaluation of all beliefs related to the use of OSS.

Web media also have a positively moderating influence on the actual use of OSS. This relationship is based on the influence 'intention' which itself is the immediate determinant of 'usage' (see Figure 6.1). This relationship is also consistent with proposition 5 (see section 3.3.4). The relationship and the definition of 'usage' (see section 3.3.4), allows us to argue that Web media have a positively moderating influence on the confirmation of use or implementation of OSS.

6.5 Perceived Behavioural Control Factors Influencing OSS Adoption

The discussion will now explain the perceived behavioural control (PBC) factors and their influence on OSS adoption, as shown in Figure 6.1. The factors will be explained according to their belief structures: self-efficacy (section 6.5.1), resource facilitating conditions (RFC) (section 6.5.2), and technology facilitating conditions (TFC) (section 6.5.3).

6.5.1 Self-Efficacy Factors

Figure 6.1 shows that self efficacy (see details in sections 3.3 and 5.3) contains four factors: core IT-skills, IT support, management support, and innovativeness, which will now be discussed in detail. These factors will be examined in terms of the ability or confidence to use

OSS successfully in a given situation and, therefore, as staff capacity to use OSS. The discussion will then present an explanation of the influence of these factors on the adoption of OSS.

Core IT-Skills

The first factor is core IT-skills and is defined as the perception of the ability to use OSS successfully in the given situation. This definition evolved from evidence which fits with the feature 'ability' to use OSS and therefore suggests contexts of 'self-efficacy' and forms of core IT-skills. To support this argument, two forms of this factor will now be discussed.

The first form is good understanding of OSS principles. The empirical evidence suggests that, for complex OSS tasks, support and maintenance, there is a need for relevant technical training or technical qualifications that provide a good understanding of OSS principles. The participant in case C03 observed that specific technical qualifications are essential for supporting complex problems such as Linux Networking (see case C03, Appendix F.11 – Core IT-skills). The participants in cases C04, C05 and C06 also observed that a trained or professional level capability with OSS may be necessary for technically demanding tasks such as those of programmers and network infrastructure engineers (see cases C04, C05 and C06, Appendix F.11 – Core IT-skills).

The second form is general knowledge of IT. The participant in case C06 observed that basic use of OSS requires a general or operational knowledge of IT especially when the user-tasks are similar to those performed on other software platforms, allowing users to apply transferable IT skills and experiences from different areas of IT (see case C06, Appendix F.11 – Core IT-skills).

The importance of IT skills in the adoption of ICT was discussed in the literature analysis (see section 2.3.3 and Lawson *et al.* 2003; Martin and Matlay 2003; Saloheimo 2005; Taylor and Murphy 2004). The two forms of 'core IT-skills' identified in this study also suggest that IT-skills is an important factor in the adoption of OSS. The importance of general knowledge of IT, which can also be viewed as 'transferable skills', has been discussed in a selected studies (see, for example, Dedrick and West 2004; Donellan *et al.* 2005), suggesting that organisations with existing IT skills relevant to OSS requirements are better able to migrate or adapt to a new OSS environment.

IT Support

The second factor is IT support and is defined as the perception of confidence to use OSS given the support of technical and informational assistance from internal or external sources. The justification for this definition is that various sources of evidence fit with the feature 'confidence' to use OSS and that suggests contexts of 'self-efficacy' and forms of IT support. Two forms of this factor will now be discussed in support of this argument.

The first form is technical and informational support. There are different types or levels of support, such as technical and information help, that are required for using OSS and for systems maintenance, as observed by the participant in case C08 (see Appendix F.12 – IT Support). The views of the participant in case C09 also suggest that basic users and technical users require different types or levels of assistance because basic users often want simple instructions to help them use the software while technical users often want technical or complex information about the software (see case C09, Appendix F.12 – IT Support).

The second form is internal and external support. The empirical evidence suggests that support is essential especially during the learning stages of changing to OSS, and external sources of support such as consultants and the OSS community can provide complimentary assistance (see case C02, Appendix F.12 – IT Support). The participant in case C05 also observed that it is necessary to have in-house staff in a similar role to a help-desk, with the relevant skills to deal with on-the-spot problems and to help users get on with using their OSS systems (see case C05, Appendix F.12 – IT Support).

The importance of IT support in SME adoption of ICT was debated in the literature analysis (see section 2.4.2 and Chester and Skok 2000; Simpson and Docherty 2004; Stansfield and Grant 2003; Stockdale and Standing 2004). Some studies acknowledge that IT support is an important issue in OSS adoption (Dedrick and West 2004; Fitzgerald and Kenny 2003; Geira 2004; Overby *et al.* 2006; Wang and Wang 2001). While the forms of IT support identified in this research study agree with these views, there is limited understanding of this factor in the literature. The diverse forms of IT support identified in this research study suggest that there is variation in IT support for OSS which ranges from informational and technical support to internal and external sources of support. Thus, the diversity of IT support suggests that there is complexity and subjectivity in the nature of this factor in OSS adoption and ICT adoption in general, and that this is an important factor in the adoption of OSS. This view is shared by Chester and Skok (2000) who argue that different SMEs may have different needs for different types and levels of support.

Management Support

The third factor is management support. Based on the triangulation of related data (see Appendix F.13 – Management Support), this factor is defined as the perception of confidence to use OSS given the involvement of management and appreciation of decisions about IT. The justification for this definition is that there is evidence which fits with the feature 'confidence' to use OSS due to the involvement of management and, therefore, suggests contexts of self-efficacy and forms of management support. Two forms of this factor will now be discussed in support of this argument.

The first form is management involvement. The empirical evidence suggests that the involvement of management in the organisation is essential for successful deployment and continued implementation of OSS and enhances the confidence to use OSS, because the manager is a key decision maker who is able to accept or reject OSS initiatives from staff (see case C01, Appendix F.13 – Management Support).

The second form is appreciation of decisions about IT. The participant in case C02 observed that management needs to consider several issues about the use of OSS in the organisation since this requires investment of scarce resources for acquiring new staff or training existing ones (see case C02, Appendix F.13 – Management Support). The participant in case C09 observed that management needs to appreciate decisions about IT and have an awareness of potential challenges from such decisions (see case C09, Appendix F.13 – Management Support). These views mean that management appreciation of their decisions about IT is essential for establishing confidence in the use of OSS in the organisation.

The literature analysis in this study has discussed the importance of the SME owner-manager involvement in supporting the adoption of OSS in the organisation (see section 2.3.2 and Blackburn and Athayde 2000; Dedrick and West 2003; Fitzgerald and Kenny 2003). The role of the management in self-definition and innovation orientation towards OSS, as discussed in these studies, supports the 'management involvement' feature identified in this research study. This form of management support represents a role of the manager in defining the position of the organisation in terms of openness to the use of OSS, and an orientation towards the use of OSS represents a positive decision that favours the use of OSS. Consistent with previous studies in ICT adoption and the importance of management innovativeness (see section 2.3.2 and Gelinas and Bigras 2004; Martin 2005; Taylor and Murphy 2004), this factor is seen as important in the adoption of OSS.

Innovativeness

The fourth factor is innovativeness. Based on the triangulation of related data (see Appendix F.14 – Innovativeness), this factor is defined as the perception of confidence to use OSS by applying internal/personal qualities. The justification for this definition is that evidence from multiple cases fits with the feature 'confidence' due to staff inter-personal qualities and therefore, suggests contexts of self-efficacy and forms of innovativeness. To support this argument, three forms of this factor will now be discussed.

The first form is open-mindedness. The participant in case C05 observed that having an open mind and broad view in relation to the selection of software solutions allows management and staff to explore and use available OSS resources, rather than being tied to a single source of software solutions (see case C05, Appendix F14 – Innovativeness). This view suggests that open-mindedness to explore and use available OSS resources indicates the confidence to use OSS.

The second form is creativity. The empirical evidence suggests that applying creativity to the curiosity about OSS allows people to learn that it is cost-free to try-out, and people tend to continue using it when they understand that it suits their needs (see case C06, Appendix F.14 – Innovativeness). This view suggests that applying creativity in exploring and learning about OSS indicates the confidence to use OSS.

The third form is self-motivation. It was observed that a self-motivated attitude helps users to develop skills which may be trivial and require getting used to, but are useful for navigating around the OSS community to find useful software and information that suits one's needs (see case C09, Appendix F.14 – Innovativeness). This view suggests that skills developed through a self-motivated attitude to explore OSS helps to develop confidence to use OSS.

Consistent with the literature analysis (see section 2.3.2 and Gelinas and Bigras 2004; Martin 2005; Taylor and Murphy 2004), innovativeness was also identified in this research study as an important factor in the adoption of OSS by SMEs. This study has identified that open-mindedness and self-motivation are important forms of innovativeness which could enable SMEs' owner-managers and staff to consider the technological, legal and business factors that may be relevant to their use of OSS in the organisation (Holck *et al.* 2004). Creativity was identified in this research study as another form of innovativeness that could be enabled by a flexible organisational structure within an SME (Martin and Matlay 2003; Robert *et al.* 2003; Saloheimo 2005). These different forms of innovativeness extend the understanding of this

factor, which is of importance with respect to SMEs' adoption of OSS mainly because the SMEs are often characterised as innovative organisations (Duan *et al.* 2002; Houghton *et al.* 2001; Martin 2005; Martin and Matlay 2003; Poon and Swatman 1999; Simpson and Docherty 2004).

Influence of Self-Efficacy on OSS Adoption

The four factors of self-efficacy – core IT-skills, IT support, management support, and innovativeness – have a positive influence on the PBC over the use of OSS. The justification for this relationship is that each of the factors is a form of 'self-efficacy' which itself has positive influence on PBC (see Figure 6.1). This relationship is consistent with proposition 3a (see section 3.3.3), which suggests that self-efficacy has a positive influence on the PBC over the use of OSS. The relationship and the definition of PBC (see section 3.3.3) allows us to explain that the factors lead to the perceptions of control over the use of the particular OSS.

The four factors have a positive influence on intention to use OSS, justified by the factors' positive influence on PBC which itself has a direct influence on 'intention' (see Figure 6.1). This relationship is consistent with proposition 3 (see section 3.3.3) which suggests that the PBC to use OSS has a direct influence on intention. This relationship and the definition of intention (see section 3.3.4) leads to the explanation that the factors have a positive influence on the evaluations of all beliefs related to the use of OSS.

The factors also have a positive effect on the actual usage of OSS, owing to the factors' positive influence on 'intention' which is the immediate determinant of 'usage' (see Figure 6.1). This explanation is consistent with, again, proposition 5 (see section 3.3.4). Therefore, the definition of usage of OSS (see section 3.3.4) leads to the explanation that the factors of self-efficacy have a positive influence on the confirmation of use or implementation of the OSS.

6.5.2 Resource Facilitating Conditions Factors

Figure 6.1 shows that resource facilitating conditions (RFC) (see details in sections 3.3 and 5.3) contains a single factor – capital investment – which will now be discussed in detail. The discussion allows us to examine this factor as a resource-based facilitation for the use of OSS. Afterwards, the influence of this factor on OSS adoption will be explained.

Capital Investment

The factor 'capital investment' is defined as the perception of the need for capital to aid the development of IT capability to facilitate the use of OSS. This definition evolved from the empirical evidence which fits with the feature 'capital resources' that facilitate the use of OSS and therefore suggests contexts of 'resource facilitating conditions' and forms of capital investment. To support this argument, two forms of this factor will now be discussed.

The first form that will be discussed is money as a facilitating resource. The empirical evidence suggests that money is used as a resource for developing IT capability which facilitates the use of OSS, as suggested by the participants in cases C01 and C05 who observed that investing money enables organisations to hire-in or train staff towards developing IT capability (see cases C01 and C05, Appendix F.15 – Investment in Support). The participants in cases C05 and C08 also observed that money is required for the costs of support from call-centres, maintenance and training of staff, all of which facilitates the use of OSS (see cases C05 and C08, Appendix F.15 – Capital Investment).

The second form is time as a facilitating resource. The empirical evidence suggests that time is an essential resource which facilitates the development of IT capability as viewed by the participants in cases C01 and C03, who observed that training of staff is an important issue and organisations need time to develop OSS expertise (see cases C01 and C03, Appendix F.15 – Investment in Support).

The literature analysis has discussed the relevance of capital investment for developing human and infrastructure capability as important factors in ICT adoption (see section 2.3.1 and Dutta and Evrard 1999; Houghton *et al.* 2001; Matlay 2000; Taylor and Murphy 2004). Although OSS licenses are cost-free, there is still a need for capital investment to provide internal and external support and access to adequate IT infrastructure, such as computing hardware and Internet services. Holck *et al.* (2004) and Kumar and Krishnan (2005) have also argued that there is diverse expenditure in OSS adoption, such as consultation for product assessment, product configuration, package integration and maintenance costs, including labour and services expenditure. While these views suggest that investment of financial resources is an important factor in OSS adoption, the investment of time, which appears to have been overlooked in previous research studies, is also important for facilitating training of staff and access to external support services. The identification of diverse forms of capital investment as an important factor that influences OSS adoption, supports the view

that SMEs are concerned about capital investment for ICT adoption (Frambach *et al.* 1998; Glynn *et al.* 2005; Kwan and West 2005; Manneart and Ven 2005; Larsen *et al.* 2004).

Influence of Resource Facilitating Condition on OSS Adoption

Capital investment has a positive influence on the PBC over the use of OSS, owing to the positive influence of the RFC on the PBC. However, the lack of capital investment can constrain the use of OSS because this factor is a facilitating condition and therefore essential for the successful use of OSS. These two relationships are consistent with proposition 3b (see section 3.3.3) – having RFC has a positive influence on PBC, while the lack of them has a constraining influence on the PBC over the use of OSS. Based on these relationships and the the definition of PBC (see section 3.3.3), it follows that having capital investment leads to perceptions of control over the use of OSS. Conversely, a lack of capital investment leads to perceptions of constrained control over the use of OSS.

Capital investment also has a positive influence on intention to use OSS, justified by the factor's positive influence on the PBC which itself has a direct influence on 'intention' (see Figure 6.1). However, the factor can also have a constraining influence on 'intention' because of the potential for a constraining influence on PBC. Again, these two relationships are supported by proposition 3 (see section 3.3.3) – the PBC to use OSS has a direct influence on intention. Based on these relationships and the definition of intention (see section 3.3.4), it follows that having capital investment has a positive influence on the evaluation of all beliefs related to the use of OSS. It also follows that a lack of capital investment has a constraining influence on the evaluation of all beliefs related to the use of OSS.

Owing to the the factor's positive influence on 'intention' which itself is the immediate determinant of 'usage' (see Figure 6.1), capital investment also has a positive influence on the actual use of OSS. However, due to the potential for a constraining influence on 'intention', the factor can have a constraining influence on the actual use of OSS. These two relationships are consistent with, again, proposition 3 (see section 3.3.4). Based on these relationships and the definition of 'usage' (see section 3.3.4), capital investment has a positive influence on the confirmation of use or implementation of OSS. Conversely, a lack of capital investment has a constraining influence on the confirmation of use or implementation of OSS. As shown in Figure 6.1, this is a special relationship inhibiting the usage of OSS and is consistent with proposition 4 (see section 3.3.5), which suggests that lack of facilitating conditions will have an inhibiting influence on the actual use of OSS.

6.5.3 Technology Facilitating Conditions Factors

Figure 6.1 shows that resource facilitating conditions (RFC) (see details in sections 3.3 and 5.3) contains a single factor – Internet connectivity – which will now be discussed in detail. The discussion allows us to examine this factor as a technology-based facilitation for the use of OSS. Afterwards, the influence of this factor on OSS adoption will be explained.

Internet connectivity

Internet connectivity is defined as the perception of the need for Internet-based connectivity to enable low-bandwidth and high-bandwidth network tasks through Internet channels such as web sites, email, Wiki, help forums and download services. This definition evolved from the empirical evidence which fits with the feature 'technology resources' that facilitate the use of OSS and therefore suggests contexts of 'technology facilitating conditions' and forms of Internet connectivity. Two forms of this factor will now be discussed in support of this argument.

The first form is network-bandwidth. The empirical evidence suggests that it is important to consider network-bandwidth suitable for Internet-based tasks that facilitate the successful use of OSS. The reason is that Internet channels support low-bandwidth activities such as accessing OSS informational resources and support services via Wiki, email and forums (see cases C03 and C05, Appendix F.16 – Internet Connectivity). However, other network intensive activities, such as downloading whole CDs or DVD of packages, implementing network-based installation or software updates and upgrade, and accessing or providing multimedia technical or informational support (see case C03, Appendix F.16 – Internet Connectivity), need to be considered to facilitate the successful use of OSS.

The second form is Internet content. The empirical evidence suggests that it is important to consider the content and quality of Internet-based information that facilitates the use of OSS. This view is supported by the participant in case C10 who observed that Internet communication channels such as chat, email and forums, provide access to more and diverse resources and support which are far more useful than printed media (see case C10, Appendix F.16 – Internet Connectivity).

Many studies have discussed the importance of IT infrastructure and, in particular, recognise Internet technology as an essential infrastructure in the contemporary information age (see section 2.2.3 and Houghton *et al.* 2001; Kuan and Chau 2001; Martin 2005; Mehrtens *et al.* 2001; Robert *et al.* 2003; Sadowski *et al.* 2002). However, there appears to be little attention

paid to its importance in OSS adoption, even though some studies do acknowledge the importance of IT hardware to facilitate the use of OSS (Dedrick and West 2004; Holck *et al.* 2004; Larsen *et al.* 2004; West and Dedrick 2001). The identification of Internet connectivity and explanation of its influence on OSS adoption in this study extends knowledge and understanding of its importance as an essential technology infrastructure that supports the use of OSS.

Influence of Technology Facilitating Condition on OSS Adoption

Internet connectivity has a positive influence on the PBC over the use of OSS. This relationship is based on the positive influence of the TFC on the PBC. However, the lack of Internet connectivity can constrain the use of OSS because Internet connectivity is essential for the successful deployment, use and maintenance of OSS. These two relationships are supported by proposition 3c (see section 3.3.3), which suggests that having TFC has a positive influence on the PBC, while the lack of it has a constraining influence on the PBC over the use of OSS. Based on these relationships and the definition of the PBC (see section 3.3.3), it follows that having Internet connectivity leads to the perceptions of control over the use of OSS. It also follows that a lack of Internet connectivity leads to the perceptions of constrained control over the use of OSS.

Internet connectivity has a positive influence on intention to use OSS. The reason for this relationship is that the factor has a positive influence on the PBC which itself has a direct 'intention' (see Figure 6.1). However, the factor can also have a constraining influence on 'intention' owing to the potential for a constraining influence on the PBC. These relationships are consistent with proposition 3 (see, again, section 3.3.3). These converse relationships and the definition of intention (see section 3.3.4) leads to the explanation that Internet connectivity positively influences the evaluation of all beliefs related to the use OSS. It also follows that a lack of Internet connectivity has a constraining influence on the evaluation of all beliefs related to the use the particular OSS.

Internet connectivity also has a positive influence on the actual use of OSS, owing to the factor's positive influence on 'intention' which itself is the immediate determinant of 'usage' (see Figure 6.1). However, due to the potential for a constraining influence on 'intention', the factor can have a constraining influence on OSS usage. These two relationships are supported by proposition 3 (see, again, section 3.3.4). Based on the relationships and the definition of 'usage' (see section 3.3.4), we suggest that Internet connectivity has a positive influence on the confirmation of use or implementation of OSS. It also follows that a lack of Internet

connectivity has a constraining influence on the confirmation of use or implementation of OSS. As shown in Figure 6.1, this is a special relationship inhibiting the usage of OSS and is consistent with proposition 4 (see, again, section 3.3.5), which suggests that lack of facilitating conditions will have an inhibiting influence on the actual use of OSS.

6.6 Implications of the Research Findings

Having presented the empirical factors and provided an explanation of their influences in sections 6.3, 6.4 and 6.5, this section will now discuss the implications of these research findings from research and practice perspectives. The research findings fulfil the research aim and objectives set out in section 1.4. In so doing, the research findings, including the factors identified and the explanations of their influences on the adoption of OSS by IT SMEs, provide an answer to the research question posed in section 1.4. The research findings have implications for research and practice which are related to the research question about the adoption of OSS. Therefore, the implications of the findings can lead us to better understand the extent of the relevance of the findings from this research study.

There are four important implications from a research perspective, including: (1) extending the scope of knowledge on OSS adoption by IT SMEs (section 6.6.1); (2) the generalisability of the research findings (section 6.6.2); and (3) the effects of complexity and subjectivity on the adoption of OSS by IT SMEs (section 6.6.3); and (4) the validity of the research findings owing to the use of the DTPB (section 6.6.4). From a practice perspective, two implications will be discussed, including: (1) relevance of the emergent theory as a reference model of OSS adoption by IT SMEs (section 6.6.5); and (2) the generalisability of the emergent theory for the evaluation of OSS adoption (section 6.6.6). These implications for research and practice will now be discussed in detail.

6.6.1 Extending the Scope of Knowledge on OSS Adoption by IT SMEs

Table 6.1 shows that new factors were found in this study that were not identified from the existing literature. The comparison of factors from the empirical model in Figure 6.1, the factors discussed in the literature analysis (see sections 2.2, 2.3 and 2.4), and the conceptual model in section 3.4, suggest that this research study has identified important factors for which there had been little evidence or understanding in the existing literature. Such factors, as summarised in Table 6.1, include flexible support, extensibility, reliability, lack of drivers, hardware compatibility, support community, lack of government support, Web media, IT support and Internet connectivity.

***Table 6.1** Comparisons of the Empirical Factors and the Existing Literature*

Theoretical Concept	Factors identified in this study	Factors common to this study and the literature	Factors in the literature and their study context
Relative advantage	**Flexible support**		
	Licence cost-saving	Licence cost-saving Licence-audit cost-saving* Energy cost-saving* Environment cost-saving*	Cost saving (OSS) Cost saving (ICT)
		Total cost-of-ownership *	Total cost-of-ownership (OSS)
	Extensibility		Quality characteristics – flexibility (OSS)
	Reliability		Quality characteristics – reliability (OSS)
		Trialability *	Trialability (OSS)
Complexity	**Lack of drivers**		Lack of support (OSS) Lack of support (ICT)
Compatibility	Functionality	Functionality	Functionality (OSS) Functionality (ICT)
	Hardware compatibility		
		Software maturity * Desktop maturity *	Product maturity (OSS)
Peer influences	**Support community**		
Superior influences	**Lack of government support**	Government IT-policies *	Government policies (ICT)
	Web media		
Self-efficacy	Core IT-skills	Core IT-skills	Staff IT-capacity (ICT)
	IT support		
	Management support	Management support	Innovativeness (OSS) Innovativeness (ICT)
	Innovativeness	Innovativeness	Innovativeness (OSS)
		Resistance to change *	Resistance to change (OSS)
Resource F.C.	Capital investment	Capital investment	Capital investment (OSS) IT Capital investment (ICT)
Technology F.C.	**Internet connectivity**		
		Hardware infrastructure *	IT infrastructure (OSS)

Key
Factor (bold) – A new factor identified in this study.
* – A factor identified in the empirical findings, but not defined due to insufficient case evidence.
F.C. – Facilitating conditions
(OSS) – Open Source Software adoption study.
(ICT) – Study in the general area of ICT adoption.

The identification and theoretical explanation of the new factors (see Table 6.1 and sections 6.3 to 6.5) extends the scope of factors that are already known to influence the adoption of OSS by SMEs. The explanation of the new factors also provides a better understanding of the factors and why they influence the adoption of OSS by SMEs.

However, the lack of scope to compare against the literature raises questions about the generalisability of the newly found factors in this study. We argue that there is generalisability in the new factors owing to: (1) the use of a highly generalisable theoretical framework (see sections 3.3 and 5.2 and Hoepl 1997; Mayring 2007; Miles and Huberman 1994; Patton 1990; Sandelowski 1995; Yin 2003) which allowed us to develop factors that are analytically

comparable to factors in other studies of OSS or other innovation adoption; and (2) the application of various triangulation techniques (Eisenhardt 1989; Guion 2002; Mayring 2007; Thurmond 1999) in the gathering of evidence (see sections 4.5.3, 4.6, 4.8, 4.9.1 and 4.9.2), the diversity of the evidence used (see sections 5.2.1) and the analysis processes that led to the definition of the factors (see sections 5.4 and 5.5).

The discussions above support the argument that the research methods applied in identifying/developing the new factors has helped to establish their credibility (Eisenhardt 1989; Galliers and Land 1987; Yin 1994). Therefore, the new factors identified in this study are argued to have validity. The credibility and analytical generalisability of the new factors are likely to enhance acceptance and common understanding of the factors. The acceptance and common understanding of such new factors is important because they help to better understand OSS adoption and the still developing theories associated with the area (Holck *et al.* 2005; Larsen *et al.* 2004; Overby *et al.* 2006).

6.6.2 Generalisability of the Research Findings

An evaluation of the research findings suggests that there is generalisability of the empirical factors from this research study, to an extent, within the area of OSS adoption and, to a wider field of general ICT adoption. Table 6.1 shows that there are similarities within the factors from the research findings in the empirical model (see Figure 6.1) and those of the existing literature (see sections 2.2, 2.3 and 2.4). The similarities suggest that factors and other issues from this empirical study, including license cost-saving, total cost-of-ownership, extensibility, reliability, trialability, lack of drivers, functionality, software maturity, lack of government support, core IT-skills, management support, innovativeness and capital investment, are generalisable to other studies of OSS adoption and therefore may be generalisable within the area of OSS adoption.

The comparison of factors in Table 6.1 also shows that there are factors common to this empirical study and studies of adoption in ICT in general. The similarities suggest that factors and other issues from this empirical study, including various cost-saving factors, lack of drivers (lack of support), functionality, software maturity (product maturity), lack of government support (government IT-policies), core IT-skills (staff IT-capacity), management support (owner-manager characteristics), and capital investment (IT capital investment), are generalisable to other studies of general ICT adoption and therefore may be generalisable to the wider field of general ICT adoption.

The discussions above show that there is, albeit a limited, analytical generalisability of the factors from this empirical study across other studies of OSS and general ICT adoption. Such generalisability gives credibility to this research study's findings (Eisenhardt 1989; Galliers and Land 1987; Yin 1994). The generalisability of the research findings is likely to enhance common understanding of the factors identified and the explanation of their influence. Such common understanding is particularly important given that the theories on the adoption of OSS are still in their infancy (Holck *et al.* 2005; Larsen *et al.* 2004; Overby *et al.* 2006).

The generalisability of the research findings in this research study is important and allow us to learn lessons across the research areas of OSS adoption and the general ICT adoption. Owing to the factors and issues common to OSS adoption and general ICT adoption, the research findings extend the existing knowledge of general ICT adoption, which may lead to new understanding and research questions in the areas of OSS and ICT adoption more generally.

6.6.3 Effects of Complexity and Subjectivity on the Adoption of OSS by IT SMEs

The discussions about the empirical factors (in sections 6.2, 6.3 and 6.4) show that there is complexity and subjectivity in the factors that play a part in OSS adoption by IT SMEs. The complexity and subjectivity of factors identified in this study has an effect on the generalisability of the empirical factors and the emergent theory of OSS adoption by IT SMEs in this research study. Complexity and subjectivity seem to be characteristics of OSS adoption raised (in section 2.5.1 and 2.5.2) during analysis of the literature related to the adoption of OSS and general ICT by UK SMEs. Therefore, we argue that these characteristics of OSS adoption have implications for the research findings, which will now be discussed.

Complexity and the Effects on the Generalisability of the Research Findings

From a complexity perspective, the empirical factors developed are simple and more valid, leading to better generalisability than their composite counterparts found in the literature. Table 6.1 shows that factors evident in the literature appear to be in a composite state but are decomposed, and therefore presented in simpler forms, in this study. The decomposed forms represent reduced complexity of the factors and this enhances their understanding (Shih and Fang 2004; Taylor and Todd 1995a, 1995b). An example is cost saving (see section 2.2.1 and Dedrick and West 2003; Fitzgerald 2004; Larsen *et al.* 2004; and Valimaki *et al.* 2005), of which license cost-saving (see section 6.3.1) is a decomposed instance. Both are relative advantage factors, as shown in Figures 3.1 and 6.1. However, a comparison of related relative

advantage factors in Table 6.1, including license cost-saving, licence-audit cost saving, energy cost-saving and environmental cost-saving, suggests that cost saving as discussed in the literature analysis (in section 2.2.1) is a composite factor and, we argue that its decomposition enhances our knowledge and understanding of the potential financial benefits accrued from the general adoption of OSS.

As a further example, the literature-based factor 'quality characteristics' in Table 6.1 (see section 2.2.4 and Glynn *et al.* 2005; Mannaert and Ven 2005; Overby *et al.* 2006; Raja and Barry 2005 and Wang and Wang 2001) is also argued to be a composite factor. The reason is that while this study has identified and developed simpler quality related factors of OSS, including extensibility (section 6.3.1), reliability (section 6.3.1), functionality and hardware compatibility (section 6.3.3) (see also, Table 6.1) and other factors not defined in this study (due to insufficient evidence), such as security standards (section 5.5.3), backward compatibility (section 5.5.3) and positive image (section 5.5.3), the factor 'quality characteristics' as discussed in the literature analysis (in section 2.2.4) represents different quality issues, such as configurability, reliability, customisability, reusability, maintainability, robustness, supportability and extensibility (see section 2.2.4) as a single composite factor. The quality characteristics of OSS are better decomposed since this provides simpler and more valid factors that allow for easier analysis and understanding of their individual influences on the adoption of OSS.

The decomposition of previously known factors in the examples above suggests that there is complexity in at least some of the factors that influence the adoption of OSS by SMEs. The decomposition of factors (see, for example, Table 6.1 – decomposed issues of cost-savings and the composite factor 'cost-saving') suggests that simpler factors were developed in this study than are present in some of the existing literature. Such simpler factors are useful for developing a simple but valid theoretical framework of the factors influencing the adoption of OSS by IT SMEs. Thus, the decomposed factors in this study are argued to have more theoretical validity than their composite counterparts, and their simplicity provide a better understanding of OSS adoption.

Subjectivity and the Effects on the Generalisability of the Research Findings

The subjectivity associated with OSS adoption (see section 2.5.2) has led us to argue that the generalisability of the research findings has multiple contexts, including technological, organisational and socio-environmental. Figure 6.1 and Table 6.1 show that OSS adoption by IT SMEs is influenced by technological, organisational and socio-environmental factors. This

argument is then consistent with other views on the variations in ICT adoption and its use across different UK SMEs (Glynn *et al.* 2005; Larsen *et al.* 2004; Martin and Matlay 2001; Stockdale and Standing 2004).

The technological factors, or attitudinal beliefs, provide a technological perspective to the issues influencing the adoption of OSS. However, such a perspective is likely to be subjective because different qualities and characteristics of different OSS may lead to different decisions within the same organisation. The organisational factors, or perceived behavioural control beliefs, provide an organisational readiness perspective to the issues that influence the adoption of OSS. Similarly, different characteristics of different organisations are likely to lead to different levels of OSS readiness or capability, and therefore different decisions about the use of OSS. The socio-environmental factors, or normative beliefs, provide a socio-environmental perspective to the issues that influence the adoption of OSS. Again, diverse and changing socio-environmental conditions are likely to influence different SMEs' decisions to use different OSS, and even to do so differently.

Based on these three different perspectives, we argue that while there is generalisability of the research findings at the factors level, the subjectivity of OSS adoption across different IT SMEs limits the generalisability at the level of adoption strategy. This view implies that different IT SMEs involved in the adoption of OSS may focus on either technological, organisational or socio-environmental factors, or all factors in all categories – a comprehensive strategy – or a combination of factors in multiple categories – a hybrid strategy.

6.6.4 Validity of the Research Findings Owing to the Use of the DTPB

The use of the DTPB as the theoretical framework and the underlying theory of adoption in this research study has, we would argue, enhanced the validity of the research findings. As shown in Figure 6.1, and the explanation of factors in section 6.2, the DTPB was used as an underlying theory for exploring the empirical factors and explaining their influence on the adoption of OSS. That is important for two reasons: (1) the research findings have enhanced validity as a result; and (2) the use of the DTPB allowed us to develop a comprehensive model of OSS adoption by SMEs. These two implications will now be discussed.

As shown in Figure 6.1, the empirical findings in this study are consistent with the underlying theoretical model, the DTPB. This means that the research findings were found to fit with the research propositions in section 3.3. Because DTPB has been applied in other ICT adoption

studies (see, for example Hung *et al.* 2003; Hsu and Chiu 2004; Shih and Fang 2004; Taylor and Todd 1995a, 1995b), its use in this study (see Figure 3.1 and Figure 6.1) allows us to argue that the empirical model and the emergent theory have theoretic and analytical generalisability outside of this research study and that the empirical factors identified in this study have high validity as the concepts of the DTPB (Liker and Sindi 1997; Shih and Fang 2004; Taylor and Todd 1995a; 1995b). Furthermore, DTPB's use in this research study shows that it is applicable for the evaluation of OSS adoption in general.

The second reason why the use of the DTPB in this research study is relevant is that its use allowed us to develop an extensive model of OSS adoption, and we argue that it is more suitable for developing extensive models of ICT adoption than models evaluated and rejected in this study (see section 3.2). Figure 6.1 shows that all belief components and belief structures of the DTPB were useful in identifying empirical factors and explaining their influence on the adoption of OSS in this study. We argue that Figure 6.1 represents an extensive model of OSS adoption by IT SMEs. The extensiveness of the model in Figure 6.1 is relevant for a more comprehensive evaluation of OSS adoption, and suggests that the DTPB can deliver a more complete model of adoption model than those developed from other models, such as those evaluated and rejected for this study in section 3.2.

6.6.5 Relevance of the Emergent Theory as a Reference Model of OSS Adoption by IT SMEs

The first implication from a practice perspective is that the emergent theory provides a strong reference model for the evaluation of OSS adoption by IT SMEs. Consistent with the view that adoption models and theories are important to evaluators and practitioners (see, for example, Benbasat and Moore 1992; Dedrick and West 2003; Riemenschneider and McKinney 1999), the strong explanation of factors and their influences from the emergent theory offer in-depth insights into the adoption of OSS by IT SMEs. The strong empirical evidence and the underlying theory for organisational adoption of ICT led to high validity and therefore high confidence in the emergent theory. Thus, we argue that the emergent theory provides a valid reference model and a strong foundation for understanding the adoption of OSS by IT SMEs.

When used as a reference model for the adoption of OSS, the extensibility of the empirical model (see Figure 6.1) underlying the emergent theory in this research study allow practitioners and evaluators to apply additional factors, thereby extending its scope for exploration and usefulness for the evaluation of OSS adoption. For example, other empirical factors identified but not defined in this study (see Table 6.1 and section 5.5.3) provide

additional reference factors that increase awareness of previously unreported issues influencing the adoption of OSS by IT SMEs. This is relevant because research in OSS adoption is still in its infancy and, therefore, the identification of new knowledge and theories extend current understanding of OSS adoption by IT SMEs. Furthermore, such new factors may be generalisable outside the area of OSS adoption, meaning that the use of the emergent theory as a reference model could be extended beyond the area of OSS adoption by IT SMEs.

6.6.6 Comprehensiveness of the Emergent Theory for the Evaluation of OSS adoption

The second implication from a practice perspective is that a comprehensive model of OSS adoption must allow practitioners to deal with the associated complexity and subjectivity. We have discussed the effects of complexity and subjectivity as key characteristics of OSS adoption and as affecting the generalisability of the research findings (see section 6.6.3).

From a complexity perspective, OSS adoption can be influenced by multiple factors (see Figure 6.1) associated with different categories of technology, socio-environment and organisation. Thus, it is important to apply a comprehensive model that allows us to deal with all of the relevant technological, socio-environmental and organisational factors that influence the adoption of OSS by the organisation. From a subjectivity perspective, OSS adoption is influenced by context-dependent technological, organisational and socio-environmental factors (see, for example, Dedrick and West 2003; Geira 2004; Lakhani and von Hippel 2003; Overby *et al.* 2006). Therefore, while reference models may provide a generalised view of issues influencing OSS adoption, practitioners need to consider context-dependent issues such as particular organisational IT capability or readiness for OSS, organisational attitude towards the use of OSS and external agents that may influence the use of OSS in the organisation. This discussion leads us to argue that comprehensive models, such as the empirical model presented in Figure 6.1, allow for the consideration of the issues of complexity and subjectivity in the adoption of OSS.

The comprehensiveness of the empirical model in Figure 6.1 is an important feature because some adoption models focus only on partial aspects of adoption and therefore provide only partial awareness of the issues influencing adoption (see, for example, TRA and TAM in section 3.2 and Davis 1989; Fishbein and Ajzen 1975). The comprehensive model of OSS adoption by IT SMEs (in Figure 6.1) avoids this by offering awareness of technological, organisational and socio-environmental factors influencing OSS adoption. In particular, we have shown (in sections 6.2 and 6.5) that organisational factors represent organisational

readiness for OSS adoption and include important facilitating conditions which, if inadequate, could inhibit adoption. We have also shown that developing positive attitude, by gaining knowledge of the relative advantages, usefulness and relevant functionality of OSS and, dealing with the complexities in using OSS are important technological factors influencing its adoption. Thus, technological factors (in Figure 6.1 and section 6.3), like organisational factors, can strongly influence the adoption of OSS by IT SMEs. This awareness leads to the understanding that there is a need for a comprehensive model, such as the empirical model from this research study, that is capable of dealing with the complex and subjective factors influencing the adoption of OSS.

6.7 Summary

This chapter has presented an emergent theory of OSS adoption by IT SMEs in this study. The empirical model, which describe the emergent theory, explains the empirical factors and their influence on the adoption of OSS by IT SMEs. Thus, this chapter has fulfilled the research aim and objectives of this study as set out in section 1.4 and, therefore, provided an answer to the thesis's research question, also posed in section 1.4.

The empirical model and the explanations developed are based on the use of the DTPB as the underlying explanatory theory. The use of this widely accepted theory has enabled us to explore a wide range of factors and also develop a strong explanation of OSS adoption by IT SMEs, allowing us to argue that the findings in this study are valid and have strong theoretic and analytical generalisability.

The analysis of the empirical model has led us to argue about its implications from research and practice perspectives. From a research perspective, we have discussed the relevance of new factors alongside others already identified in the literature, arguing for the analytical generalisability of the research findings. We also argued that the factors influencing the adoption of OSS by IT SMEs are complex and subjective, which are key characteristics common to general ICT adoption and, consistent with the general lessons learnt from the literature analysis of OSS adoption in sections 2.5.1 and 2.5.2.

With respect to the implications for practice, we argued that the research findings provide a reference model for IT SMEs to better understand and support their adoption of OSS. Such a reference model is important because research in OSS adoption is still in its infancy and models and theories are still under development. Another implication discussed is that the

new factors identified in this study extend the existing scope of factors influencing the adoption of OSS and may contribute to the amendment/development of previous OSS adoption policies or the development of new ones.

7

Conclusions

7.1 Introduction

In this final chapter, we present the conclusions of this study which has empirically identified factors and sought to develop an extensive explanation of their influence on the adoption of Open Source Software (OSS) by the UK Small to Medium sized Enterprises (SMEs) in this study. This objective follows the presentation of the research findings and their implications in Chapter 6, including a theory that helps to explain, and therefore understand, the adoption of OSS adoption by SMEs. To better understand the context of the issues that are discussed in this chapter, a thesis review is presented in section 7.2, highlighting the work from the research stages and processes undertaken within the chapters of this thesis. Based on the research findings and their implications, this chapter presents novel research contributions (section 7.3), research limitations (section 7.4) and suggestions for future work (section 7.5), which will now be introduced in more detail.

Section 7.3 discusses and justifies the novel contributions that emerged from the work in this research study. The discussions focus on the relevance of this research study, which is argued to fill a knowledge gap in the area of OSS adoption by UK SMEs. In doing so, the originality of this work is emphasised, and the contributions of the research findings are discussed from research and practice perspectives.

In section 7.4, the limitations of the research findings are discussed, focusing on how the research findings and their scope of generalisability may be interpreted, and on the credibility of the research design. These issues are important because, first, there is limited

generalisability in research in OSS adoption which is still in its infancy, and second, this study also uses maturing qualitative research methods and techniques. In defence of these research limitations, measures taken to enhance validity in research findings and credibility of research design will be discussed.

Section 7.5 focuses on the potential for future research that aims to address the research limitations in this study, including validating the research findings and extending the emergent theory of OSS adoption in this or other areas of Information Systems research. Drawing on these issues, the suggestions for future research include: a confirmatory research study to test the emergent theory using a positivist approach; a longitudinal study to extend the emergent theory by identifying and validating new factors influencing the adoption of OSS; and to address some limitations in the DTPB which led to initial difficulties in using the theory in this study.

7.2 Thesis Review

This section presents a review of the stages that this study went through in the evaluation of OSS adoption by UK SMEs. This review briefly discusses the objectives and outcomes of the previous chapters of this thesis.

In Chapter 1, we presented an introduction to this thesis, discussing the research context of OSS adoption, with a particular interest in UK SMEs and their adoption of ICT. Following a brief review of existing work in the area of OSS adoption, we argued that while this is an emerging research area, there is a need to extend the research to explore and understand the adoption of OSS by SMEs. This argument of the gap in research led to us to focus on a research problem, leading to the research aim and objectives of this study. Following that, we briefly discussed and justified the suitability of a qualitative research mode, using a case study strategy, for exploring the adoption of OSS by SMEs in this study. Then, a thesis structure was presented as a guide to the reader, briefly introducing the objectives of the subsequent chapters of this thesis.

Following the introduction of the research focus in Chapter 1, Chapter 2 presented a review and analysis of relevant literature to identify factors and understand their influence on the adoption of OSS by UK SMEs. The review and analysis led to the identification of various factors which were classified into the semantic categories of technology, organisation and environment. Because research on OSS adoption is still in its infancy, we expanded the scope

of our literature research by drawing knowledge from other areas of ICT adoption. This approach led to the development of a framework of diverse conceptual factors influencing the adoption of OSS, which suggested that OSS adoption is complex and subjective. The analysis of the factors and the framework led us to argue that there is a lack of a common framework for exploring the adoption of OSS and, therefore, a lack of theories for evaluating the adoption of OSS by SMEs. This problem led us to argue for the need to develop a theory-based framework for exploring factors and explaining their influence on the adoption of OSS by SMEs. This set the main goal of the following chapter.

In addressing the need to develop a theoretical model that supports a common understanding of OSS adoption by SMEs, Chapter 3 presented the development of the research propositions and a conceptual model of OSS adoption by SMEs. An initial evaluation of proven ICT adoption models and theories led to the selection of the Decomposed Theory of Planned Behaviour (DTPB) as the theoretical framework for this study. Following its selection, the DTPB was operationalised within the context of OSS adoption, using the factors identified in Chapter 2. The operationalisation led to the development of research propositions which, together, formed a theory-based conceptual model of OSS adoption by SMEs. The use of the DTPB to categorise factors and explain their influence on the adoption of OSS helped to confirm its suitability for the context of this study. The research propositions and conceptual model provided relevant theoretical concepts that were applied in developing the empirical research methodology in this study.

Chapter 4 presented an empirical research methodology that established the nature and scope of the empirical inquiry, including the data collection methods and analysis procedures that were applied in this study. In doing so, we discussed the research epistemology arguing for an interpretivist stance based on the research question, and the research aim and objectives (in Chapter 1). This research epistemology led to the selection of a qualitative research mode, which was also consistent with the research question. The complexity and subjectivity of OSS adoption suggested that an exploration of multiple settings was required, leading to the selection of a multiple-cases study strategy. The use of interviews was argued to be the most effective and traditional data-source for qualitative research, leading to the use of qualitative data analysis techniques including data reduction, data displays and conclusion drawing. Although there are no specific theories for the selection of qualitative research methods, and also because the literature on qualitative research methods are still in developing, we justified our selection of methods, instruments and techniques based on our research question, and the research aim and objectives as set out in Chapter 1.

Following the development of the research methodology reported in Chapter 4, Chapter 5 presented the analysis of qualitative data, leading to the identification of empirical factors influencing the adoption of OSS by the 10 participant SMEs in this study. The sampling of SME cases for this study was discussed to show that the factors that emerged from the analysis were supported by rich and diverse sources of empirical data. The use of Conversation Analysis (CA) techniques was discussed to show that simplifying and standardising the structure of the qualitative data led to a high quality interview transcripts for this study. The theoretical framework for analysis was presented, showing that a structured framework from the research propositions and conceptual model was developed for the analysis of the empirical data. The use of a two-stage data analysis approach was discussed. The first stage was the within-case analysis which enabled a close reading and interpretation of individual case transcripts, leading to the identification and coding of related segments of text into new categories or categories represented by the theoretical framework. The second stage was the cross-case analysis, applied to collate similar factors identified in the fist stage of analysis, leading to the selection of factors with high logical replication that met the selection criteria; this acted as a theory-building process to develop theory-supported descriptions of the selected factors. The factors identified form components of the theory of OSS adoption by the SMEs, which was discussed in Chapter 6.

Chapter 6 presented the research empirical findings including a theory that explains the factors influencing the adoption of OSS by SMEs in this study, and also discussed the implication of the findings. The theory was presented as an empirical model of OSS adoption by SMEs, based on factors identified in the data analysis (in Chapter 5) and the research theoretical framework from Chapter 3. The definition of the factors identified in the analysis in Chapter 5 were presented and also justified. The empirical model was used to explain the factors and their influence on the adoption of OSS by SMEs in this study. Thus, the discussions of the empirical model provided an answer to the research question and fulfilled the research aim and objectives stated in Chapter 1. The implications of the research findings were discussed from a theory perspective focusing on the effectiveness of the DTPB as an underlying theory for exploring and explaining the adoption of OSS by SMEs, and also from a practice perspective focusing on the relevance of the findings as a strong empirical framework for SME owner/managers involved with the organisational understanding and policy making on the adoption of OSS.

Having presented a review of the thesis chapters, this chapter continues with a discussion of the novel research contributions that emerged from the work.

7.3 Research Contributions

There are three novel contributions to research and practice in the areas of OSS adoption and general ICT adoption arising from this research. The contributions are summarised in Table 7.1 and will now be discussed in detail. The discussion highlights each contribution and discusses its relevance, arguing for the novelty and originality of the contribution from research and practice perspectives.

The first contribution in Table 7.1 is the empirical research model. This is an original contribution because this study appears to be first to develop an empirical theory of OSS adoption by UK SMEs (see Figure 6.1 and Table 6.1). This is a novel contribution that fills a knowledge gap in the emerging research area of OSS adoption and the IS field in general. The following discussion presents contexts for this contribution, providing support for our claim of novelty and originality.

There is a general demand for theories in the IS field partly because theories enable researchers to better analyse, explore and understand existing and emerging research issues and their interrelationships in theory and practice (Holck *et al.* 2004). Thus, studies focused on theory-building, such as this exploratory study, contribute by filling knowledge gaps in the IS research field. The need to fill knowledge gaps is also relevant for this particular area of IS research because OSS adoption research is an emerging area (Agerfalk *et al.* 2006; Dedrick and West 2003; Fitzgerald and Kenny 2003; Holck *et al.* 2005; Larsen *et al.* 2004; Overby *et al.* 2006).

OSS adoption research is still in its infancy (Fitzgerald and Kenny 2003; Holck *et al.* 2005; Larsen *et al.* 2004; Overby *et al.* 2006) and there appears to be very few proven theories to support the exploration and understanding of OSS adoption. Also, research on OSS adoption by UK SMEs seems largely to have been ignored, suggesting that there has been little or no focus on this research gap.

***Table 7.1** Research Contributions*

Contribution	Relevance	Scope	Evidence
Empirical research model	Fills a gap in the general demand for theories in the IS field and this emerging research area. Provides a structural definition of factors Gives a theory-supported explanation of factors. Presents a generalisable understanding of OSS adoption.	Theory and practice	Figure 6.1 and Table 6.1
Conceptual model using augmentation of factors	Introduces factors from other areas of ICT adoption. Extends the scope of theory-based models for research on OSS adoption.	Theory	Figure 2.1; Tables 2.1, 2.2 and 2.3; Figure 3.1
Framework for analysis of adoption models	Provides criteria and choices of theories suitable for ICT adoption within an organisational context.	Theory	Table 3.1

However, theories are important for developing valid analysis, exploration and better understanding of research issues and their interrelationships (Benbasat and Moore 1992; Riemenschneider and McKinney 1999; Dedrick and West 2003; Rhodes and Courneya 2004; Taylor and Todd 1995a, 1995b). Therefore, the OSS adoption theory developed in this study is relevant, as shown in this study, for undertaking a structural and widely-valid analysis of factors, leading to a better understanding of such factors and their influence on the adoption of OSS.

The relevance of this contribution has implications from a theory perspective because researchers may apply the empirical model for the evaluation of OSS adoption, or similar research problem of ICT adoption. This perspective suggests that the empirical model can be used in subsequent research to survey a population and identify significant factors influencing the adoption of OSS within that population. The model also provides a reference framework for developing an exploratory and interpretivist, or confirmatory and positivist, data collection instrument for an OSS or similar ICT adoption field study.

There are also implications for the contribution from a practice perspective because SMEs and other practitioners may apply the empirical model as a reference for developing policies which guide the adoption of OSS in their organisation. This perspective leads to two important examples of the relevance of the empirical model: (1) it can be applied in developing an evaluation instrument for predicting the critical-success-factors influencing OSS adoption in an organisation; and (2) it provides a reference model for discussing and understanding the factors and their influence on the adoption of OSS within an organisation.

The second contribution in Table 7.1 is the conceptual model. We argue that the conceptual model (see Figure 3.1) represents an original contribution that fills a gap in the developing research area of OSS adoption and the IS research field in general. The conceptual model was developed based on a structured analysis that drew on valuable lessons from multiple disciplines within the IS research field. The innovative use of an augmentation approach to draw on knowledge from multiple research areas has enabled us to extend our scope of awareness and conceptualisation of factors influencing the adoption of OSS by SMEs. The context of this contribution will now be discussed further to justify our claim for its novelty and originality.

The IS discipline is a dynamic research field and many of its studies and theories are still in their infancy. OSS adoption is one such research area (Dedrick and West 2003; Fitzgerald and Agerfalk 2005; Fitzgerald and Kenny 2003; Fugetta 2003; Glynn *et al.* 2005; Holck *et al.* 2005; Larsen *et al.* 2004). Although there are more mature research studies in other areas of ICT adoption, lessons from such areas seem to have been mostly ignored in recent studies on OSS adoption. Because knowledge was drawn from multiple areas of ICT adoption research, the conceptual model developed in this study introduces new knowledge to the developing area of OSS adoption research. Such conceptual models are important for many reasons including: conducting a structured analysis of issues relevant to an emergent research phenomenon; developing valid explanations of the relationships between concepts of a research phenomenon; and identifying the most relevant issues within a complex research phenomenon (Daniel and Grimshaw 2002; Dedrick and West 2004; Levy and Powell 2003; Sadowki *et al.* 2003; Wu and Wu 2005). Based on this discussion and our experience from this research study, we argue that researchers developing conceptual frameworks of OSS adoption can benefit from extending the scope of their analysis of the literature by using valuable lessons from other areas of ICT adoption research.

Having discussed the general context of conceptual model as a novel contribution from this study, the contribution extends to its implication for theory and practice. From a theory perspective, the conceptual model developed provides researchers with a framework for analysing issues relevant to OSS, or other similar ICT adoption. In this context, the model provides a strong theoretical foundation for exploring and explaining the relationships between factors and concepts relevant to the adoption of OSS or other ICT. Although the conceptual factors in the conceptual model (in Figure 3.1) lack validity, a limitation of its relevance from a practice perspective, the factors and underlying theoretical framework still

provide a useful structured-model for explaining, and therefore better understanding, an organisational context of OSS adoption.

Table 7.1 shows that the third research contribution is the framework for analysis and selection of ICT adoption models. This is a novel contribution because most IS studies appear to ignore the importance of applying theoretical foundations in the research design (Chang 1998; Mathieson *et al.* 2001; Venkatesh and Balal 2006; Venkatesh and Davis 2000; Venkatesh *et al.* 2003; Wu and Wu 2005). In the area of OSS adoption research, few studies (for example, Dedrick and West 2003) have explored and implemented concepts from proven theories associated with ICT adoption. Although theories in the IS field are still developing, the lack of use of existing theories can be argued to be a reason for the limited validity and generalisability, and therefore, the lack of common understanding in the area of OSS adoption research. The following discussions on the context of this contribution presents further justification for this argument.

Theories are important for conceptualising research phenomenon (Dedrick and West 2003; Taylor and Todd 1995b), enabling the association of existing or known and emerging knowledge, and therefore allow us to identify generalisability of existing knowledge over an emerging field of study. Theories, when applied appropriately, enhance the validity of research findings (Benbasat and Moore 1992; Eisenhardt 1989; Galliers and Land 1987; Yin 1994), which can lead to higher confidence in the subsequent theoretical or practical utilization of such findings. Therefore, the selection and application of the most suitable theory to a research problem is relevant for high quality research. As mentioned earlier, there are few mature theories in the IS field. The lack of adequate understanding and the complexity of existing and emerging theories may be reasons why it is difficult for researchers to understand and apply such theories. Hence, an evaluation and selection framework that eases the selection of appropriate theory is important and represents a relevant contribution to the research area.

The framework in Table 3.1 is applicable to the evaluation and selection of proven ICT adoption theories that help to explore and understand OSS, or other ICT adoption. The framework allows for the consideration of the degree of complexity and subjectivity of research phenomena as selection criteria. Although the framework in Table 3.1 features mostly proven models of adoption, its flexible structure allows for the extension of its capability by the addition of other models relevant to particular research problems and contexts.

7.4 Research Limitations

The research findings and their implications in this study are not without limitations. Appreciation of the limitations allows us to better understand the boundary of this study and its contributions, and to minimise the ambiguity that may lead to misinterpretation of the research findings and contributions. Two limitations will be discussed, including the generalisability of the research findings and the credibility of the case study research design. In defence of these limitations, the measures taken to maintain the validity in the research findings and the credibility in the research design will also be discussed.

The first limitation is the generalisability of the research findings, which is relevant because qualitative research studies often risk ambiguity in the interpretation and type of generalisability of research findings and this is particularly relevant where theory-building approach are applied (Eisenhardt 1989; Mayring 2007; Meredith 1998; Yin 2003). There is also the inherent risk of generalisability of research findings in an emerging research area (Dedrick and West 2004; Overby *et al.* 2006), which is relevant because research in OSS adoption is still in its infancy (Agerfalk *et al.* 2006; Dedrick and West 2003; Fitzgerald and Kenny 2003; Holck *et al.* 2005; Larsen *et al.* 2004; Overby *et al.* 2006). These situations have made it difficult to compare our research findings with that in the existing, albeit limited, literature on OSS adoption. This problem has led us to use diverse factors influencing ICT adoption, through augmentation (in sections 2.2 to 2.5), to develop a literature-based framework of factors that influence the adoption of OSS by SMEs. The factors from that augmentation were also applied in the comparative literature analysis (Mayring 2007) in sections 6.3 to 65, to evaluate the empirical factors identified in this research study. The limitation owing to issues of generalisability will now be discussed in detail from the perspectives of the sampled cases and the timeliness of the research empirical framework.

Generalisability is also an issue in this research study owing to the scope of the cases sampled (in section 5.2.1). This issue raises the question of bias in the sampled cases and it has three implications for the limitations of the research findings. The first implication is that the study's case organisations are UK SMEs in the IT industry. Although, the research findings reflect our observations and analysis of OSS adoption by the sampled cases, the findings may not be generalisable across the SMEs population, in the context of statistical generalisation (Eisenhardt 1989; Mayring 2007; Meredith 1998; Miles and Huberman 1994; Yin 1994). Instead, the emergent theory of OSS adoption is applicable to cases of OSS adoption, in the context of theoretic and analytical generalisation (Eisenhardt 1989; Mayring 2007; Meredith 1998; Miles and Huberman 1994).

The second implication is that various types of OSS were identified from different UK SMEs in this study. However, the different OSS applications observed in each case were generalised as the within-case findings for each sampled case (in Chapter 5). Thus, the research findings (in Chapter 6) represent theoretic and analytical generalisation of OSS adoption rather than the adoption of particular software applications such as desktop or server applications, operating systems and embedded systems. However, the research framework developed in this study represents an analytical theory of OSS adoption: the meanings of the factors observed and the explanations of their influences are embedded in an analytically generalisable theory (the DTPB), which continues to be applicable over time and across different contexts of ICT adoption and behavioural studies. Therefore, the analytical theory of OSS adoption developed in this study is likely to be applicable over time. In particular, the flexibility of the research framework allows it to be adapted to new situations in the context of time and the arena in which OSS adoption takes place.

The third implication is that majority of the study participants were OSS vendors/consultants, who can be expected to have a positive attitude towards the use of OSS. Although the use of a purposeful sampling strategy has allowed us to pursue common views from common participants, the resulting common samples in this study raises the question of possible bias in the views of participants observed. Similarly, the targeting of IT managers or managers/owners in the roles of participants and informants and who are seen in this study as rich sources of information, also raises the question of bias of using one viewpoint in the organisation. This particular bias is relevant because users, IT staff and external parties such as consultants may also influence the adoption of OSS in the organisation. However, we have applied a sample scope of recommended maximum number of cases, allowing us to capture diverse and rich sources of information for this study.

The generalisability of the research findings may also be affected by the timeliness of the emerged theory of OSS adoption by UK SMEs. Generally, time has been discussed as an influential factor in the diffusion of an innovation (Rogers 1995). In the context of this study, there is potential for variations in the relevance and influences of the existing and the emerging OSS characteristics, socio-environmental factors, and organisational characteristics which influence the adoption of OSS by SMEs: increasing competitiveness of OSS and its popularity may drive its wider acceptance; and increasing participation of large players in the software industry and the better supportive government initiatives are also likely to enhance its diffusion (Rogers 1995). From an organisational perspective, the internal awareness about

OSS and its potentials are likely to enhance SME managers'/owners' confidence in trying and using it in their enterprises. Research frameworks that capture relevant issues within these time-line perspectives are likely to vary. Therefore, time is likely to influence the particular set of factors observed to influence the adoption of OSS.

The second research limitation is an issue inherent to the use of maturing qualitative research methodologies (Creswell *et al.* 2007; Meredith 1998; Priest *et al.* 2002; Seale and Silverman 1997). The design and implementation of research methodology is important for establishing valid research procedures and credible research results. Also, the maturity of qualitative research methods and procedures has an influence on the credibility of the research design and the validity of the research findings. These issues are relevant for qualitative research studies in the IS field because theories in qualitative research design are still emerging.

Although we acknowledge the issues mentioned above, studies suggest that IS researchers have applied existing qualitative research instruments and procedures in different research areas, including OSS and general ICT adoption (Dedrich and West 2004; Fitzgerald and Kenny 2003; Gilmore *et al.* 2001; Martin 2005; Overby *et al.* 2006; Ritchie and Brindley 2005). The use of existing literature on qualitative research methodology, albeit complex and difficult to understand, and hence requiring extra effort to implement, has also enabled us to develop a qualitative case study research methodology for this study. Therefore, this study is also open to the inherent limitations of using maturing qualitative research methodologies. However, we have applied rigour in developing the structured qualitative research methodology presented in this thesis. For example, we have justified the choice of an interpretivist research paradigm (see section 4.2), the selection of qualitative research methods (see section 4.3), the use of a case study strategy (see section 4.4), and presented the data collection instruments (see section 4.6) and the analysis techniques and procedures (see section 4.8). Further measures of rigour applied to this research design include ensuring highest quality and credibility in research design (see section 4.9); extensive sampling of rich and diverse case data from different sources (see section 5.2); and have maintained a structured case study database (see section 4.9.4), including the documentation of the case transcripts (see section 5.2.2), the theoretical framework for the data analysis (see section 5.3), the processes and results of within-case analysis (see section 5.4 and Appendix C – Within-Case Analysis), the processes and results of cross-case analysis (see section 5.5 and Appendix D – Cross-Case Analysis; the frequency analysis of factors in Appendix E – Frequency Analysis of Factors; and the theorisation of factors in Appendix F – Description of Factors).

7.5 Future Research

The research limitations discussed in section 7.4 have led us to identify opportunities for future research, including: (1) a confirmatory research study to determine the validity of the factors and external variables in the theory of OSS adoption by SMEs in this study; (2) a longitudinal exploratory research study to extend the scope of factors and the understanding of their influence on the adoption of OSS; and (3) an exploratory research study to extend the exploratory and explanatory capabilities of the DTPB. These opportunities for future research will now be discussed in more detail.

The first suggestion is to undertake a confirmatory research study to determine the validity of the factors and the emergent theory of OSS adoption by SMEs in this study. Such a study may identify the significance of the factors leading to the development of a statistically generalisable model of factors influencing the adoption of OSS by IT SMEs. Such a model may also provide a framework for identifying critical-success-factors for OSS adoption by IT SMEs in the UK. A future confirmatory study could also address the issues of bias in the case samples and the participants in this study: the use of questionnaire administered by mail is likely to randomise the survey participants' roles and business area/speciality.

The second suggestion for future work is to undertake a longitudinal exploratory research study to extend the knowledge and understanding of factors influencing the adoption of OSS. Such a study should focus on exploring additional empirical evidence to support the theoretical definition of emerging factors identified but not defined in Chapter 5. To do so, future studies may apply a theory-building approach, such as the one presented in the research methodology in Chapter 4, the data analysis in Chapter 5, and definition and reporting of the factors in Chapter 6.

The third area of future work is to extend the exploratory and explanatory capability of the DTPB for similar research in ICT adoption. Doing so could enhance the effectiveness of the DTPB, which may also extend the understanding gained from the use of the theory. Future research may consider three areas for realising this opportunity.

The first area for extending the exploratory capability is the extension of the DTPB and the inclusion of relevant theoretical concepts from other information systems related theories of adoption and diffusion. For example, trialability and observability have been proven to be relevant concepts in adoption (in the Diffusion of Innovations theory – DOI in Rogers 1995, 2004; Rogers and Scott 1997) and their inclusion in the DTPB may extend the exploratory

capability of the theoretical framework for exploring and explaining the adoption of OSS. Another example is the importance of considering individuals differences and characteristics, including age, gender, experience, educational level and organisational level, which have been reported to moderate the influence of factors on the adoption of innovation by individuals (Goh and Agarwal 2008; Igbaria 1995; Mathieson *et al.* 2001; Venkatesh *et al.* 2003; Wu and Wang 2005). Such characteristics of an individual extend the understanding of the influence of organisational factors because they are related to the characteristics of SME owner-managers and their staff, which are likely to vary across organisations and, have been observed to influence OSS adoption by the IT SMEs in this study.

The second area is in improving ease of use of the DTPB by simplifying the definitions of some problematic theoretical concepts, including the peer influences, the superior influences, the resource facilitating conditions and the technology facilitating conditions. Doing so would help to minimise the ambiguity of the meaning and use of such concepts, thereby improving the understanding of theoretical concepts and the theory as a whole. Furthermore, additional concepts may be developed to enable a deliberate exploration of the limitations of a specific innovation such as the relative disadvantage of its use over selected alternatives. Alternatively, the scope of the 'complexity' belief structure of the DTPB may be extended to cover issues related to the relative disadvantages of using a specific innovation over selected alternatives.

The third area is in extending the exploratory capability of the DTPB by the identification and implementation of crossover effects. Crossover effects are additional relationships between belief structures and belief components other than those which they are traditionally associated with (Taylor and Todd 1995a). Thus, crossover effects could be implemented in the DTPB to broaden the scope for explaining the influence of factors on the adoption of an innovation (Taylor and Todd 1995a). In the context of this research study, exploring and implementing crossover effects in the DTPB could broaden the scope for explaining the influence of factors and better understanding the adoption of OSS by IT SMEs. Furthermore, he implementation additional relationships is likely to enhance the nomological network of concepts in the DTPB, enhancing the validity of the theory as a whole.

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Appendix A – Data Collection Instruments

A.1 Participant Information Sheet

Participant Information Sheet

Project title: **An Evaluation of Open Source Software Adoption by UK SMEs in the IT Industry**
Name of researcher: **Mr. K. Mijinyawa** (*Ph.D, M.Sc., B. Eng., CNA, CompTIA)
Academic Institution: School of Information Systems, Computing and Mathematics, Brunel University, Uxbridge, Middlesex, UB8 3PH, UK

This is an academic research project on Open Source Software technology adoption. This research is approved by the Brunel University Research Ethics Committee, and is part of my PhD work.

The aim of this research is to explore and understand the various factors that influence Open Source Software adoption by UK SMEs. The exploration and understanding of such factors will enable the development of an evaluation model to help SMEs decide whether or not to adopt Open Source Software.

This research will be conducted through interviews with people in SMEs. The interview questions are related to issues that may influence Open Source Software adoption such as perceptions about the benefits, challenges and usefulness of Open Source Software; social and environmental issues that have influenced the adoption of Open Source Software; and facilitation that was organised for the adoption of Open Source Software in your company. The interview will be audio recorded because this enables the development of an original interview transcript. Each interview is expected to last for about one hour.

Participants will be provided with a copy of the outcomes of the research. Participants have the opportunity to ask questions regarding this information sheet or any aspect of the study.

Participation in this research project is voluntary, and participants may withdraw at any time from the project without providing a reason. In order to protect the identity and confidentiality of participant data, participants will not be referred to by name in any report concerning the study.

Thank you for your participation.

A.2 Consent Form

Participant Consent Form

Please tick appropriate box

	YES	NO
Have you read the Research Participant Information Sheet?	☐	☐
Have you had an opportunity to ask questions and discuss this study?	☐	☐
Have you received satisfactory answers to all your questions?	☐	☐
Who have you spoken to? …… …….....		
Do you understand that you will not be referred to by name in any report concerning the study?	☐	☐
Do you understand that you are free to withdraw from the study:		
• at any time	☐	☐
• without having to give any reason?	☐	☐
Do you agree to take part in this study?	☐	☐
Signature of Research Participant…….....		
Date……		
Witness statement		
I am satisfied that the above-named has given informed consent. Witnessed by..... Date:.....		
Name n capitals:		

A.3 Interview Questions

Interview Questions

Organisational Demographic Information	
Company ID: Company Name:	
Business Type:	
Staff Count: What proportion of staff have OSS skills:	
Participant's Name:	Date:
Participant's Name (fictional):	Time:
Participant's Role:	

What OSS applications do you use for – Email – Website – E-Commerce – E-Business – Electronic Office – Enterprise Integration –
What OSS do you intend to use in future:
Please describe your existing IT Infrastructure: Hardware equipment: Network service(s):

INTENTION
What are your evaluations or judgements about the use of OSS in this organisation? Do you think it is good, or bad? Why do you think so?

ATTITUDINAL BELIEFS
What are the benefits that encourage your use of OSS?
R1 – What *features or qualities* of OSS do you feel makes it attractive to your firm? *Please describe the features or qualities that you feel are most important?
R2 – What are the *economic benefits* of adopting OSS to your firm? (*e.g. cost savings, improved innovativeness and productivity)* *Please describe the benefits that are most important in your firm; *Are there other economic benefits?
R3 – How has OSS usage improved internal/external organisational perceptions or status in your firm? *(e.g. corporate perception, business competitiveness, compliance with I.P laws, IT standard)* *Please describe the most important benefits of these examples; *Are there other benefits?
R4 – What issues or areas of your work makes OSS relatively *more convenient* to use? *(e.g. simplicity, reliability, ease of use, software maturity)* *Please described the most important areas of OSS usage; *Are there other software areas where OSS was applied?
R5 – In what ways do you feel that using *OSS in your firm has worked well*? *(e.g. security, reliability, quality, stability, maturity)* *Please described the examples you feel are most important; *Are there other issues of satisfactory OSS usage?
What do you feel are the difficulties or challenges in using OSS?
CX1 – In what areas of your software usage do you feel OSS was most *difficult or problematic*? *(e.g. usability, maturity, functionality)* *Please explain the examples you feel are most important; *Are there other OSS usage related problems?
CX2 – For which areas of software applications do you feel OSS *training or migration was most difficult* in your firm? *Please explain the OSS training or migration difficulties you feel are most important; *Are there other OSS training or migration related issues that your experienced?
How does OSS fit with your business and internal software needs?
CP1 – In what ways do you feel that OSS *fits with existing software policies or practices* in your firm? *(e.g. flexible licensing, trialability, customisability, reconfigurability, support for Open Systems, conforming to software licenses)* *Please describe the most important of these policies or practices; *Are there other policies or practices?
CP2 – Which *IT skills or experiences* did your staff have that are important to the current use of OSS in your firm? *(e.g. software programming, document processing, hardware support, OSS self-training programs)* *Please describe the most important of pre-adoption staff IT skills or experiences; *Are there other pre-adoption staff IT skills or experiences issues?
CP3 – In what ways has OSS *matched the software requirements* of your firm? *(e.g. business sector software needs, front office and back office needs)* *Please describe the most important of such software requirements; *Are there other software requirements?

NORMATIVE BELIEFS
Please describe how external people or organisations have supported or encouraged the use of OSS in your firm?
N1 – What *peer groups have influenced the decisions* to use OSS in your firm? *(social network e.g. work colleagues, friends or families)* *How do you feel the most important group has influenced decisions to use OSS in your firm?; *Are there other peer groups?
N2 – Are there *other subjects* that have influenced the decision to use OSS in your firm? *(secondary information e.g. software vendors, public news, commercials or agencies)* *Please describe how the most important subjects have influenced the use of OSS in your firm; *Are there other subject that have influenced your decision to use OSS?
N3 – Are there *government departments or other agencies* that have influenced the decisions to use OSS in your firm? *(e.g. government backed migration support agencies, government software policies)* *Please describe how the most important of these government bodies influence your decision to use OSS; *Are there other government bodies that have influenced your decision?

CONTROLLABILITY BELIEFS
What measures of preparation has enabled your continued use of OSS?
S1 – What qualities do you feel give you the *confidence or ability* to use OSS? *(e.g. knowledge of OSS projects and services, related skills for using particular OSS)* Please describe how the most important of these qualities influence your confidence or ability to use OSS; *Are there other qualities?
F1 – Do you feel that *staff time* was an issue in the implementation of OSS in your firm? *(e.g. time table for planning, piloting and migration to OSS)* *Please describe how the most important staff time related concerns that had to be resolved in your in implementation of OSS; *Were there other similar concerns?
F2 – In what ways do you feel that *financial resources* were necessary for the implementation of OSS in your firm? *(e.g. internal/external OSS training for staff, accessing supporting services such as Internet connection, acquisition or upgrade of supporting IT infrastructure)* *Please describe the most important finance related concerns that have influenced the implementation of OSS in your firm; *Are there other issues?
F3 – What changes to the *pre-adoption IT infrastructure and support systems* were necessary for the implementation of OSS in your firm? *(e.g. internal and/or external training, consultation, outsourcing of OSS support, new IT infrastructure, new IT services such as broadband)* *How do you feel that the most important of these changes has influenced the use of OSS in your firm; *Were there other similar changes?
F4 – Were there any *concerns about the state of existing IT infrastructure* during the decision to use OSS in your firm? *(e.g. adequacy of hardware and other supporting IT infrastructure such as Internet connection, consultancy)* *How do you feel the most important concerns have influenced the decision to use OSS in your firm?; *Were there other concerns related to the existing IT infrastructure?

A.4 Definition of Theoretical Constructs

Construct	*Definition*
Usage	Refers to the actual use and continued use of the OSS. It is also a direct function of intention towards the use of the OSS (Taylor and Todd 1995a; 1995b).
Intention	Refers to the SME's evaluation of all beliefs related to the use of the OSS, and it is the immediate determinant of OSS usage (Taylor and Todd 1995a; 1995b).
Attitude	Refers to the SME's perception, evaluations, or judgement that the use of an OSS is favourable or unfavourable (Ajzen 1991; Benbasat and Moore 1992; Davis 1989; Taylor and Todd 1995b; Venkatesh et al. 2003).
Relative advantages	Refers to the degree to which an OSS provides benefits which supersede those of its precursor and may incorporate factors such as economic benefits, image enhancement, convenience, and satisfaction (Rogers 1995; Taylor and Todd 1995a; 1995b).
Complexity	Refers to the degree to which the SME perceives an OSS to be difficult to understand, learn, or operate (Rogers 1995; Taylor and Todd 1995a; 1995b).
Compatibility	Refers to the degree to which an OSS fits with the SME's existing values, previous experiences, or current needs of the SME (Rogers 1995; Taylor and Todd 1995a; 1995b).
Subjective norms	Refers to the SME's perceptions of social pressures (from referent groups such as friends, families, or work colleagues) to adopt or not adopt the OSS in question (Davis et al. 1989; Venkatesh et al. 2003). Normative-influences refers to the SME's perceived normative beliefs (weighted by the motivation to comply) that social pressures by a particular referent group (for example, friends and families), and information from secondary sources (e.g. news on TV, newspaper), are influencing the SME to adopt or not adopt the OSS in question (Taylor and Todd 1995a; 1995b).
Peer influences	Refers to an SME's perception that peers such as friends, families, and colleagues influence the SME's normative beliefs that using an OSS is good or bad (Taylor and Todd 1995a 1995b).
Superior influences	Refers to an SME's perception that information from secondary sources such as news on the Internet, TV, and newspapers influences the SME's normative beliefs that using an OSS is good or bad (Ajzen 1991; Brown and Venkatesh 2003; Taylor and Todd 1995b).
Perceived Behavioural Control	Refers to the extent to which the SME believe they have control over the personal/internal or external factors (also referred to as perceived facilitating conditions) that may facilitate or constrain the use of OSS (Ajzen 1991; Venkatesh et al. 2003). Facilitating conditions refers to the objective factors in the SME's environment (such as time, money, IT support and resources) which are required for supporting the OSS in question (Taylor and Todd 1995; Venkatesh et al. 2003).
Self efficacy	Refers to the SME's ability or confidence to use an OSS successfully in the given situation (Ajzen 1991; Taylor and Todd 1995).
Resource facilitating conditions	Refers to the supporting resources, such as time and money that may facilitate or constrain the use of the OSS (Taylor and Todd 1995b).
Technology facilitating conditions	Refers to the technology compatibility issues that may facilitate or constrain the use of an OSS (Taylor and Todd 1995b).

Key:
Construct (bold) – behaviour; ***construct*** (bold-italics) – belief components; *construct* (italics) – belief structures.

Appendix B – Transcripts

B.1 Transcript of Case C01

Researcher: Case C01-A Introductions

Researcher: What feature or qualities of OSS do you feel makes it attractive to you?

Participant: Um I think it is very high quality.

Researcher: Yes.

Participant: As a result of the collaborative approach to develop Open (.) the many pairs of eyes looking at the code Um

Researcher: Yes.

Participant: Um (.) So, its quality. There is security, and convenience (inaudible) And if I need a program to do something, I can just do a quick search, download it, and install it in (.) a matter of seconds.

Researcher: #NOISE#

Participant: I don't have to worry about licenses. I need to think whether it is compatible with other things. Um I just download it and use it.

Researcher: Um So, although I think that OSS is free (inaudible)

Participant: I think (inaudible) I think that yes it is free. Its free for those who are prepared to make the effort to understand it to use it properly.

Researcher: Yes.

Participant: If you don't have best expertise yourself or the time to develop that expertise, then you need to hire-in. Um In hiring-in, it may possibly be more expensive than hiring-in corresponding MS certified engineers. But having said that (.) because to my experience, the software is that much more robust. It doesn't require so much maintenance.

Participant: So, I think in terms of cost, a number of elements. I think the license is obviously an advantage. No licensing cost. Above that you don't have the cost of keeping track of licenses, which is probably more expensive than actually having the licenses cost.

Participant: So, you are in a large organisation, actually tracking that you got valid copies of the core software, proprietary software, is quite an overhead. Where as with OSS, how come you have worry about um The issue of maintenance is that, Uh if its cheap to maintain I would own it because it provides much less intervention in my experience. Uh it is smart to be running it on servers. And they run until some (.) very important involvements with the odd security upgrades. So that really depends. Having said that, you know, when you need to do something, um you need to have the knowledge to deal with (.) to organise things, like changing from one server to another.

Researcher: Yes.

Participant: So it does take a fair amount of time, but I don't believe it takes any longer considering the corresponding proprietary system. And after the (inaudible), once its set-up, it requires much less intervention.

Researcher: Its very interesting that you mentioned about tracking licenses because people just don't see the challenges in tracking licenses (inaudible)

Participant: Well, MS in particular has become much more ah invasive in terms of your licensing. And unless you can prove to them under the terms below (.) I am not an expert on MS licenses. But, unless you can prove to them that you have accounted for all the licenses issues related to all the software that you are using, they will impose a blanket cost on you. Um This is effectively a tax for using their (.) their software. Their auditing (.) the cost of auditing the licenses is competitive to the large organisation. And even then you can't be sure because you may have an employee

who downloads a piece or brings in a piece of software. And if you are not careful, you could be using a software that you don't know you are using (.)

Researcher: Yeah.

Participant: in your organisation. And you could fall down on the licensing restriction law. In OSS, its just not an issue. It doesn't arise.

Researcher: Well, so, how might (inaudible)

Participant: And I think people fall into generally two tents. Those who get it, and those who don't. Um I think amongst those who get it, there are those who are now villains producing something other than OSS. Um There are others who um recognise that for something, they have to use proprietary tools. Um So, we spend quite a lot of time running mixed environments for our clients.

Researcher: Hm

Participant: And they might be using (.) on the servers, they will be using Debian. But for workstations, they will be using a Pentium, Mac, Windows machine and Linux machines.

Researcher: Hm

Participant: The perception, I think is changing. I think (.)

Researcher: #mobile phone warning#

Participant: all these software has changed what it actually means a high quality products.

Researcher: Hm

Participant: For example, one of our clients uses something called SugarCRM, which is a customer relationship management system. And it is better than anything else out there at their market, because it looks very slim, very professional. So, I think perceptions are changing.

Researcher: Yeah. Um

Participant: But in a sense, they don't necessarily do. Because of the ubiquity of MS, there is so much money spent by MS to protect their market share. Changing perceptions, is quite difficult because (.)

Researcher: Sorry to interrupt you. I just got a message. My phone card is running out, so if it does go out, I ll have to go out, top it up and call you back. Just In case, I am just saying. #phone adjustments - interview continues in next recording#

Researcher: Case C01-B Continued

Participant: who really understand Open Source. But I would think that there are minority but there is still a lot of people in the world who haven't heard of it.

Researcher: Yes.

Participant: Um And to them, I think, MS is computing.

Researcher: Yes.

Participant: And its (.) its going to take quite a long time for them to realise there is an alternative.

Researcher: Yes.

Participant: I mean, not many people realise that companies like Google, #Emerton ST Trade# are businesses that are built on OSS.

Researcher: Um OK. We talked a bit about the advantages. What do you think are the challenges or the difficulties, or the barriers eh for using Open Source, particularly in your case?

Participant: I think the disadvantage is (.) is what we've just touched upon, which is perception. Because MS has a business model which generates huge amounts of money.

Researcher: Yes.

Participant: That gives them the economic muscles to market and dominate the market, both visually and from the point of view of perception.

Researcher: Hm

Participant: Which makes it very difficult for Open Source to compete. Because Open Source by definition, is low margin. So, there is not (.) then very few Open Source businesses have any sort of marketing and such institutes to speak of.

Researcher: Yes.

Participant: And therefore, one is (.) to some extent, its one of the best kept secrets around, that there is all these (.) there is this reservoir that you can use, that nobody knows about.

Researcher: Hm

Participant: So, I think the big challenge is getting acceptance, not just among corporate but amongst ordinary people.

Researcher: Yes. Um you did mention, eh initially about eh not just being free, but also when it comes to cost, there is a (.) the ability to actually use it and training, difficulty or challenges. How do you feel about um areas where using OSS is difficult in terms of training or migration?

Participant: Well, obviously, what Open Source tends to involve by virtue of people needing a solution to a problem, (.)

Researcher: Yes.

Participant: and typically people who develop OSS started by developing things for themselves. So, if one contrasts it with the proprietary world, what normally happens in the proprietary world, somebody comes up (.) the marketing department comes up with the need, and then the engineering department will engineer the solution So, there are areas where OSS is yet to make a real headway in terms of having reputable applications.

Researcher: Hm

Participant: Um So, particularly in specific industries, um there are say banking packages or investment management packages, which tends to be proprietary because there is nothing for them in the Open Source world, as yet. So, for Open Source to penetrate every market sector, it is going to take a while. There needs to be adequate incentives till somebody builds something, that there's (.) they are prepared to build along the Open Source model.

Researcher: Yeah.

Participant: Having said that, um there are usually a combination of tools available that will deliver what you need. Another area that Open Source is not great at the moment is in accounting packages. Um There are Open Source accounting packages, but they cannot be very sophisticated. So, for a enterprise, there are limited options for Open Source accounting packages.

Researcher: Hm I (.)

Participant: So, I think those are the sort of difficulties that one encounters. Then, on top of that, you've got the issue of cultural acceptance and training people.

Researcher: Yes.

Participant: And that's a (.) that s a function of time as much as anything.

Researcher: And, when we (.) when you look at training and migration, um while we accepts that it is difficult and is something that hopefully, will improve with time, what will you say are some example of measures towards this improvement?

Participant: Well, here, one of the (.) have you heard of Firefox?

Researcher: Yes. I use Firefox eh web browser.

Participant: Right. Well, Firefox was launched from a zero base with no marketing #spent# worth talking about. #After an offensive#, it was free to download. So,it was marketed by viral means. So, by word-of-mouth, almost.

Researcher: Yes.

Participant: Um And yet, (inaudible) but I think it is something like twenty percent market share, I think, a couple of years ago. So, um there are (.) there are ways of gaining acceptance in (.) except in migration. And, the beauty of doing (.) starting with something like Firefox, is that it runs on Windows.

Researcher: Yes.

Participant: So, once you start running free applications on Windows, it is (.) it is so much less a step bend to start using Firefox on a Linux based platform as opposed to Windows platform. Generally, OpenOffice is available for Windows.

Participant: For most offices, for most functions, you need to browse the web, read emails, and create documents and spreadsheets, if you like. So, between Firefox, Thunderbird and OpenOffice, all of which run on MS eh, as well as Linux, you can port your organisation onto those three fairly painlessly over time. Once you've done that, then shifting your platform to Linux (.) excuse me, Linux as opposed to Windows, is not as big a step, as doing it in one hit.

Researcher: Yes.

Participant: So, in terms of the way one goes about it, I think at the back end of the server-end is something that you can do fairly transparently with users not (.) not really noticing.

Researcher: Yes.

Participant: So, when it comes to the desktop, I think you have to do it gradually. There will be those who take to these new packages much more readily than others.

Researcher: Hm

Participant: So, specifically, we would advice clients to start with Firefox, Thunderbird, and OpenOffice. Then once those gain 'acceptance', their objectives tends to move onto more ambitious things like actually changing the desktop to Linux based as opposed to Windows based.

Researcher: Yes. You mentioned some of these applications, Firefox, OpenOffice, accounting packages, um within yourself environment, how does OSS fit with what you do, or what solutions do you use of what you do?

Participant: Um Well, we use Firefox, Thunderbird for email, and the desk Office. And, I am working (.) exchanging files with people using MS Office. So, I don't (.) There are very few issues that arise. Issues that tends to arise are more limitations from Outlook, which tends to do strange things with email.

Researcher: Yes.

Participant: Ah But in the main, we can (.) there is exchange-ability or compatibility between the programs that I am using, and the programs that other people are using on a Windows platform. So, those are the main ones. I also use a text editor called 'Vim'. You know 'Vim'?

Researcher: Eh "Zim". No, I've never heard of that before.

Participant: Well, its a (.) its a text editor that is used (.) its original concept was for programming, but its (.) its a (.)

Researcher: Oh, you are talking about Vim, V-I-M, text editor. Yes. Yes. I know Vim, nano, gedit, and midnight composer.

Participant: Midnight Commander.

Researcher: Commander, sorry.

Participant: Yeah.

Researcher: MC.

Participant: #Yeah I do#. When I started using Linux, a few years ago, I started learning as many programs as I could. But, I tend to settle down to the ones that I need rather than ones I look out for interest sake.

Researcher: Yeah.

Participant: Um (inaudible) companies.

Researcher: There's also Emacs, now that we talking about editors. But, I think Emacs is a bit technically challenging and I need to remember all the commands.

Participant: Um But also, I mentioned that we use SugarCRM, which is a very sophisticated customer relationship package, that run on a web browser.

Researcher: Yeah. Eh SugarCRM, Compiere, and all those supply chain (.)

Participant: Compiere is small enterprise resource management, including accounting.

Researcher: Hm

Participant: Uh I've not actually used it.

Researcher: OK. Every now and again, at the moment, in my business, we still use Sage on Windows for accounting. And I've yet to find a package, an Open Source package to take place of that. I like to, but I haven't found one yet. So, you do use SugarCRM?

Participant: Yeah, we do.

Researcher: Yeah. How do you find, um in regards to all the things we talked about, you know, the advantages of using it, uh the difficulties of using it, and how well it fits into uh (.) uh your business?

Participant: Um with SugarCRM, its (.) we are running hosts. Sugar actually hosts it. We did try running it ourselves.

Researcher: Hm

Participant: But they (.) they have two versions. They have a paid for version, and a free version. The free version doesn't have quite the same functionality as the paid for version.

Researcher: Hm

Participant: So, um We use a paid-for version. And, they host it and provide support. Um So, in that respect, its (.) you know, its no issues, no different from running any other software. Um Other than the fact that it is Open Source.

Researcher: But (.) but the (.)

Participant: The other (.) other things that we run (.) like we run databases ourselves. Remember PostgreSQL?

Researcher: Yes. PostgreSQL.

Participant: on some of our servers. Because (.) its as good a database package you will find anywhere.

Researcher: Yeah. yes. I know PostgreSQL and MySQL databases. Um

Participant: But I think PostgreSQL is a bit more grown up than MySQL.

Researcher: Right, I didn't know that.

Participant: Well, MySQL I think is used a lot, but its (.) I am not an expert in these things, but I can say this. In terms of data integrity and to heavy duty (.) heavy duty work, I think PostgreSQL is the best of solutions. A more sophisticated solution than MySQL. Having said that, there are a lot of packages including Sugar, based on MySQL.

Researcher: Hm That is quite interesting to know.

Participant: Hm

Researcher: However, although you get them to provide you support on your SugarCRM, um but it is still the Open Source?

Participant: Yes, its still Open Source. Well, its the (.) the development of their software is Open Source, Yeah.

Researcher: Yes. Say, within your circle, how (.) how is OSS perceived such that may be, what the standards of the organisation. or even in your organisation eh, may be, people or agencies, sort of give you ideas to use Open Source,or may be there are some rules or policies that make you to use Open Source or not to use Open Source?

Participant: Well, we run our own company, so (.) and its quite small, so basically, we do what we like, we don't have a problem.

Researcher: Hm

Participant: Um where the issues lies, is when we are dealing with clients. But on the social and environmental issue, I think (.) I am (.) I have been a member of the Debian community for four years or so. And there is (.) I think OSS is quite a democratising force. Because everybody can (.) everybody can participate to the level that they choose. And the only hierarchy, particularly in Debian, is based on technical expertise. You know, you come to respect those that know what they are talking about. And we can communicate on news groups. Um so I (.) I see OSS as a model for social intervention in businesses is quite an interesting one. I think the jury is out to how sustainable it is in the long term. (inaudible) the impression I get of the ethos is (.) is quite egalitarian.

Researcher: Hm

Participant: But everybody is working towards the same end, which is to create the best software of all.

Researcher: And you think this sort of community or um group, sort of makes one to do more, in terms of adoption, or usage or (.)

Participant: Well, I'll say yes. From a selfish perspective, you want the software to be as good as it can be, and you want more (.) as many people as possible to use it. Because more people will use it, the best it will be. So its a virtual circle in a sense.

Researcher: Hm

Participant: Uh Because theres more people who use it, more people are looking at it, the features will become rich (.) richer. Um All the bugs get squashed out.

Researcher: Hm

Participant: So, its a virtue of circumstances. Um More usage brings in uh better software, better software brings in more users.

Researcher: Hm OK. Um We can now go away to the last part of these questions. This one is about looking at it from your point of view, your ability to use it, what are the sort of resources you need to put in to use it? So,

Participant: What are the what, sorry?

Researcher: I am now going into the third part of the (.) of my questions, which is looking at the use of OSS from your point f view, your perspective, the kind of skills that you need, the kind of resources, may be, time to set things up, or you need to employ new staff with new skill,. So the first question on this area. Um What qualities do you feel give you the confidence or ability to use OSS?

Participant: Um well I devoted a lot of time and effort, and late nights, experimenting. And I (.) My first #forray# into OSS was invest in Debian, on (.) on a very old Mac. It was quite complex to install. It took me (inaudible) without components six months to get it to installed.

Researcher: Yes.

Participant: Which sounds like a long time, for a lot of false starts, but during that process, I learned a lot. Uh And since then, I've installed in sorts of machines, Macs, Intel machines, um on all sorts of flavour.

Researcher: Hm

Participant: Um And also learned in (.) learned to do some things because I am not a programmer. My background is not (.) not a technician.

Researcher: Yeah. On a sort of user scale, is that right?

Participant: Yeah. How I use it I guess. So, I basically taught myself networking and system administration. I would (.) I would say that the more I Learned, the more I realised I don't know. But I probably know enough to run the system.

Researcher: Yes, to do what you really want to do.

Participant: Yes, to do what I want to do. But it takes a personal commitment to want to do that. And, if you don't want to do that, you've got to hire someone in to do it.

Researcher: Yes, I agree. So, based on what you've just said, there is a (.) there is a need to commit some sort of time (.)

Participant: Yeah, quite a lot of time.

Researcher: Yes, quite a lot of time, in fact , to make that more precise. Quite a lot of time to develop sort of necessary skills to get whatever usage implemented, to say.

Participant: Well, if you take the contrast between (.) if you take the contrast between Debian and Windows, (.)

Researcher: Yes.

Participant: is that if I am prepared, as I was, to spend the effort to understand how to use it, how to install it, how it works, I have a measure of control of my computing environment that a Windows user can only dream of even if they are an expert.

Researcher: Yes.

Participant: Because so much programming is closed, you can't get in there to see whats gone wrong. And a typical response to the problem is to reboot your machine. Where as in Linux, in case you've spent the effort in understanding it, you know how to stop the process, you know how to restart it. You learn how (.) how to sort out the mail queues.

Researcher: Yes.

Participant: Um So, there is this (.) Its basically giving you much more power over your computer than Windows will allow you to. Even if you read the user license agreement, basically, they are saying you don't actually, have the right to do what you want to do with your computer. You have to decide with their licensing obligations.

Researcher: Hm

Participant: So, its not only (.) from both a licensing and from a technical point of view, it gives you much greater control of your computing environment. And from the security point of view as well.

Researcher: Yeah. From the security point of view as you just mentioned, how does that link to ones skills, as we were talking about now, the skills and the time one puts into getting things sorted, and may be whatever facility one might need to put in to get it up to this security standard you speak about?

Participant: Well, I think your average Windows user, lets say now, with Windows, you come to learn that you try (.) you try to differentiate between user privileges and the mass privileges. But most people get to sit under admin privilege on their machine, (.)

Researcher: Yes.

Participant: so if they receive an executable, it will execute with eh those privileges. That will never happen in Linux.

Researcher: Hm

Participant: You have to deliberately go and run something with scripts or improve privileges to (.) to be able to do that (inaudible). Already you cut down the risk to your computer system quite effectively. Thereafter, its a function of understanding the way the software works, and the best way to configure it, and use it. Um And a lot of it is common sense. But certain amount of it is technical understanding.

Researcher: Yeah.

Participant: Its a question of how much you are prepared to put into that. Having said that, out of the box, when you install Debian, it is pretty secured. It doesn't need a lot of support services. But, generally, its (.) its more of that you have to turn things off rather than turn (.) eh, turn things on rather than turn them off. Where as Windows runs (inaudible) (.)

Researcher: Yes, yes, yes

Participant: find out security, if you have to run things off. So, I understand, I am not an expert in Windows.

Researcher: Would you say by default, then, this is another advantage of using, well, not just OSS, but Linux sort of platform?

Participant: Well, as I said, its quality and security. And I think security plays a very big part of (.) in the advantage that Linux has over Windows.

Researcher: And this particular example of it being from out-of-the box, things are sort of turned off.

Participant: Um Yeah. I mean, I (.) from what I gather, and I've only looked at Windows on (.) eh Vista on one machine, from what I gather, MS now tends to work on basis that they don't turn everything on, and open every port.

Researcher: Yeah.

Participant: And if so, I suspect it is inherently less secure out-of-the box, than Linux or Debian anyway. Specifically, I can (.) I can only really talk for Debian because that's the system I use. And I have played with other distributions than Debian, and they work.

Researcher: Hm Ahh, well, just like myself because my reason, I (.) I (.) it is important for me to get a perspective of most of the distributions, so I use Ubuntu, Mandriva, and Open Suse.

Participant: Yeah, Ubuntu is pretty good, but it is based on Debian.

Researcher: Yes.

Participant: If I am giving a Linux distribution to somebody else, I will give them Ubuntu. Because I think Debian requires too much knowledge to use out of the box. But Ubuntu, you can use out of the box, just like Windows. And I would suggest it is more secure.

Researcher: Now about (.) sort of resources, we have talked about time, what other kind of resources have you needed to put in? Well, it very common knowledge now that with Vista, you have to be clear about your hardware and whatever that is needed.

Participant: Well, that's the other great advantage that you can run (.) I run Debian on a number of ranges of hardware, a lot of which is quite old.

Researcher: Hm

Participant: First time I installed, I installed on a very old strange piece of kit. #An E-BUS# Mac. Um Since then, we've acquired a lot of second hand servers. Stocks from labs. In fact, our main server is a G-Force, which is probably five, six years old

Researcher: Hm

Participant: Um So, one of the things that using Linux does is enable you to extend the life of your hardware. Um So, its another cost advantage instead of having to replace your hardware every three years, as you do under Windows. Um You can extend the life of your hardware indefinitely.

Researcher: Um So, looking at this advantages of hardware, when it comes to adopting OSS, for example in your case, um what changes did you need to make to your previous infrastructure or what support did you needed to get in in able to be able to, may be use OSS or migrate from previous platforms?

Participant: Um Its mainly time configuring stuff. I mean, the one area that Linux has a disadvantages is the area of hardware drivers (.)

Researcher: Hm

Participant: Eh for instance, I've a screen (.) I've a screen (.) eh graphics cards client. So she buys a spanking new kit. The likelihood of finding proprietary drivers that will run is quite low.

Researcher: Hm

Participant: So, generally, you are better off buying hardware which is (.) has been older, (.)

Researcher: Yeah.

Participant: you know, to a year or so. So, its (.) people had time to write registered drivers because a lot of the manufacturers won't release specifications to the OSS community to write proper drivers. So a lot of it had to be reverse engineered.

Researcher: Yeah.

Participant: Personally, we didn't have to change anything in terms of our hardware. I mean there were other issues like some (.) some network cards don't work well under Linux. But network cards cost twenty quid to replace.

Researcher: Hm

Participant: Um but we've not really had any big issues with hardware. But having said that, before we buy anything new required, we tend to make sure we know it will run, before we buy it.

Researcher: Hm

Participant: Um So, yeah. I am sure in the margin, there is some sexy hardware around that doesn't work well with Linux. But, we don't have a need for it. #Twenties,# probably more talk than its worth.

Researcher: Yeah. And um looking that it is OSS as you said, and it takes time and may be, collaboration with manufacturers, for community developers to develop drivers, um how do you think using OSS and using new technology works, in consideration of support of the development community, in reacting to new innovations, and getting those new innovations usable with the OSS community?

Participant: Well, luckily, there's a fairly vibrant community. Its small staffed. Its a (.) its a fairly sort of limited number of people who have an interest in Linux and the development of OSS. The community is growing enormously and also takes in quite a lot of corporate players, who are prepared to invest money in um developing drivers,

developing fixes, software, or attributes with network companies. (inaudible) Tesco has started selling PCs with Ubuntu on. Dell is also selling PCs with Ubuntu. HP is selling Linux computers, I think Ubuntu, but certainly with Linux on. So increasingly (.) And IBM is supporting a lot of Linux installations. So there's been very big players who are actually investing in software development, because it suits their business. So, I think these issues, will become less and less of a problem, going forward.

Researcher: That is eh very, very interesting because um I remember a year or two ago, the involvement of some of these big companies uh made a very big paradigm, because suddenly overnight big companies are talking about it, because these big companies are doing something, are playing a part. So, it was a very interesting and if I may even say, an exciting time.

Participant: Well, it is (.) I think if you really want to know the power of OSS, it lies on the continent and elsewhere. I mean, in this country in the (.) amongst the public sector, there is very little use of OSS, in reality.

Researcher: Hm

Participant: Where as if you go to the continent, there's the (.) the French (inaudible) which is still open to OSS. There are areas in Spain, a whole districts that have gone Open Source, and have rolled out computing across the public sector, at a fraction of the cost of what it would have cost for proprietary installation. So, there is a (.) there is a roller-coaster of activity, particularly on the continent, and we in the UK are just quite a long way behind on that.

Researcher: And (.) and why do you think it is so?

Participant: Um because of the amount of money that companies like MS invest in political lobbying in making sure that they get government contracts.

Researcher: Right. Right. So, basically, if we go back to some of the environmental and social issues, we are now looking at ah say for example, MS and its investment and policies are sort of um hindering the development or the spread of OSS.

Participant: Yeah. They've been fighting tooth and nail. You know, its not for nothing that there has been anti-trust missions both in the UK, in Europe, and the United States, against MS. They (.) they have very deep pockets, they can afford to spend a lot of money on political lobbying. So, basically, what he is fighting against that, is the individuals who believe passionately in the power of Open Source. Um But they don't have a lot of money behind us. But, never the less, you know, we are winning.

Researcher: Yes.

Participant: But its a long war.

Researcher: It is a long war. Especially in consideration of you know, some of these new paradigms that are happening, social networking, peer-to-peer computing uh where the activities are not so much central to the technology itself, but to the people and what they want to do, or what they are trying to do. Um Looking at that from some of the ideologies of OSS, what do you think, you know, in empowering people to do what they want to do, rather than what the technology says they can do, or cannot do?

Participant: Well, I mean (.) I think there is (.) this is happening on two levels. On the one hand. On the one level, in the end Open Source community, peer-to-peer file sharing, and (.) and that sort of social intervention has been enabled for quite sometime, but its not been very visible. Um the evolution of things like MySpace, Facebook and these other sites, has (.) has created a whole new world that a lot of people have plugged into, but they've been bought by eh imitations um MySpace by Ruport Murdock, Facebook, I think has been bought by (.) trying to remember. But anyway. So, they have been (.) they have been manipulated to ramp up their value through marketing uh and advertising revenues, etc. So, I am fairly sceptical on how Open these communities are, and how desirable they are. I think (.) I think it is good for people to be able to share and collaborate, but I think there are many issues that go way beyond the technology, and then more to do with who is controlling these portals.

Researcher: Hm

Participant: Um So, I am not sure that Open Source is really a big issue in there. Although I am (.) I bet there (.) there is a lot of OSS that sits at the back of the office servers that are running these things. Um but I think the issue is much more social and political, than technological.

Researcher: Hm Well (.)

Participant: And I don't think what the software is, is really the main point.

Researcher: Well. it is interesting you say that, because we now come back to some of the norms: the back office and the front office. How do you think OSS plays in the balances and the popularity of the most usage in the front usage and back office?

Participant: Well, I am sure it depends on the industry. Um I think increasingly, one is going to be looking at applications through a web interface.

Researcher: Yes.

Participant: And frankly, I knew that Firefox is a much better browser, sufficient than Internet Explorer. So, um OSS could be a major beneficiary in that. And also the client (.) the server-client model that Linux is built on is much more attuned to that sort of environment than Windows, which is not natural a client-server architecture. Um So, I think in terms products of office applications, I see Open Source being potentially a powerful force. But again, it comes back to having the right applications for what users want.

Researcher: Hm

Participant: And you know, if there is specialised applications that are only provided by the proprietary providers, and so, that's where its going to lie.

Researcher: And so (.) because of the popularity of a lot of the applications from the um back office side, you think that is where OSS has more strength, however, the front office as you said, really depends on the applications and what users want to do?

Participant: Yeah. But I think (.) I think if you recall most people as I said earlier, are using web browsers, email and Office package. Then they can do it equally as well through Open Source, and I would argue, more effectively, or more economically.

Researcher: Hm Interesting. But, however, why is um (.) why is there so much divide between the front office and (.) #NOISE# the popularity of the front office and the back office?

Participant: Because I think user acceptance on the desktop is going to take a long time. OK. You know, its a much (.) if you are talking to people in the back office, they tend to look at, you know, is this technical solution better that that technical solution? If you talking about desktop, its what people are familiar with. Um People (.) people change, very reluctantly.

Researcher: Right.

Participant: They like, you know, the familiarity, the comforts of familiarity. So, I think you know, that's (.) that is something that would take time.

Researcher: This is very interesting because now we have on the front office, we are talking about user acceptance and familiarity. Whereas, at the back office, we are talking about technical solution.

Participant: Yeah.

Researcher: This is something that managers and even sometimes technical people, they don't see this dividing line. And I think making a particular focus in either of these areas can really improve awareness (.)

Participant: Hm

Researcher: and decision making. So, looking at this from the use acceptance side, from the front office, what do you think are the difficulties? And what do you think is the way forward?

Participant: Um I am going to have to round it up because I need to be on

Researcher: I understand, thank you.

Participant: That's all right. Um I (.) I think, to give a credit, Windows (.) if you use Windows XP, it is easy to use. It is not difficult to use, as long as its working.

Researcher: Hm

Participant: When it goes wrong, that's a different matter though. But when its working, particularly if you've got used to working it, it works reasonably well, it does quite clever things. Eh Its quite intuitive, in some respects. Although, it can be counter-intuitive in other words.

Researcher: Yeah.

Participant: So, once you become familiar with it, to go and use something different is quite a stretch. Having said that, those people who try and say Ubuntu is the alternative, find that XP is not dissimilar to use, in some respects. Uh Its obvious there is a difference. But thats not (.) not a huge problem.

Researcher: Hm

Participant: Um Personally, I am not a great lover of Gnome, which is what Ubuntu use at the front-end. But um I don't (.) I think its (.) I don't think one can rubbish Windows as being bad software.

Researcher: No.

Participant: I think (.) I think my problem is their business model, and their monopolising position makes them a very disreputable competitor. And I think they need a healthy competitor to keep them honest, if you will.

Researcher: Yes.

Participant: Um So, I don't think there (.) I think Windows has a lot of sauce. But, a lot of other software does. Um And its more marketing web, than it is technically good. But for all that, I think you know, its not bad stuff to use.

Researcher: Hm

Participant: So, its a question of people being exposed to an alternatives and becoming (.) and spending enough time to become familiar with it. And I guess that Ubuntu is probably in the best position to combat that, particularly now you can buy a computer in Tesco or Dell, or elsewhere with Ubuntu on it. Does that answer your questions?

Researcher: Yes, um that gives me some insight into the familiarity issue from the user acceptance side. We've discussed extensively on the back office side. But I don't know if there is anything else you will like to add on you know, looking that from the back office, often people are looking at technical solutions at work. I don't know if you have (.)

Participant: Well, also, you know, you are going to have to overcome the picture, there is still individuals in the back office as well. (inaudible) at the end of the day, it comes down to a technical solution. If you are a MS certified engineer, then you are going to find installing Debian or something else quite daunting.

Researcher: Right.

Participant: Um But over time, more and more (.) I know MS engineers who increasingly play with OSS. So I think the balance will tip, almost naturally.

Researcher: As you say, if its individual, then how does that work with may be, an IT manager, or the manager or and the technical people who actually use or who implement the systems. I mean, there is a sort of a decision management level, how does that work?

Participant: Well in (.) eh I couldn't tell you with any great precision about what happens in most companies, the point typically from what I can see, is that you have (.) lets say you've got an IT department which has a director and manager, and say ten people. Um There may be two or three within there who understand Linux. And they might (.) they might use um products (.) projects, almost on a quite using Linux. And then they show the idea to their management. And over time, that's how it changes.

Researcher: Hm

Participant: But (.) but if the shop has a firm policy of MS and you (.) then there is not a lot that any individual can do about it.

Researcher: Right. Hm So (.)

Participant: So it depends on the politics. And to my mind, the key to changing an organisation is to go to the top. So, basically, its selling the benefits to the finance directors and the chief executive is where you need to go. And then everything else follows from there.

Researcher: And in a way would I be correct to say. from what you've eh (.) gathering from what you've said, that the technical people have to make this kind of initiative rather than the management.

Participant: Um possibly. Although you know, our business (.) One of the things our business does is (.) is seek to persuade companies that they ought to look at all Open Source as a normal personal alternative, so if we go and talk to their chief executive, or managing director, we would talk about the financial benefits, the stability benefits, the security benefits. Um He will then ask his IT people what they think. And he may get one or two answers. They may say yes, its something we ought to look at. Or they may say, in all earnest, Linux is rubbish.

Researcher: Hm

Participant: We won't touch it with a barged pole. But then down to their pride in IT versus mine.

Researcher: Hm interesting. Well, thank you for your time so far.

Participant: Well, you are welcome.

Researcher: I will like to send you an email of the page, just so that you can give me some organisational demographic information which

Participant: Yeah, that's no problem. Have you got my email address?

Researcher: Um

Participant: Its on the web site.

Researcher: OK.

Participant: #participant gives contact details# OK.

Researcher: And also, I will be creating a transcript of the things we've discussed and attach it to a database [researcher comments] But thank you very much.

Participant: You are most welcome.

Researcher: As I go through what we've discussed, I will (.) I am very keen to show you what I've pointed out and hopefully you can help me double check some of the assumptions I've made, or will making in the future.

Participant: All right, yeah. I ll have a look.

Researcher: OK. Thank you very much again. i am very very happy and I appreciate you time so far.

Participant: You are welcome.

Researcher: Thank you very much.

Participant: Bye.

Researcher: Bye bye #Closure#

Appendix C – Within-Case Analysis of Factors

C.1 Data Analysis of Case C01

Demographic information: One of the things our business does is [...] is seek to persuade companies that they ought to look at all Open Source as a normal personal alternative, so if we go and talk to their chief executive, or managing director, we would talk about the financial benefits, the stability benefits, the security benefits

Technologies: Debian, Firefox, Thunderbird, SugarCRM

Relative advantage		
Factors	**Related Data Extracts**	**Memo**
License cost-saving	if I need a program to do something, I can just do a quick search, download it, and install it in (.) a matter of seconds [...] I don't have to worry about licenses [...] Its free for those who are prepared to make the effort to understand it to use it properly [...] I think the license is obviously an advantage. No licensing cost [...] if you are not careful, you could be using a software that you don't know you are using [...] in your organisation. And you could fall down on the licensing restriction law. In OSS, its just not an issue. It doesn't arise	suggests that there is license cost-saving because there are no fees for OSS licenses. This suggests a cost advantage over most proprietary software, which require purchase of a license.
License-audit cost-saving	you don't have the cost of keeping track of licenses, which is probably more expensive than actually having the licenses cost [...] in a large organisation, actually tracking that you got valid copies of the core software, proprietary software, is quite an overhead	suggests that there is a cost saving in the cost of license auditing because adopter does not have additional costs in keeping track of OSS licenses (cost of license-audit). There is a cost advantage over the use audit of proprietary software licenses.
Extended use of hardware	I run Debian on a number of ranges of hardware, a lot of which is quite old [...] In fact, our main server is a G-Force, which is probably five, six years old [...] one of the things that using Linux does is enable you to extend the life of your hardware. Um So, its another cost advantage instead of having to replace your hardware every three years, as you do under Windows. Um You can extend the life of your hardware indefinitely	suggests that use of Linux to extend the use of old hardware, is a cause of, cost advantage (instead of replacing hardware every so often) Therefore, extending the use of hardware, is a cause of, cost advantage. This is an advantage over replacing hardware every so often, which is the case under some proprietary computing platforms

Extensibility	the contrast between Debian and Windows [...] is that if I am prepared, as I was, to spend the effort to understand how to use it, how to install it, how it works, I have a measure of control of my computing environment that a Windows user can only dream of even if they are an expert [...] so much programming is closed, you can't get in there to see whats gone wrong [...] Its basically giving you much more power over your computer than Windows will allow you to [...] from both a licensing and from a technical point of view, it gives you much greater control of your computing environment	suggests that OSS allows users more control to extend their computing environment, than allows closed-source software. Also suggests that this is an advantage from a licensing and technical point of view, over a closed-source alternative This suggests that technical OSS extensibility is related to the knowledge that is gained form learning to use the OSS, install it, and knowing how it works.
Reliability	I think it is very high quality [...] As a result of the collaborative approach to develop Open (.) the many pairs of eyes looking at the code [...] to my experience, the software is that much more robust. It doesn't require so much maintenance [...] if its cheap to maintain I would own it because it provides much less intervention in my experience [...] once its set-up, it requires much less intervention [...] They run until some (.) very important involvements with the odd security upgrades [...] I knew that Firefox is a much better browser, sufficient than Internet Explorer. So, um OSS could be a major beneficiary of that. And also the client (.) the server-client model that Linux is built on is much more attuned to that sort of environment than Windows, which is not natural a client-server architecture. Um So, I think in terms products of office applications, I see Open Source being potentially a powerful force	suggests that reliability, is a cause of, high quality of the OSS (because they run well until some odd security upgrades, and because of the underlying client -server architecture) suggests that reliability, is a cause of, software robustness (leading to low maintenance cost because it requires much less intervention) Therefore reliability, is a cause of, high quality of OSS. This is an advantage over less reliable proprietary technologies that requires more intervention, and therefore, more maintenance cost
Security standard	lets say now, with Windows [...] most people get to sit under admin privilege on their machine [...] so if they receive an executable, it will execute with eh those privileges. That will never happen in Linux [...] You have to deliberately go and run something with scripts or improve privileges [...] Already you cut down the risk to your computer system quite effectively [...] out of the box, when you install Debian, it is pretty secured It doesn't need a lot of support services [...] I think security plays a very big part of (.) in the advantage that Linux has over Windows	suggests that security standard, is a cause of, more secure mode of Linux and Debian systems suggests that security, is a cause of, the advantage of Linux over Windows Therefore, system security, is a cause of, more secure mode. This is an advantage of Linux over Windows because of collaborative approach of the OSS community

Complexity		
Factors	**Related Data Extracts**	**Memo**

Lack of drivers	the one area that Linux has a disadvantages is the area of hardware drivers [...] for instance, I've a screen (.) I've a screen (.) eh graphics cards client. So she buys a spanking new kit. The likelihood of finding proprietary drivers that will run is quite low [...] So, generally, you are better off buying hardware which is (.) has been older [...] you know, to a year or so. So, its (.) people had time to write registered drivers because a lot of the manufacturers won't release specifications to the OSS community to write proper drivers. So a lot of it had to be reverse engineered	suggests that lack of drivers, is a cause of, disadvantage in using Linux (due to difficulty in using some computing hardware as a consequent of hardware manufacturers not releasing drivers to the OSS community) suggests that some vendors may not support hardware drivers for Linux systems, and this limits the use of such proprietary hardware in Linux environments Therefore, lack of drivers, is a cause of, difficulty in using some hardware under OSS. This difficulty is a relative disadvantage in OSS, because the hardware are more supported under proprietary OSS
Lack of applications	there are areas where OSS is yet to make a real headway in terms of having reputable applications [...] particularly in specific industries, um there are say banking packages or investment management packages, which tends to be proprietary because there is nothing for them in the Open Source world [...] Another area that Open Source is not great at the moment is in accounting packages. Um There are Open Source accounting packages, but they cannot be very sophisticated. So, for a enterprise, there are limited options for Open Source accounting packages	suggests that the lack of reputable OSS applications in some industries makes it difficult to operate OSS platforms in such industries suggests that lack of applications, is a cause of, difficulty in using OSS in some industries Therefore, lack of applications, is a cause of, limited use of OSS. This is a disadvantage of Linux over alternative software platform, because there is no matching quality of proprietary software, or even nothing for some industries in the OSS world

Compatibility		
Factors	**Related Data Extracts**	**Memo**
Server applications	it is smart to be running it on servers [...] in terms of the way one goes about it, I think at the back end of the server-end is something that you can do fairly transparently with users (.) not really noticing	suggests that OSS server applications fit transparently in the server-end, with little intrusion to user activity suggests that server application, is a cause of, OSS fit as a server-end or server platform Therefore, server application, is a cause of, OSS fit as a server platform. This means that OSS fits as a server platform.

Interoperability	There are others who um recognise that for something, they have to use proprietary tools. Um So, we spend quite a lot of time running mixed environments for our clients [...] there is exchange-ability or compatibility between the programs that I am using, and the programs that other people are using on a Windows platform	suggests that OSS are have exchange-ability (interoperability) with other software in a mixed IT environment suggests that interoperability, is a cause of, OSS fit in a mixed IT environment Therefore, interoperability, is a cause of, OSS fit in a mixed IT environment. Thus means that interoperability allows OSS to be used with other non-OSS systems
Functionality	For most offices, for most functions, you need to browse the web, read emails, and create documents and spreadsheets, if you like. So, between Firefox, Thunderbird and OpenOffice, all of which run on MS eh, as well as Linux, you can port your organisation onto those three fairly painlessly over time [...] If I am giving a Linux distribution to somebody else, I will give them Ubuntu [...] Ubuntu, you can use out of the box, just like Windows [...] those people who try and say Ubuntu is the alternative, find that XP is not dissimilar to use, in some respects. Uh Its obvious there is a difference. But that's not (.) not a huge problem	suggests that Linux systems such as Ubuntu and other OSS applications offer IT functionality that fit in many areas of organisational IT needs, and are viable alternatives to similar offerings from non-OSS vendors suggests that functionality, is a cause of, OSS fit in many areas of organisational IT needs Therefore, functionality, is a cause of, OSS fit in many areas of organisational IT needs. This means that OSS functionality makes it fit in many areas of organisational IT needs
Supports legacy hardware	I run Debian on a number of ranges of hardware, a lot of which is quite old [...] we've acquired a lot of second hand servers. Stocks from labs. In fact, our main server is a G-Force, which is probably five, six years old [...] Um You can extend the life of your hardware indefinitely	suggests that OSS such as Debian fits on legacy or old IT infrastructures, which helps to extend the life of old hardware, possibly indefinitely suggests that support of legacy hardware, is a cause of, extended life-cycle of old hardware Therefore, support for legacy hardware, is a cause of, extended life-cycle of old hardware. This means that support for legacy hardware makes OSS fit with old hardware, to extend their use

Peer influences		
Factors	**Related Data Extracts**	**Memo**

Support community	I think OSS is quite a democratising force. Because everybody can (.) everybody can participate to the level that they choose. And the only hierarchy, particularly in Debian, is based on technical expertise. You know, you come to respect those that know what they are talking about [...] the impression I get of the ethos is (.) is quite egalitarian [...] But everybody is working towards the same end, which is it to create the best software of all [...] Because theres more people who use it, more people are looking at it, the features will become rich (.) richer. Um All the bugs get squashed out [...] More usage brings in uh better software, better software brings in more users	suggests that the OSS model of flexible participation, support and contribution appeals to the participant, and motivates participation in the OSS community suggests that flexible OSS community, is a cause of, Open participation and contribution, for a common goal This means that members of the OSS community influence another in an Open participation and contribution, for a common goal
Growing OSS community	The community is growing enormously and also takes in quite a lot of corporate players, who are prepared to invest money in um developing drivers, developing fixes, software, or attributes with network companies [...] Tesco has started selling PCs with Ubuntu on. Dell is also selling PCs with Ubuntu. HP is selling Linux computers [...] So there's been very big players who are actually investing in software development, because it suits their business	suggests that OSS community and product developments are growing, partly due to input from large corporate players suggests that the growing OSS community, is a cause of, more resource investments in OSS projects (partly from a lot of corporate players) Therefore, growing OSS community, is a cause of, more investments in OSS projects. This means that growing OSS community influences more investments
Lack of government support	in this country in the (.) amongst the public sector, there is very little use of OSS, in reality [...] There are areas in Spain, a whole districts that have gone Open Source, and have rolled out computing across the public sector, at a fraction of the cost of what it would have cost for proprietary installation. So, there is a (.) there is a roller-coaster of activity, particularly on the continent, and we in the UK are just quite a long way behind on that	suggests that there is lack of government support for the use of OSS in the public sector, compared to other areas in the EU suggests that lack of government support, is a cause of, little use of OSS in the public sector Therefore, lack of government support, is a cause of, little use of OSS in the public sector. This means that unlike areas such as Spain, the lack of government support, has a negative influence on the use of OSS in the UK
Software monopoly	companies like MS invest in political lobbying in making sure that they get government contracts [...] its not for nothing that there has been anti-trust missions both in the UK, in Europe, and the United States, against MS. They (.) they have very deep pockets, they can afford to spend a lot of money on political lobbying [...] I think my problem is their business model, and their monopolising position makes them a very disreputable competitor	suggests that investing in political lobbying, is a cause of, getting government contracts suggests that software monopoly, is a cause of, anti-trust missions against unfair competition suggests that software monopoly, is a cause of, unfair competition Therefore, software monopoly, is a cause of, unfair competition. This means that unfair competition has a negative influence on the spread of OSS

Self-efficacy		
Factors	**Related Data Extracts**	**Memo**
Core IT-skills	when you need to do something, um you need to have the knowledge to deal with (.) to organise things, like changing from one server to another [...] I devoted a lot of time and effort, and late nights, experimenting [...] during that process, I learned a lot. Uh And since then, I've installed in sorts of machines, Macs, Intel machines, um on all sorts of flavour [...] Um And also learned in (.) learned to do some things because I am not a programmer. My background is not (.) not a technician [...] So, I basically taught myself networking and system administration [...] I probably know enough to run the system	suggests that having core IT-skills increased the participant's ability to run the OSS suggests that core IT-skills, is a cause of, having the ability to run the OSS
Resistance to change	when it comes to the desktop, I think you have to do it gradually. There will be those who take to these new packages much more readily than others [...] if you are talking to people in the back office, they tend to look at, you know, is this technical solution better that that technical solution? If you talking about desktop, its what people are familiar with [...] if you use Windows XP, it is easy to use. It is not difficult to use, as long as its working [...] when its working, particularly if you've got used to working it, it works reasonably well, it does quite clever things. Eh Its quite intuitive, in some respects [...] once you become familiar with it, to go and use something different is quite a stretch	suggests that due to familiarity with previous system, and differences in the IT needs of technical users and desktop users, users may be resistant to changing to a different or new systems suggests that resistance to change, is a cause of, difficulty in changing to another system Therefore, resistance to change, is a cause of, difficulty in changing to another system. This means that resistance to change inhibits the ability to change to another system
Lack of awareness	Because Open Source by definition, is low margin. So, there is not (.) then very few Open Source businesses have any sort of marketing and such institutes to speak of [...] And therefore, one is (.) to some extent, its one of the best kept secrets around, that there is all these (.) there is this reservoir that you can use, that nobody knows about [...] So, I think the big challenge is getting acceptance, not just among corporate but amongst ordinary people	suggests that there is a lack of awareness about the available reservoir of OSS resources that can be used suggests that lack of awareness, is a cause of, low use of reservoir of OSS resources Therefore, lack of awareness, is a cause of, low use of OSS resources. This means that lack of awareness about OSS influence the ability to use it
Management support	lets say you've got an IT department which has a director and manager, and say ten people. Um There may be two or three within there who understand Linux. And they might (.) they might use um products (.) projects, almost on a quite using Linux. And then they show the idea to their management. And over time, that's how it changes [...] the key to changing an organisation is to go to the top. So, basically, its selling the benefits to the finance directors and the chief executive is where you need to go	suggests that getting support from top management is key to influencing IT change in the organisation suggests that management support, is a cause of, IT change in the organisation Therefore, management support, is a cause of, IT change. This means that management support enables IT change in the organisation

Resource facilitating conditions		
Factors	**Related Data Extracts**	**Memo**

Capital investment	If you don't have best expertise yourself or the time to develop that expertise, then you need to hire-in. Um In hiring-in, it may possibly be more expensive than hiring-in corresponding MS certified engineers	suggests that where there is no in-house expertise or time to develop such expertise, investing in external support may be necessary suggests that investment in support, is a cause of, having expertise Therefore, investment in support, is a cause of, having expertise. This means that investment in support enables access to expertise, when such expertise is not available in-house, or there is no time to develop it

Note:

The notation [...] represents omitted segments of the dialogue, or a combination of related segments of the dialogue. The notation (.) represents a pause in dialogue.

C.2 Data Analysis of Case C02

Demographic information: we are running consultancy, We concentrate on server and embedded, with most of our customers

Technologies: web and database servers, compiler tools chains

Relative Advantage		
Factor	**Related Data Extract**	**Memo**
License cost-saving	licensing cost are a big issue, depending on the Open Software you are talking about [...] there's definitely a cost advantage [...] that generally occurs when you have an unusual situation where you have um for some reason, you need to deploy many (.) many copies of a piece of software. Um and eh and the pricing structure of the closed-source competition aren't really good for that particular application one client who wanted to deploy um eh using web content management, but he wanted to reduce power consumption. And in doing so, he wanted to use a number of low power processors rather than a single high power processor. [...] But the closed-source option, they wanted to charge him a lot more because they had a per CPU licensing model	suggests that license cost-saving, especially in bulk licenses, is a cost advantage relative to the costs of licenses of closed-source alternatives *an example of cost savings based on comparison between OSS and closed-source bulk license cost*
Environmental cost-saving	you can extend the life out of a PC by may be, three or four years, in an Open Source application [...] From a green perspective, spending wise, I mean, you obviously have environmental benefits from reusing equipment than is throwing it away [...] So if you can extend the lifetime by thirty, or sixty percent, or even hundred percent, then you make huge gains from the environmental perspective	suggests that in OSS applications, the life of a computing hardware can be extended, and thus generate cost savings from both a spending and an environmental perspective
Energy cost-saving	if you are able to use lower specification or lower power equipment, then your [...] uh environmental running costs are lower [...] for instance, uh MS Windows, you can only buy for Intel or Intel compatible processors like AMD. Whereas in Linux, it will run on low power processors like the ARM processor [...] I have an ARM machine which uses um two or three watts [...] my PC based machine uses a hundred watts [...] you can run most of the same software on Linux on ARM, that you had on Linux on PC. Whereas with Windows, you don't have that option [...] you have more possibility of doing green things with OSS because [...] you have flexibility [...] And if you want to do something different, then generally, [...] its easier with OSS than closed-source, because you have more control [...] the majority of the world runs on relatively power hungry PC [...] my friend is replacing them with lower power Linux machines running [...] on an ARM processor [...] they use less power [...] So the cost is lower. And um the power consumption is lower	suggests that OSS (Linux) allows use of low power equipment for similar PC applications, at a lower cost of power consumption, and thus lower environmental running costs another example of using low power processors to save on running energy, thus saving on cost
Costs of complex IT-needs	The majority of the savings is um (.) with companies who need (.) who have more complex IT requirements rather than simpler ones [...] um embedded is a very big growth area [...] Embedded controls. So, things like eh um mission control, um you know, built-in software, um to anything from radios to video recorders, to pretty much any type of consumer electronics which needs very sophisticated eh computing	suggests that companies with complex IT needs, such as in embedded applications, stand to make cost savings
Ease of use	Firefox, if anything, is probably easier to use than their closed-source competition	suggests that this application, very significant in web browsing, is competitively more easy to use than closed-source alternatives

Positive image	they are generally seen as more flexible, forward looking companies, most conservative	suggests there is a positive image of organisations that who use OSS
Flexible support	for most OSS, you have free support available [...] So, you can deal with the community yourself directly, or if you don't want to, or you are unable to, then you can always employ somebody else to do so	suggests there is a choice of support, either free from the OSS community, or by paid for services
Ease of modification	because it is closed-source you can't make a heavy modifications [..] Um (.) Whereas with OSS you are able to (.) it is a lot easier to make extensive modifications to tailor it [...] if your closed-source software has trouble operating with the OSS, you can just look at the source code of the OSS and see what should be done	suggests that OSS is easier to modify and adapt to applications because the source code is availability
Total cost-of-ownership	there's definitely a cost advantage [...] I think majority of the benefit, probably in most cases comes from increased reliability, flexibility, and ease of modification, ease of maintenance, really. Those are the (.) those are the biggest things as a total cost of ownership	suggests that various important qualities makes OSS more competitive in terms of total cost of ownership
Extensibility	You get more flexibility um with Open Source. So, you generally (.) are able to reduce resource requirement if necessary, with Open Source. And, you have more flexibility, you can take components out. You can disable things. You generally have more flexibility over doing that, than with closed-source.	suggests that OSS allows the user more control because it allows modifications and extension of of functions and qualities which can reduce resource requirement

Complexity		
Factor	**Related Data Extract**	**Memo**
Lower quality of user interfaces	Occasionally, um for user focused software, they are (.) sometimes the interfacing isn't as good in OSS. But, for majority (.) majority of our uses, that's not really an issue	suggests that lower quality of user interface, in some user (desktop) OSS applications are not as good as closed-source alternatives. This affects the ease of using such applications.
Poor interoperability	You also have the interoperability with MS as being a big (.) big barrier [...] on the desktop, the main (.) main issue would be um quality (.) sorry, differences between um say MS Office document and the OpenOffice not being able to correctly interpret MS Office document. So, although OpenOffice can read MS Office Word document, sometimes, it doesn't do a good job of it. And in a business setting, that may not be acceptable	suggests that interoperability with other platforms is a problem that may result in poor functionality, in this example of an important office application
Scalability	at very high end, occasionally you have for instance with databases, I mean, you can't (.) write ah database with MySQL or PostgreSQL, as you can with Oracle [...] So, at very high end, um on server software, you can still find some areas where proprietary software um still offers advantages	suggests that some OSS may not be suitable for high end applications, thus an issue of scalability of such OSS
Desktop maturity	server is much more mature um desktop is less mature. You have problems with (.) the programmers wanting to solve their own problems [...] So, making the environment for a relatively inexperienced desktop user does not interest most developers. They want to write software for themselves or for their own company, to fix (.) to solve their own problems	suggests that desktop applications are less mature, due to inadequate support of programmers

Lack of drivers	you did used to have um in certain (.) certainly on (.) in (.) on server space, where you have hardware vendors not supporting OSS by releasing specifications. And, um that has been an issue (.) a big issue on the desktop [...] the fact that the major PC hardware suppliers, AMD and Intel, have been worked (.) have very good relationship with Open Source community for a long time helps things a lot	suggests that lack of driver support from proprietary vendors, was an issue that limits the use of such proprietary hardware in OSS in platforms

Compatibility		
Factor	**Related Data Extract**	**Memo**
Multi-platform applications	you can use your Firefox web browser on Windows. Or you can use you OpenOffice on Windows	suggests that some some OSS fit on non-OSS computing platforms, making them multi-platform applications that offer users the choice to retain their existing computing platform
Functionality	For majority of businesses, they don't (.) it doesn't really make any difference to them, as long as the software does the job. Um they don't mind who has made it, or why they made it. For most businesses, if it works, then they will use it	suggests that the useful functionality of OSS applications fits the business IT needs and makes it a suitable IT solution
Supports legacy hardware	for older hardware, Open Source has better support than (.) closed-source, in my experience. Because if somebody still has the hardware, they have an interest in making things keep working. Whereas, for their (.) for the vendor, if they (.) if their software last unit was five years ago, they have no interest in updating their drivers	suggests that OSS can fit in old or legacy IT infrastructure environment because older hardware are more supported and usable under in OSS, than they are under closed-source

Peer influences		
Factor	**Related Data Extract**	**Memo**
Social interaction issues	some members of the OSS community can (.) um can be abrasive, and they can (.) they can come back with replies which may seem rude. And um there is certain sort of social um familiarity that has to occur. You have to know how the Open Source community works, or at least to watch and learn for a while before you start interacting [...] there is social issues in, you know, in Open Source support which ah initially, some people don't realise that are there [...] sometimes there are cross-cultural problems with this sort of thing as well. Whereas in some cultures, um a certain way of asking a question may be considered as acceptable. In other cultures, that may cause offence [...] a lot of people who deal with Open Source [...] don't have to do it. Its not their main job. So [...] when you are asking for support, ah if you are complaining, you have to be very polite. Or you won't get any support [..] you need to have a good understanding to social workings of Open Source, to be (.) really successful with Open Source	suggests there are social familiarity issues or cross-cultural problems within the OSS community, which users may not be aware of, but need to understand in order to interact successfully
Lack of government support	I think the involvement of the UK government is very low [...] people doing the procurement comparative services think that Open Source is new. And they don't want any risks. So, they are not ready to try something new [...] Um So, the EU seems more um enthusiastic. And countries like Germany and Spain have a lot more the use of public system Open Source than the UK	suggests there is low involvement, and thus support, of UK government in use of OSS in the public sector, compared to other countries in EU

Software monopoly	the absorption is pretty good in the private sector. Its just the public sector where (.) where things aren't so good really [...] I think there's a huge difference in scale [...] I think it is concerted (.) its partly um physical involvement from large companies like ah MS and the big consultancy companies [...] They stand to lose money by these Open Source, and they have a lot political power. And MS has a lot of involvement with the British government, presumably labour party, which has um reduced usage of OSS	suggests that proprietary vendor political influences and lobbying to gain monopoly of the software industry, limits the use of OSS within public sectors
Loss of OSS-developers	at very high end, um on server software, you can still find some areas where proprietary software um still offers advantages. Ah but its only really (.) I mean databases is pretty much the only example I can really think of where that is the case. The gap is closing continuously, despite companies like Oracle um trying to prevent it happening (.) by for instance, buying up or employing developers to OSS, to stop them working on OSS. Bribing people to stop working on OSS, more or less [...] most of these stuff is (.) is in the public domain with (.) in OSS, there is (.) you know a lot of these things are documented on sites like Linux Weekly News	suggests that large non-OSS vendors may be preventing progress in the OSS development community by reducing the OSS work-force – however, is this not similar to head hunting of skilled staff, after all developers can choose not to leave the OSS community

Self-efficacy		
Factor	**Related Data Extract**	**Memo**
Innovativeness	they are generally seen as more flexible, forward looking companies, most conservative. Um um usually it is companies with the great eh (.) which do have in-house knowledge and are prepared to use their in-house knowledge to reduce their cost [...] I would say that the skill level is (.) required is generally a bit higher for OSS [...] you have to have technically able people. Um but once you got those creative people, they can do a lot more work than they can do with closed-source software	suggests that companies with IT qualities such as innovativeness and in-house knowledge are able to apply OSS to reduce cost and deliver higher productivity
IT support	when changing from a closed-source to an Open Source, you always have a learning curve. Um but same as when changing from one piece of software to another [...] majority of our customers, they already taken the decision to use Open Source. So, you know, we are really ah (.) we are just helping them with it	suggests that IT support helps new users through the learning curve of migrating to OSS
Management support	a company has to decide weighing up on licensing, cost of ownership, skills of personnel. These are all factors in their decision making process. But its really a big decision for them.	suggests that management has to deal with many issues in the decision process, to support their use of OSS

Note:

The notation [...] represents omitted segments of the dialogue, or a combination of related segments of the dialogue. The notation (.) represents a pause in dialogue.

C.3 Data Analysis of Case C03

Demographic information: our company only deals with OSS, we provide ongoing support, and obviously the initial consultancy, the initial configuration

Technologies: Ubuntu, OpenOffice, Exim for mail, Apache, Tomcat, Ruby, PhP, Thunderbird

Relative Advantage		
Factor	**Related Data Extract**	**Memo**
License-audit cost saving	one of the main benefit is the freedom from concerns about licensing [...] We don't have to worry about our (.) have our desktops got suitable licenses. Um which is something that our customers that still have proprietary software worry about all the time. They always have to check if they have appropriate licenses [...] We know we got appropriate licenses, we don't have to worry about that. It saves us a lot of (.) a lot of time and overhead [...] With proprietary, we would have to audit all the software we had on the machine. Make sure we didn't have anything installed that we hadn't paid for the license, or the license has run out. Or, I mean, we will have to be continually monitoring what our employee were doing. Um we don't have to worry about that because we know they are only installing OSS and we know that we are licensed to use it [...] once you've made the change, um there is no cost for licensing any more, and there is no cost for auditing of licensing	suggests that license-auditing cost-saving is an advantage in using OSS because Open Source licenses eliminates the participants concerns about license auditing including time and other overheads
Extensibility	we've got the source code. So, you know, if there's anything we need to change, we can do [...] With other software, you don't get the source code [...] the fact that we have access to the source code of all software, means that we can modify it to be suitable for the non-standard problems [...] if it was not OSS, you wont be able to do it at all. Because if you don't have access to the source, you can't modify the software [...] it makes something feasible. Um it makes it possible. I mean, you know, you wont be able to solve these problems if it weren't for OSS	suggests that access to source code allows the users more control to modify and extend OSS qualities and functionality and therefore, extends ability for independent resolution of problems
Reliability	if you are trying to run a large highly available, very scalable website, you haven't really got any option other than to use OSS. And, you know, expand upon it. Um People have, you know, come across problems, they've added patches to Apache. And you know, other various pieces of software [..] what I am more interested in is the fact that it is extremely stable and reliable [...] I think for non technical users, the primary reason to use it, is because of their stability and reliability [...] I mean, I suppose, really, stability and reliability, I am using as synonyms here. Its one and the same	suggests that the participant is particularly interested in the unique, extremely stable, and reliable qualities of some OSS, which makes them fit for running highly available, very scalable applications
Server hardware support	There is better support from OSS, for the various types of hardware than there is, um from commercial software [...] These days, pretty much any hardware you can think of is supported by OSS [...] its something that one needs to check, but its not (.) its not a large worry [...] generally, its not for issues (.) certainly not for server side issues [...] On the desktops, there are, you know, there are problems that graphics cards manufacturers don't (.) tend to not want to give out data, and the same for wireless networking, um drivers. But on the server side, its not really a problem. You know, I mean, this is very much server focused rather than desktop focused	suggests there is better hardware support in OSS, especially for server infrastructure, than there is in commercial software

Training aid	I think commercial software, particularly Windows software, hides a lot of what it is doing from you. OSS tends not to. It tells you what it is doing [...] Um In actually, I would say it aids training because you can show people what's happening underneath. So people can have a better understanding. But people, you know, to be able to utilise (.) the information available, they need to be able to understand it	suggests that access to underlying technology makes OSS a better training aid for better understanding
Diverse documentation	I think its more a case of documentation is done very differently with OSS. With commercial software, if there is documentation [...] its all in one place [...] With OSS, you know, there might be a Wiki. There might be a mailing list. There might be a web-based forum. There is many sources of documentation. And its often more diverse [...] generally, there is actually more information out there. Its more the case that its not all centralised [...] But there is more (.) more variety of access to information	suggests that OSS documentation is more diverse in format and in access to information.
Flexible support	If you've got an obscure problem, you can normally find, you know, the person that has been working on that aspect (.) of the code, and you can speak to them. And that would, in most cases, get the problem sorted for you, or at least point you in the right direction. Um whereas, you've got no hope of that with commercial software. Um you know, em actually, OSS, it has a massive advantage in that aspect	suggests that members of the OSS community offer flexible IT support in direct contact with users, and this is a massive advantage that is not available with commercial software

Complexity		
Factor	**Related Data Extract**	**Memo**
Lack of drivers	It used to be an issue five years ago, you know, ten years ago, yeah, it was a big problem [...] Obviously, yeah, its something that one needs to check, but its not (.) its not a large worry [...] Yeah, I mean (.) that does exist and it does happen. But, generally, its not for issues (.) certainly not for server side issues [...] On the desktops, there are, you know, there are problems that graphics cards manufacturers don't (.) tend to not want to give out data, and the same for wireless networking, um drivers. But on the server side, its not really a problem. You know, I mean, this is very much server focused rather than desktop focused	suggests that although hardware drivers are not as much an issues as they used to be, there is still need for caution especially with desktops systems

Compatibility		
Factor	**Related Data Extract**	**Memo**
Functionality	We've used it in a lot of different scenarios. We've deployed it in (.) for a lot of different companies and we've seen how it can work for us [...] You know, we've seen (.) empirically, you know, we've observed it working	suggests that the participant applied and observed the IT functionality of OSS in different areas of their work, and that makes it an IT solutions that fits in their computing environment
Software maturity	Most of the software that we use is pretty matured. I mean Exim is being about what, ten, fifteen years now. Courier is being about for good ten years. OpenOffice is probably the least matured product we use, to be honest [...] But I mean, you know, there is a different degrees of mature. OpenOffice has only been about what, sort of four or five years. Um so, you know, and if you are looking at its competitors, I mean, Word has been about twenty years now	suggests that software maturity is a selection factor, thus a chosen software is expected would meet maturity standards

Peer influences		
Factor	**Related Data Extract**	**Memo**
Lack of government support	the government tend to be very much behind the curb on IT anyway. And, um they have been traditionally, and still are, very much tied into MS-based solutions. Um I think, certainly in this country anyway, there is a very low level of government take up of OSS [...] Um potentially, they could be very useful, but in practice, they are completely 'use-less'	suggests there is a low level government uptake of OSS due to being tied to proprietary vendor solutions, thus government is not playing an active role in supporting use of OSS *this is relevant in OSS usage in public sector such as schools, hospitals, library. people become more familiar with alternative technologies, rather than the existing monopoly*

Superior influences		
Factor	**Related Data Extract**	**Memo**
Print media	I have to say the print media has been quite poor quality [...] I think because most people that are interested in OSS get most of their information from the Internet, it means that there is a poor readership for those sort of magazines [...] I have not been impressed by any, you know, print-based media about Open Source	suggests that available OSS print media are of poor quality, and therefore do not do well in promoting the use of OSS. People prefer to use Internet as a source of information
Internet media	With OSS, you know, there might be a Wiki. There might be a mailing list. There might be a web-based forum. There is many sources of documentation [...] You know, I think that (.) as with anything these days, you use Google and you search the Internet [...] The Internet is key. Um Realistically [...] Internet based information is where most eh most information is going to come from [...] most people that are interested in OSS get most of their information from the Internet [...] I would never have started using it actively if it wasn't for the Internet because I won't have been able to get a copy of it [...] So, really, I think, the Internet is the only distribution medium of any consequence, with respect to OSS	Suggests that Internet media such as Wiki, mailing-lists, forums are the key sources of documentation and have even become the norm for distribution of OSS and related information

Self-efficacy		
Factor	**Related Data Extract**	**Memo**
Lack of awareness	I suppose people aren't aware of it [...] I think you will find a lot of people at the top, that are not necessarily technical, but they do have a perception ' well its free software. If its free, how can it be any good?'	suggests there is lack of awareness about OSS and the OSS model
Core IT-skills	I think you need a good understanding of the principles behind what's happening. For example, if you are using networking stuff where you need to probably understand TCP-IP [...] a good understanding of computer science is really necessary to support the software. Not necessary to use it. But, to be able to support the software, well, you need to have a good understanding of general computer science principles [...] you don't necessarily need to be a computer programmer, but you need to have at least a basic a understanding of programming concept, to be able to take full advantage of that	suggests that core IT-skills is necessary to support particular OSS that is in use

Resistance to change	the main problem that people have when they are looking to migrate is the amount of time they have with their current system [...] once people are used to using something, whatever you change it to, if you change it to something different, they will complain [...] its not a specifically an OSS problem. Although it is something that we encounter when you are trying to get people to change to OSS [...] one of the main issues is training of staff. Um Making sure that the staff are aware how to use the new software [...] if people are used to one system, they may not necessarily want to change to the other system	suggests that due to familiarity with existing systems, users may resist changing to new a system

Resource facilitating conditions		
Factor	**Related Data Extract**	**Memo**
Capital investment	one of the main issues is training of staff. Um Making sure that the staff are aware how to use the new software [...] what you gain, um in not having to pay licenses, obviously, you have to spend in training	suggests that an important issue is the training of staff to use the new system, and therefore provide internal system support. it also suggests that savings made from free licenses can be invested in training staff, thus financial resources are relevant in this context

Technology facilitating conditions		
Factor	**Related Data Extract**	**Memo**
Hardware infrastructure	In terms of server hardware, um OSS tends to be (.) make more efficient use of hardware. But, I mean, you know, you make sure when you are buying commercial or OSS, you purchase hardware appropriate for the task really	suggests that although OSS makes more efficient use of hardware, it is necessary to acquire adequate hardware for particular computing tasks.
Internet connectivity	The Internet is key. Um Realistically, if you have a software that is implementing that, you are obviously using computers. And, Internet based information is where most eh most information is going to come from [...] there are Wiki, there are blogs, there are various articles on the Internet about how to use specific pieces of software, and how to use specific pieces of software for a particular a task [...] I would never have started using it actively if it wasn't for the Internet because I won't have been able to get a copy of it. Um so yeah, without the Internet, I don't think OSS could exist in its current form [...] the very first thing you do when you install Linux distribution is connect it to the Internet and download the updates	suggests that the Internet is an important IT infrastructure that facilitates access to OSS products, information and services

Note:

The notation [...] represents omitted segments of the dialogue, or a combination of related segments of the dialogue. The notation (.) represents a pause in dialogue.

C.4 Data Analysis of Case C04

Demographic information: we provide and manage codes and everything serviced. all the code that we write is geared towards that

Technologies: Gnome, Slackware, Debian, Apache, Apache2, MySQL, PhP5

Relative Advantage		
Factor	**Related Data Extract**	**Memo**
License cost-saving	suggests that there is license cost-saving because there is no fee on OSS licenses	
huge benefit from a licensing point of view. Um but probably not as big as most people would think [...] I am not having to pay for licenses for each and every test server that I am setting up		
Security standard	suggests that security standard is an advantage with OSS because there is quick reaction to dealing with security issues suggests that rapid reaction to security issues, is a cause of, security standard Therefore, security standard, is a cause of, security advantage of OSS over proprietary software because of more rapid reaction to security issues	
fairly rapid reaction to any security issues. Uh, the fact that we have the source code available and if necessary, we can make changes to it ourselves [...] It is secure. If there are any security issues, they tend to be are fixed very quickly		
Ease of maintenance	suggests that it is easier to perform maintenance tasks on OSS systems, than on some proprietary alternatives	
I can roll updates out across a lot of systems with very little effort [...] I can roll out upgrades across forty-six machines in minutes [...] You know, not even comparing it to something like Windows, I've used some commercial Unix systems, some which the updates are absolutely horrible [...] Um but the updates on OSS tends to be very painless [...] As I said, the update mechanism on (pause) certainly some commercial Unix systems don't seem as as easy to operate. Um certainly the way some of the packages are frankly a pain. Um but, um so things like Windows go, its not something that Id ever come to the running of the server for anything mission critical		
Ease of use	suggests that OSS are flexible to use with different configurations, and there are flexible choices of software to try and choose from	
I've got a pilot equipment here that I can use to roll-out desk configurations on of um new versions of our software. I can see how it works. I can play with configurations. Um change stuff. Um play with lots of different server layouts [...] Um its just a lot of user experience really.		
Flexible hardware-choice	suggests that there is support for wide variety of hardware, and hardware replacement in OSS environment is simple, compared to replacements in certain proprietary computing environments	
there is support for a huge array of hardware. So, if for example, a network card dies in one of our machines, I could grab a spare from a shelf, and go and drop it in. And if it wasn't the same as what I've just taken out, there is a very (.) very good chance that its just going to be a drop in replacement [...] Which isn't the case on certain operating systems from em (pause) 'Raymond'. Change hardware on that, and eh you could be in for a whole world of pain		
Flexible IT-solutions	suggests that there is a vast amount of software available for OSS platforms, and these offers great choice to users	
from my point of view, um one of the (inaudible) is purely the amount of software out there that is available. It gives me a great choice. I can choose the best tool for the job, rather than being stuck with, you know, one web server [...] The ability to just go out there and see what software is available, and try it out and see if its appropriate for us		

Flexible support	suggests that the participant was able to get prompt and flexible personalised support directly from specialists within the OSS community, which is unlikely to be available from a non OSS organisation, without support fees
there has been occasions where we've been in direct contact with the programming teams of some software, um where um we needed to either clarify stuff or find out if something that we were seeing was actually bug, or was intended to work that way. And, I just don't think you can get that kind of response from a large organisation [...] We had a problem resolved in probably, a couple of days. And, where realistically, I think, if we haven't have had that kind of support available, um it could have run on into months [...] I think if it was a commercial equity that we were dealing with, um in the time that we actually reported the problem and have it resolved, with a Open Source, we would probably, have been asked for our credit card number and told that we would be called back	
Trialability	suggests that users can search OSS resources to see what is available, develop pilot systems with these , try it out with different configurations and find which is appropriate
I've got a pilot equipment here that I can use to roll-out desk configurations on of um new versions of our software. I can see how it works. I can play with configurations. Um change stuff. Um play with lots of different server layouts. And I am not having to pay for licenses for each and every test server that I am setting up [...] Um its just a lot of user experience really. The ability to just go out there and see what software is available, and try it out and see if its appropriate for us	

Compatibility		
Factor	**Related Data Extract**	**Memo**
Functionality	suggests that the participant's business IT needs are dependant on the IT functionality of some OSS	
well, it provides a platform that allows us to run our business, basically. All the software we've written in house is based on Linux, Apache, MySQL, PhP		
Server applications	suggests that server applications, is a cause of, OSS fit in the server environment suggests that the maturity of OSS server applications makes them fit more in the server environment rather than desktop environment Therefore, server applications, is a cause of, OSS fit in the server environment. This means that OSS fits as a server environment.	
I certainly think that at the moment, it is more geared towards servers rather than main office people's desktop [...] these sort of main big desktop projects hasn't been running as long, as um the stuff that is, you know, holding the whole thing together, really. Um so I think the server end is just more matured		
Hardware compatibility	suggests that the participant is able to use OSS with existing computing hardware, because of availability of support for a huge array of hardware	
nothing out of the ordinary really. Um they all (pause) they all run on just commodity PC hardware [...] It basically comes down to availability. Whatever is widely available is going to be better supported, um from a drivers point of view, than any locked down stuff that they don't want you playing with, which would be the case with Apple [...] there is support for a huge array of hardware. So, if for example, a network card dies in one of our machines, I could grab a spare from a shelf, and go and drop it in. And if it wasn't the same as what I've just taken out, there is a very very good chance that its just going to be a drop in replacement [...] Which isn't the case on certain operating systems from em (pause) 'Raymond'. Change hardware on that, and eh you could be in for a whole world of pain		

Peer influences		
Factor	**Related Data Extract**	**Memo**
Support community	suggests that members of the OSS community were helpful in providing flexible technical support to the user of OSS	

we did have one very strange problem with ARP protocol using an older Linux Kernel. And, we actually ended up speaking directly with one of the Kernel developers. Um which very rapidly got that sorted out [...] they are very interested in ensuring that the software that they produce is, em there's bug free and useful as possible. Generally, if you find something very strange in there, um they will be interested in getting as much detail from you as possible, and sorting the problem out

Self-efficacy		
Factor	**Related Data Extract**	**Memo**
Core IT-skills	suggests that having core IT-skills for related tasks allows better support of the OSS system, and ensure best performance of the applications	
from a development point of view, we need programmer skills in the language that we are using [...] from my point of view, as it happens, I won't pick out anything in particular. Its more a good overall knowledge of how the system hangs together. Um obviously, on the programming side, you need someone who is well versed in the languages that you are using [...] there are a lot off-the-shelf sort of set-ups, that you can throw at a machine and it will do the job. But if you want to get the most performance out of it, like anything else, you need to understand how it works. And you need to be able to tune it to your specific needs		
Management support	that IT management support is important to ensure successful operations	
from a systems management point of view, we need people with decent Unix skills background, um to ensure that everything runs smoothly		
IT support	suggests that the participant is more confident in using OSS when there is available IT support	
you need the right staff in order to actually make use of those benefits, Um without that, you may as well be paying someone else to do it [...] but from a small company point of view, where we got technical staffs, the benefits of actually running OSS, eh just far out weights any problems that would ever happen [...] we get a hell of a more confidence that things are going to get fixed, if we can speak to the person who is going to be fixing it		

Note:

The notation [...] represents omitted segments of the dialogue, or a combination of related segments of the dialogue. The notation (.) represents a pause in dialogue.

C.5 Data Analysis of Case C05

Demographic information: we are working with ARM chip manufacturers [...] expanding the range of tools available for people using Linux on our processors, mobile phones, hard disk, copying machines [...] We make a living selling licenses to use software, which is most available Open Source with the obligation to disclose source code. And available in a proprietary form, to people who pay us

Technologies: Debian, Ubuntu, OpenOffice, Apache

Relative Advantage		
Factor	**Related Data Extract**	**Memo**
License cost-saving	I don't (pause) I've never paid for Linux [...] its free. That's a distinction feature. Having registered with Ubuntu for the desktop um (pause) with Debian, um it just happens, a little icon comes up when there is a new upgrade [...] This happens with Windows as well. But with Windows, you have to have paid MS first [...] proprietary operating systems are (pause) are very private, and sequestered, and exclusive, and you have to pay for access	Suggests that there is a cost-saving because OSS licenses are available at no fee
Ease of maintenance	I got an update (pause) upgrade for my desktop this morning over the Internet, just as if it were a Windows applications [...] Having registered with Ubuntu for the desktop um (pause) with Debian, um it just happens, a little icon comes up when there is a new upgrade [...] Its convenience and flexible. When an upgrade comes along, it might take us oh um a couple of hours [...] It is much less drastic than going from uh (pause) Windows XP to Windows Vista [...] it has become much more polished that you don't have to piece together in almost downloads	suggests that OSS upgrade deployment is quicker compared to a drastic deployment in a non-OSS environment, thus making the maintenance task easier, compared to doing so in a non-OSS computing platform
Flexible support	if you have a problem with Windows application, you are only going to get help from a Windows appointed support system, person, or organisation, or supplier. The virtue with an Open Source system is that there is no limit to the people who can join in and throw their weight into tackling the problem [...] proprietary operating systems are (pause) are very private, and sequestered, and exclusive, and you have to pay for access. Um In Open Source, in principle, any body can play, and they probably won't need to pay	suggests that IT support in OSS is flexibly free and open to the public, compared to the private, sequestered, and exclusivity of proprietary alternatives
Extensibility	There are a lot of people around who don't want to be tied to Windows. And that disposition, that preference, not to be tied to MS, is one of the several drivers for using Linux [...] there's up-teen million people out there that want to do things nobody else has ever done before, and therefore, need the flexibility [...] In general, the barriers and restrictions and inhibitions to uh developing application under MS, as a freelance rather than as a captured member under MS development (inaudible) are very considerable. And you will not get (pause) well if you sign up as a MS developer, you ll probably get quite a lot of support. But what you develop is only going to work on MS operating system. And of course you will have to upgrade all your development tools when they change the operating system. And that is going to cost you. In the Open Source world, these barriers are non existing, or much much lower	suggests that OSS offers users more control to extend their computing environment than is possible under a closed-source alternative. Reasons include not wanting to be tied to closed-source software vendors, people wanting to do new or innovative things, barriers, restrictions and inhibitions of closed-source source, mandated upgrade and additional costs of using closed-source software development tools

Trialability	license entails the obligation, to disclose the source code, of applications that run, using ah any GPL code (.) any GPL application. #software-reference# is a GPL application. So, people who take our software from our web site and use it, can play with them as much as they like, try it out, eh test it in service. Provided they don't sell the product using it	Suggests that OSS licenses allow users the privilege to try-out the full functionality of the software prior to committed deployment

Compatibility		
Factor	**Related Data Extract**	**Memo**
Hardware compatibility	We just bought a new multi-function machine, which is a scanner and a fax machine and a colour printer. There is a Linux driver for it, which we put in [...] I am very pleased that um (pause) that when we bought a new HP scanner, copier, fax machine, we were able to get a driver from it (pause) for it, um free, from HP web site	suggests there is easy access compatible hardware drivers for a modern office hardware
Functionality	Linux is a popular operating system for embedded applications [...] ARM therefore needs to develop the tools available to developers, to allow them, to develop applications for ARM processors, using Linux software [...] ARM processors don't normally run eh Windows or any MS applications or Mac OS [...] you can develop for a staggering variety of applications using Linux [...] So, there are people making for example, surveying equipment using GPS to define positions and space on (pause) on the surface of the earth [...] We wanted a web browser, a very good email handling package, and a good office suite. And they existed. Um Most of them were probably being upgraded since we started using it, but they continue to be perfectly satisfactory for our purposes	suggests that the IT functionality of Linux and other OSS makes them suitable for developing a wide variety of embedded applications, and for the participant's office computing needs

Peer influences		
Factor	**Related Data Extract**	**Memo**
Support community	It is very popular because it is (pause) uh very powerfully supported by a great many people during the developments stage [...] it is characteristics of the Linux users of the world, that they help each other out. That they read newsgroups about problems somebody is having, getting a driver for a specially exotic piece of kit. And they advice each other where to look. Um And, this supportive behaviour from the user community [..] is something that MS cannot, and of course will not develop [...] On the other-hand, it is very very important components of the Unix class of operating systems, of which Unix (pause) Linux is a particular case [...] You depend upon your ability to connect to a community that will help you if you get stuck [...] you need to be able to connect to a community of like-minded users who will help you out when you get stuck [...] I am saying that intellectual curiosity and caring about what goes on behind the system are a characteristics of Open Source people	suggests that flexible support, learning and sharing knowledge about innovation in the OSS community is an important and appealing characteristic of OSS communities
National IT-security	There are national governments in South America who have been arguing very hard for the broader introduction of Open Source, because they don't want to have a foreign company owning completely all the operating system that they absolutely depend upon from all areas of administration of their tax system, their payment system, and so on. They are vulnerable, they feel. And quite rightly, I am sure [...] And Um you know, MS can hold them to ransom, if it wants [...] MS is running an imperialistic monopoly [...] I cannot resist pointing out that the EU recently fined MS half a billion dollars for um exceeding the competition rules and dominating its market too much	suggests that software vendor lock-in and monopoly is seen as a threat to inter-national IT security

Superior influences		
Factor	**Related Data Extract**	**Memo**
Web media	license entails the obligation, to disclose the source code, of applications that run, using ah any GPL code (.) any GPL application. #software-reference# is a GPL application. So, people who take our software from our web site and use it, can play with them as much as they like, try it out, eh test it in service [...] If you are able to connect to such a community, they don't have to be local. In fact, so much of the communication now is via the Internet um including chat and email. But they don't need to be local at all [...] I am very pleased that um (.) that when we bought a new HP scanner, copier, fax machine, we were able to get a driver from it (.) for it, um free, from HP web site	Suggests that Internet media, such as the web, chat and email are used in spreading OSS and related information that helps, even remote users, to try the software

Self-efficacy		
Factor	**Related Data Extract**	**Memo**
IT support	It is probably necessary to have somebody around, who is fluent in using Linux [...] The most of all thing, is to have somebody available to you, who has the capacity to get (pause) the staff who will be using Open Source um familiar enough with it to get confident, and then help them if they get stuck [...] you need to have somebody around to have recourse if you get stuck. Otherwise you are (pause) you are getting frustrated that you are unproductive [...] just as no complicated system, digital or strictly mechanical, um can be operated without support (inaudible), you need somebody around you who is capable of supporting them when they (pause) challenge you [...] what made it valuable to have this person around was his capacity to solve problems that popped up in Linux applications, um in the same way that technical support or desk cooperation would solve problems that pop up in Windows applications	suggests that in-house skilled IT staff are valuable or even necessary, to provide IT support in resolving technical problems in complicated systems.
Core IT-skills	we are involved in development work, and need capabilities that other people don't automatically need [...] I won't have embarked on this at all, unless we had skills in-house that allowed us to get the best out of Linux [...] I have um learned to use OpenOffice and make it do everything I want [...] server users are more highly trained. And, um more fluent in more than one type of server. They have broader knowledge. They are (pause) they are perhaps more like multi-lingual people, than like people trained only in English	suggests that having core IT-skills was necessary, for control of their OSS, and to make best the use of Linux.
Lack of skilled IT-staff	There is an awful lot of rubbish around. And there are not enough competent fluent people in (pause) in the development of web applications. There probably not quite enough competent people available for supporting the um change over to OSS from Windows [...] the potential support community for people struggling with server based applications or yeah, running servers, is smaller than the potential community supporting people using desktops and laptops [...] because there were fewer servers, there would be fewer people using the servers successfully, who also have the disposition to help other people out when they get some advice	suggests there is difficulty in access to skilled staff to support migration to OSS because there are not enough skilled people to provide IT support for server based applications
Innovativeness	we try and keep an Open mind, and a broad view um and to use the resources that we find are around us [...] central to it were two things. First of all, a wish formulated long ago, not to get tied to MS. And second, having somebody around who was already fluent in Linux [...] And therefore, was able to provide the support on site	suggests that open mindedness allows the participant to use in-house resources and OSS for their IT solution

Resource facilitating conditions		
Factor	**Related Data Extract**	**Memo**
Capital investment	big organisation who use Windows have a problem when they um switch to a new version of the operating system. And they have to get a call centre to back their front-line IT core people. And it (pause) its a painful process and this is what keeps the IT support people in business. The need for their services is always there. What I am saying here is that, there is not a fundamental qualitative difference between Windows um MS on one hand and OSS on the other hand, in terms of the amount of resources needed to deploy it in real life companies	suggests that there is need for IT support services and this require resources in IT investments

Technology facilitating conditions		
Factor	**Related Data Extract**	**Memo**
Internet connectivity	you need to be able to connect to a community of like-minded users who will help you out when you get stuck. And I have to admit it, when you get stuck, not if you get stuck [...] If you are able to connect to such a community, they don't have to be local. In fact, so much of the communication now is via the Internet um including chat and email. But they don't need to be local at all	suggests that Internet is an important technology that provides various channels for remotely accessing information and support from OSS communities

Note:

The notation [...] represents omitted segments of the dialogue, or a combination of related segments of the dialogue. The notation (.) represents a pause in dialogue.

C.6 Data Analysis of Case C06

Demographic information: we promote it for um (.) server applications [...] Well, we are specifically looking for companies that don't have a network infrastructure, don't have a server infrastructure, is not (.) is not upgrading [...] Now, if they want to upgrade their desktops, then we will do that as well. But we do it using Windows

Technologies: LAMP - Linux operating system, Apache web server, MySQL database, and PhP, Firewalls, IPTables, shared file and print, Samba, Intrusion detection systems, SugarCRM, Easy-CMS

Relative advantage		
Factor	**Related Data Extract**	**Memo**
Flexible support	there is a lot more access to the vendor, if you like. Where as if you've got commercial operating system problem [...] Sometimes you have to pay to even get to speak to somebody. In Open (.) in Open Source world, it s not like that at all	suggests that access to OSS community support is Open to all and does not require payment
License cost-saving	cost is another issue. Um you know, it beats me why people pay for commercial web engines when eighty percent of the Internet is driven by Apache [...] this is a benefit that I can pass onto (.) onto customers	suggests that license cost-saving in license is a benefit and the financial benefit that can be passed onto business customers
Reliability	we've got [servers] here that (.) that runs literary four years without being switched off. You know, normally it gives a fast, efficient (.) it just do the job. It fits the server in the background [...] What you find is (.) that it is so reliable, um it just (.) it never needs attention. It just sits there	suggests that their OSS applications have shown to be reliable by very long uptime, fast and efficient operation, with little or no user attention
Extend use of hardware	say build a firewall, you know, if you (.) you can (.) I've got an expression, 'you can always get away with pain', you know. You can like go out and you can buy a Cisco Pix5 or whatever [...] that might cost you anything from two thousand pounds to whatever you want to pay, a hundred thousand pound [...] You know, and there is (.) its like, very little technical skill required [...] to implement a firewall that way [...] this way around, they can have it basically for the price of the hardware and the labour to commission it	suggests that using OSS applications to extend use of hardware, is a cause of, cost saving (using OSS and technical skills to implement a firewall, can save price of specialist hardware and the labour to commission it) Therefore, extending the use of hardware, is a cause of, cost saving. This is an advantage over the cost of a specialist hardware and cost of commission it.

Complexity		
Factor	**Related Data Extract**	**Memo**
Lack of documentation	very often if you are trying to set something up for the first time, or if you are trying to compile something you downloaded, um and you (.) you got to use your own skill to know how to do it [...] Its very often, installation or compilation instructions are very brief or non-existent [...] the more widely supported and more widely used things like MySQL, like OpenOffice, um (.) are pretty well documented [...] what you find is, you might have a number of competing projects basically, and over time um some projects will fall by the way side because they are not as good, they are not as popular as other ones. Other ones that survive tend to be the ones that eventually do get proper documented	suggests that lack of documentation, especially for smaller and minor software projects, makes the use of OSS difficult for the participant
Lack of drivers	If we talking about trying to deploy it on a desktop, to replace Windows or Mac, then, you've got a problem [...] So, what you've got to do if you want to deploy in on a desktop, you have to check your hardware compatibility list [...] very carefully	suggests that OSS deployment on desktop may be problematic due to limited or the lack of hardware drivers for Linux compatibility

Compatibility		
Factor	**Related Data Extract**	**Memo**
Hardware compatibility	Um What Amanda is, is an application for managing um automated backups [..] because that software interfaces into any number of different devices, ranging from small tape drives through to um million pound robotic (inaudible) Amanda has got a huge long list of drivers that they produced to support their software	suggests that some OSS applications have high hardware compatibility because they interface into any number of different devices

Peer influences		
Factor	**Related Data Extract**	**Memo**
Support community	there is a very very active development community out there. So if you are using one of these products and you think there is something wrong with it, then so long as you are supported through um forums like source forge, you can post your problems back, and they will get it fixed [...] you always find that if you (.) if you are trying to use something, and you've got difficulties, then the authors of the software are usually very proud to be asked a question [...] because somebody out there has taken an interest. And more than happy to answer the questions	suggests that flexible OSS communities offer users flexible IT-support from other members of the community
Government IT-policies	what I am aware of is uh the OGC which is the Office of Government Commerce, they have (.) its actually sponsored the creation of um some Open Source products [...] What they also said is well, the OGC is responsible for recommending purchasing policy to our government departments, right. A couple of years ago, they stipulated to the rest of government that where tender was made, or put out by government for software services, they could not specify that eh Office format files must be used [...] so that any solution should be open if possible	suggests that UK government bodies supports the use of OSS because it stipulates fair policies regarding software procurement and usage in the public sector

Superior influences		
Factor	**Related Data Extract**	**Memo**

Web media	if you are using one of these products and you think there is something wrong with it, then so long as you are supported through um forums like source forge, you can post your problems back, and they will get it fixed [...] So there is (.) there is a lot more access to the vendor, if you like	Suggests that end-users are able to use Internet media such as forums to get support for their OSS problems

Self-efficacy		
Factor	**Related Data Extract**	**Memo**
Innovativeness	From a personal point of view, initially it was curiosity. I've heard and read all this claims about this software, and what it could do, and it didn't cost me anything. Well, and so, I thought OK, we'll give it a go. See if it lives up to its claims [...] So, over a period of about twelve months, uh, I personally built all the things that we've been talking about with it	suggests that Innovativeness and self initiatives to try out OSS was initial driver to using OSS
Core IT-skills	Using Linux systems from an operational point of view or from an installation and commission point of view, you are talking about just the same skill-set as you need to install Unix [...] you know, or the same or similar skill-set that you will need to deal with any multi-tasking operating system [...] it is a general knowledge of IT, what these things do, uh, how infrastructure works [...] you talking about general network knowledge that (.) it gives (.) well, you have to be the equivalent of an MCSC in (.) in Unix/Linux world [...] I think you just got to be relatively technical and pretty determined. You know, because it is difficult um if you are not trained as a network infrastructure engineer, its difficult to discern from the outside, what do all of these components do, and how it (.) how it fits together	suggests that using Linux in an operational context requires core IT-skills, and depending on tasks and particular applications, specialist skills may be required

Note:

The notation [...] represents omitted segments of the dialogue, or a combination of related segments of the dialogue

C.7 Data Analysis of Case C07

Demographic information: We are basically a MS partner [...] We are part of MSDN [...] Microsoft Development Network [...] we do train people here as well [...] we also tune and develop timber company [...] I have to maintain their email systems

Technologies: MS software, Outlook, MS SQL, Visual Studio, MS Exchange, MS IIS for for our Internet, hardware firewall

Relative Advantage		
Factor	**Related Data Extract**	**Memo**
Limited cost savings	We are basically a MS partner, so we can get good deals with that	suggests that the participant is able to get good deals from the software vendor on the condition that they are MS partners *OSS is Open to all with no such conditions*
Limited free support	Because we are a MS partner, we do get free support from MS and the outset	suggests that the participant is able to get free support on the condition of being a MS partner *support in the OSS community is Open to all*
Reliability	Its actually with actual technology. Every so often, on the Exchange, the information store servers won't start up. That's the most common problem that we have with our emails [...] Not very often. May be, once or twice a year [...] They are very reliable	suggests that the MS application is notably reliable, requiring little attention over a long period *OSS alternatives are known to have even better reliability over longer periods of time*
IT choice	our first one, but we are in the process of upgrading to the latest [...] in seven years, two [...] I think the people before me never got around to upgrading it. So, left me with the job	suggests that participant's choice of when to upgrade Exchange from 2000 to 2007 is voluntary since previous staff 'never got around to doing' the upgrade, and therefore some control over changes in IT *this is different from complete control as observed in cases of OSS use*
Basic modifications	We can add add-ons onto Outlook [...] We don't have the need to, really [...] we do make our own stock systems which is completely made from scratch by us. Um But we won't have any need to change the actual Outlook or Office programs	suggests that the participant is able to use add-ons to make basic modifications that extend the functionality of the applications, but not the core functionality *OSS allows far more flexibility in terms of adding, changing, and rebuilding from original software versions*

Complexity		
Factor	**Related Data Extract**	**Memo**
Software defect	Every so often, on the Exchange, the information store servers won't start up. That's the most common problem that we have with our emails	suggests that there is a common problem with Exchange, which makes it difficult to operate
Legal restrictions	No. We don't actually change that [...] I believe by law you are not able to change it, because I think it is copyrighted by MS	suggests that proprietary copyright laws restricts participant control to modify the software

Compatibility		
Factor	**Related Data Extract**	**Memo**
Hardware compatibility	we got old and new machines here, and we have no problems	suggests that the proprietary software used by the participant are compatible with their old and new computing hardware

Peer influences		
Factor	**Related Data Extract**	**Memo**
Vendor relationship	Yes. Its been very good. I mean, we've been dealing with them for many years. Its been fine as far as we are around	suggests that the participant is satisfied with existing support relationship with the vendor

Superior influences		
Factor	**Related Data Extract**	**Memo**
Web media	There's a Microsoft Development Network [...] There's forums which people can give suggestion to MS and stuff like that really. Any problems	Suggests that end-users are able to use Internet media such as forums to communicate with software vendor or development network

Self-efficacy		
Factor	**Related Data Extract**	**Memo**
Core IT-skills	you do need to be trained up on it. But, we do train people here as well	suggests that training are needed in order to acquire relevant IT skills for using the software
IT support	we have no major problems with any of them really, but occasionally, we do have a bad day when we have to call in a support [...] if I do too many changes at once and something goes wrong, you don't know whats actually caused it. So I am doing a very slowlier migration up to the new version	suggests that there is need for support to control the use of the software, especially when complex changes may result in disruptive complications

Resource facilitating conditions		
Factor	**Related Data Extract**	**Memo**
Capital investment	I am doing it very (.) over a long period of time [...] So I am doing a very slowlier migration up to the new version. So, I start by (.) we can run both Exchange 2000, Exchange 2007 at the same time. So, I move a few people across to the new one. The last turn moves everyone across. So its a slow transition between the two	suggests that adequate time management is important for some complex activities such as upgrading to new versions

Technology facilitating conditions		
Factor	**Related Data Extract**	**Memo**
IT hardware	That means hardware firewall we got is installed after (inaudible) [...] That means hardware firewall we got is installed after (inaudible) [...] Its a complete hardware solution. There is no, em (.) Its not like a MS software. Its actually hardware	suggests that there is a need for specialist hardware, but the functionality can be delivered using either proprietary software or OSS solution
Internet connectivity	We use Outlook [...] we use MS Exchange (.) for our email. And We make use of MS IIS for our Internet	Suggests that Internet is important for their business functions especially in the area of and communications

Note:

The notation [...] represents omitted segments of the dialogue, or a combination of related segments of the dialogue. The notation (.) represents a pause in dialogue.

C.8 Data Analysis of Case C08

Demographic information: we are an exclusive OSS shop. We use no MS software. We use no commercial software. Absolutely everything we use is Open Source. [...] we set up servers. We run servers for a number of organisation. We build network infrastructure. So, we are very much an IT consultancy rather than an end-user in that respect. And, if it doesn't exist, we make it [...] We are somebody developing network Infrastructure, um that need to operate with different equipments. We need to be to (.) you know, we are very much at the very technical edge of IT consulting [...] We make contributions to a number of projects, yeah [...] um there's DC Oracle2, which is an Oracle2 driver for Python and Zope. We redeveloped K and Tobacity which is a inter-base and fibre driver for Python. We have contributed to Python fuse. We contributed to the PKCS11-DNS stack. Its a secure DNS signing tools deployed by some of the biggest organisations. We've contributed a number of projects

Technologies: Apache, Zope, Linux, C, Python, and PhP, MySQL, PostgreSQL, SQLite, LTPNS, OpenDPN, OpenSSL, Racoon, Courier, Thunderbird, Evolution, KMail

Relative Advantage		
Factor	**Related Data Extract**	**Memo**
License cost-saving	I think the main advantage is um (.) partly its cost and flexibility. But its also the ability to bring more value to a project. Um Rather than (.) with any commercial off-the-shelf software, um if the software doesn't do what the projects needs it to do, then I need to buy some other software, or work around (.) work around the problem	suggests that cost-saving in not having to pay for OSS license is cost advantage over commercial off-the-shelf software.
Extensibility	For example, for high availability and high security. Um you can't book out at (.) evaluate the systems, test it, test it, test it. Find out where all the possible pitfalls are, then deploy something that your are very confident of. Its very difficult to do that with a commercial package because I think it s a black box [...] we got the source code. We can see the source. We can change the source. We can look through it, find out how software works, find out where the bugs are. And we do do that when we encounter problems, we do go back to the source code, and we say, well this is where is it going wrong	suggests that OSS offers the participant more control to independently extend OSS qualities and resolve issues in software, which allows deployment of solutions with confidence
Reliability	the fact that Linux is very good at the high availability and high security side, is one example of where it is easy to sell that. To be able to say, but look, you know, if you compare how stable a Linux server is compared to say a Windows server, there is no competition um that on Linux servers that we run, that has been running for well in excess of four hundred days. Without shut down, without reboot, without anything	suggest that Linux has better quality in operational reliability, because it has competitively more high availability than a proprietary competition

Complexity		
Factor	**Related Data Extract**	**Memo**
Complex to deploy	I think it is more difficult. But I think that's because it gives you far more options. Um there's far more to choose from. And because there is far more to choose from, you need to know more, to be able to make the right decisions [...] so yes, it is a bit more complex. But it gives you more flexibility [...] What you gain with flexibility, you lose with simplicity [...] Right across the board, databases, um its (.) its perceived as very easy to install MS SQL server, you know, people know how to do that. Obviously the end. Away you go. Its more difficult to set up a Linux box running databases. There is more involved. Um so databases, web servers, right across the board. But, again, it comes down to flexibility versus simplicity, in many cases	suggests that deployment of a Linux based application platform can be difficult due to the various complex options
Lack of drivers	typically IBM, Dell, HP are (.) are the sort of servers pretty much any infrastructure that other companies make is OK [...] on the hardware side, it doesn't really matter. So long it is supported. and that just comes down to drivers [...] Occasionally, one can have compatibility problems. But all those three manufacturers, IBM, Dell, and HP are committed to Linux on their servers. So drivers are made available by them [...] I will struggle to recall the last time we took in a server that wasn't a HP or IBM. Yeah. Pretty much all servers you see these days are made by one of those three. Yeah, you do see some others, but the vast vast majority are those	suggests that while some major hardware manufacturers provide driver support, there may be others that don't. And these are more likely to be related to desktop, rather than server hardware drivers

Compatibility		
Factor	**Related Data Extract**	**Memo**
Hardware compatibility	we have a mix between Dell, HP, Compaq, and own built systems as well [...] on the hardware side, it doesn't really matter. So long it is supported. and that just comes down to drivers, at the end of the day [...] one can have compatibility problems. But all those three manufacturers, IBM, Dell, and HP are committed to Linux on their servers. So drivers are made available by them	suggests that OSS such as Linux fits on different different hardware platforms and thus enables a mixed hardware IT environment
Server applications	suggests that OSS server applications, is a cause of, fitting in on the server side Therefore, server applications, is a cause of, fitting in on the server side. This means that server applications makes OSS fit in as a good server-side platform	
those technically challenging projects are the ones that OSS tends to win it [...] It fits in very nicely on the server side, very well on the network side. Its very good at high availability [...] But, high availability, high security, and networks and servers tends to be where it is (.) we find it is (.) it out performs anything else		

Peer influences		
Factor	**Related Data Extract**	**Memo**
Government IT-policies	there are policies that government tries to set, increasing use of OSS products or whatever, but by and large they don't affect us. Um it tends to be a decision made locally, rather than, at a much higher level [...] a 'direct.gov.uk' website and MS consultations and recommendations made on (.) suggesting that public bodies consider, eh using OSS when they (.) when they look out projects, they should consider Open Source along side commercial off-the-shelf products	suggests that government sets IT policies to encourage use of OSS in the public sector

Self-efficacy		
Factor	**Related Data Extract**	**Memo**

Core IT-skills	In the Open Source world, if it doesn't do something, we are highly skilled software developers, we'll make the software do what we need it to [...] we find that Open Source is brilliant, because we can thoroughly understand the software we are about to deploy. And, we can understand the bugs. We can work around any problems, we can extend it where it doesn't meet the full requirement [...] because there is far more to choose from, you need to know more, to be able to make the right decisions	suggests that having core IT-skills is important because understanding the software, and applying core IT-skills to their problems enhances their confidence to work with OSS
Resistance to change	if you do desktop deployments, there will be resistance because, well, they are used to (.) they like the way this works, they understand it. Any change is (.) is just a huddle. Its just work for staff. And (.) and equally in the technical side (.) in the IT services side, it is going to be change for that. So there will be resistance as well [...] it is difficult to convince people to use the right tool for the right job [...] They have to look at it and feel that this is familiar [...] And if it doesn't look or feel familiar, they won't want to use it, whether it is a good system or not. Um so, familiarity becomes important. Um making everything user-friendly	suggests that staff reluctance to change to a new or an unfamiliar system is a barrier that hinders migration to OSS
IT support	I've seen huge numbers of staff supporting IT systems. And it doesn't matter how much a software cost, it cost a million pounds or it cost nothing, you've still got to (.) um you got a (.) you got staff that you got to support it. You've got to have a help-desk. You've got to have people fixings servers	suggests that having IT support is important for fixing servers, and providing help-desk support
Management support	I think one of the biggest problems that I have encountered is, the mentality of senior managers or executives, which is nobody has got fired for buying MS, or for buying Oracle, or for buying SAP or whatever. There is a mentality 'well, everybody else uses MS, so why don't we?' [...] that (.) that can often be difficult to sell. It can be very difficult to convince some people that are (.) are in that mindset. And, normally because they are being very defensive. They (.) they are trying to minimise on that risks to themselves	suggests that gaining management support is difficult due to management's lack of understanding of OSS

Resource facilitating conditions		
Factor	**Related Data Extract**	**Memo**
Capital investment	really the cost of a software in any project is actually quite small. But depending on the project, but often, the software cost is quite small compared to the support, maintenance, training [...] the other challenge is staffing [...] Often there is a little bit more involved on a Linux side in understanding what goes on [...] it is a bit more difficult to (.) to for example set-up a web server on Linux, to administer firewall or whatever. I mean, there are things that would to make it easier, but its (.) its not (.) its a more difficult um it s a more difficult task in some respect, and fewer people have those skills	suggests that there are costs in support, maintenance, and training, and particularly, staffing is a challenge because there are fewer people with the right skills to deal with difficult tasks of system support

Technology facilitating conditions		
Factor	**Related Data Extract**	**Memo**
Ethernet technologies	Ethernet, you got to want Ethernet. And you got to understand IP. And those are the (.) those are the most common things people use anyway. Most networks these days are IP networks, using Ethernet technologies there	suggests that Ethernet technology is an important infrastructure for supporting the use of OSS

Note:

The notation [...] represents omitted segments of the dialogue, or a combination of related segments of the dialogue. The notation (.) represents a pause in dialogue.

C.9 Data Analysis of Case C09

Demographic information: Software systems development and support

Technologies: Suse, Debian, Lotus Domino, Apache, Tomcat, Postgres databases, OpenOffice, KMail

Relative Advantage		
Factor	**Related Data Extract**	**Memo**
License-audit cost-saving	you don't have to worry about keeping, you know, probably licensed copies of everything and counting them all and making sure that you got all those licenses. All that fair of management just often vanishes [...] it means you don't have to do it. If you don't have to do it, then it doesn't cost you anything. And you don't (.) you neither have to have the people to do it, or the (.) or the money to pay for it	suggest that with OSS, there is no need for all management tasks involved in license auditing, and this generates savings in time and cost of employing staff to do it.
Extensibility	I am not locked-in to doing things when the manufacturer tells me to. So, if I want to upgrade, I can. If I want to use an old version of something, I can. Um I can mix and match as I want [...] If you don't like KDE, you can try Gnome [...] there are lots of alternative ways of solving the same problem. So, it is much easier to find something that is going to suit. The fact of the point is that the technology should be there to help the user. Shouldn't be there to force them to do things. And um giving the user choice, while not swamping them with it [...] I tell you, because you are being forced to do things by the manufacturing, you have no knowledge of what is being done on your behalf	suggests that OSS offers users more control to extend their IT platform by choices of hybrid software solutions than is allowed under proprietary platforms.
Flexible support	if it doesn't do what I want, I can fix it [...] If you are using OSS, even if you don't have the skills yourself, you can find somebody who does, that can solve the problem in your time scale, not somebody else's, with your sets of priorities, not somebody else [...] It does ninety percent of what I want. I can build the other or find the other from somebody else. Which means, I am solving the problem I wanted to solve, not the problem that I am being allowed to solve [...] the problem with the closed-source stuff, especially when you buy a machine on which it has been preloaded [...] um is that you don't know what you are getting until it arrives [...] If you are installing it yourself, then you know what you are installing. Then you are in good order. And it is much easier to plan for	suggests that OSS and its community offers the participant flexibility to resolve issues and make choices according to their needs and their circumstances
Backward compatibility	think of the archiving that has to go on within a government organisation, and compare that within big commercial organisation. You have to keep your old records. You have to keep old copies of these things lying around the place [...] Um now if your word processor five years ago, was, um whatever that Word product, oh say WordPerfect [...] or a version of Word that was around then, do you have anything now that will read it? In Open Source, you do, because you can always come back to the old one [...] But the old version of Word, or the old version of WordPerfect won't run under Vista [...] And the new version of eh (.) the new version of um Word, won't read the old file from years ago	suggests that OSS offers better backward compatibility that allows to maintain use of legacy data and related applications

Flexible IT-solutions	with Open Source, there are generally at least three ways of solving exactly the same problem. So, if you don't like one, you can find another one you do like [...] For instance, if you don't like OpenOffice, you can always try KOffice or, um there are (.) there are other obvious um offerings around the places as well [...] with Open Source, I've got lots of choice to go out and find the one that I feel most comfortable with	suggests that OSS provides users with flexible choice of IT solutions
Trialability	But the advantage with Firefox, with OpenOffice is that they (.) and many other things like them, is that you can use them, even in the proprietary environment you are used to living in and feel comfortable in (.) And you can have on one machine, both IE and Firefox (.) So you can try it. See if it solves your problem. And if it does, then you can use it (.) My suggestion would always be because it is a no cost option, other than your own time, download one or two things like OpenOffice, like Firefox, and try um out to see whether you like em. If you do, then we can talk about how you might use more of it	Suggests that users can try OSS at no cost, even in non-OSS environments, by downloading it, trying it and exploring how it might be used more in a committed deployment

Complexity		
Factor	**Related Data Extract**	**Memo**
Lack of local-support	It is more difficult to learn (.) to find your local IT company that can come in and help you on an as needed basis. Um And guide you through a migration. um That is more difficult to do. Um But increasingly, I think people are doing it	suggests that there is a lack of readily available local OSS support
Lack of drivers	you got to be a wee bit careful when you buy a new piece of kit that they are not using some (.) As I said, there are a couple of manufacturers, you tend to find them more in laptops than you do in um um general systems. For instance, some of the wireless chips (.) [...] um are badly supported in Linux because the manufacturers won't tell anybody how to drive them and therefore how to write a driver. and they won't do it themselves. Um Broadcom are a bad example of this	suggests that there may be difficulty in getting drivers for modern or new hardware, due to poor support from manufacturers. And this is especially related to laptops, rather than general hardware

Compatibility		
Factor	**Related Data Extract**	**Memo**
Functionality	Its the standard thing I use. Netwise, it does everything I need, and I feel comfortable working with Linux [...] OSS is popping up all over the place. I mean, it appears in almost all the little um ADSL routers you get out of, you know, the little wireless routers, they (.) all of those run Linux these days. Um the um a lot of the new appliances, the new little sub mini (.) sub laptop that Asus has produced - the Eee PC [...] that runs Linux. Um set-top boxes, all that sort of stuff runs Linux [...] there is almost nothing you can't do with them these days, by way of computing	suggests that the functionality of OSS is being applied as innovative IT solutions in many areas such as embedded systems, and new innovative computing systems
Standard user-interface	The Asus box by default, comes with (.) with Linux installed on it [...] But I would bet, most of its users don't notice the difference [...] They just get on with using it [...] The fact that its using Linux under the (inaudible) actually doesn't make a heck of a difference [...] these days, most OSS are easy to use [...] if you go and read the reviews about the Asus PC, um you will find that all these reviewers just picked it up and used it [...] the fact is, this sort of thing proves its not (.) it can't be difficult	suggests that recently, most OSS provide standard graphical interfaces that are are easy to use and simply fit in with users existing IT skills and computing environment

Hardware compatibility	most hardware work off the shelf these days, even laptops. Um And I mean, I've been using Linux desktop as my only operating system since the month [of August] 2001 [...] the um hardware selection generally isn't a problem for an office desktop. Its going to work	suggests that OSS has high hardware compatibility, especially for office desktop or computing hardware
Multi-platform applications	its always easier to use what you (.) what you are already using. And its even easier if it comes pre-loaded. Um If (.) if the (.) if we can get rid of that problem, then um and that is beginning to happen with things like this Asus PC [...] But the advantage with Firefox, with OpenOffice is that they (.) and many other things like them, is that you can use them, even in the proprietary environment you are used to living in and feel comfortable in [...] And you can have on one machine, both IE and Firefox [...] What's more, if you have an application that only runs on Windows, using odd little things like Wine [...] you can make it run under Linux	suggests that some some OSS applications are similar to their non-OSS counterparts, and are also multi-platform, making them usable in non-OSS computing environments

Peer influences		
Factor	**Related Data Extract**	**Memo**
Support community	its important for people who want to use (.) just want to use it rather than understand it, and (.) and develop it and learn some things, get themselves connected to something like Ubuntu, and therefore find the friendly front-end and the community of people that is aimed at the sort of users they are [...] And that works very well, in my experience [...] its an environment that encourages people to contribute and help, but be helpful and be contributive. And (.) and that is something that the commercial world with its 'the barriers' have never found a way of doing. But I certainly feel a lot more comfortable in that environment than I did in the old world, which in my case was IBM OS2, not Windows	suggests that the participant feels more comfortable in an OSS community because of its flexible participation and contribution, and flexible support for users of community software
Social interaction-issues	some groups um being heaving techies, and I can say this being one myself, um have the social skills of a rampaging elephant. Um And they are very intolerant of new or novice users [...] They don't understand how anybody can find it difficult [...] a lot of the reputation that it has for being difficult is based on the fact that there are few out there who um ah really don't teach themselves how to behave in public [...] you can also get that with an age divide. A lot of the developers are young [...] a lot of first time men end-users um are, you know, grand parents [...] The fact that they don't have these enormous technical skills [...] really should be taken into account by the people answering questions [...] Um but like, youths all over the place, they can be short handed, you know, a bit short tempered	suggests that interaction between member in the OSS community can be a problem due to the differences in social skills and social background
Multi-language support	Um A lot of the technical stuff is done in English. So, if you want to be heaving techie, very probably you are going to end up learning English. Because that way you are going to get most of the information [...] Um As an end-user, the larger project, very often will have news group or whatever that will speak your local language [...] obviously when its a small community, you are going to be limited by the languages that are spoken by the people who are running that community [...] Um Yet you can get into difficulty if the people who (.) if you got a problem, and the only people who know how to solve it, don't know you local language	suggests that multi-language support enables OSS access from a wider user communities, although this can be limited since most technical materials are done in English language

Lack of government support	I think in terms of their advice to other people, I think um most sensible people work on the principle that actually government are very good at making a mess of technology um and asking the government on technological question is probably a bad thing to do. Because you are probably not going to get the right answer [...] The way procurement used to be done within government really militated against Open Source, because he couldn't comprehend the idea that something was free. Um And went to great length to make sure that the proper fees were paid for things [...] And as I said, they couldn't cope with the idea that something might not have a fee associated with it [...] Um to be honest, with their record, the normal thing is you look at it and you say 'oops, they are doing it this way, I'll find another of doing it, thank you'. Ah but that's just me being cynical I am afraid	suggests that due to lack of understanding of OSS, government departments show little support for the use of OSS in the public sector

Superior influences		
Factor	**Related Data Extract**	**Memo**
Web media	you will tend to find that a distribution like Ubuntu, or Kubuntu, there (.) there is two different flavours I think, um are (.) their help-desk, their forums are designed with end-users in mind. And the system then tries to be helpful to them [...] the bigger projects like KDE or Oracle or whatever, do support a lot of languages. And uh both in terms of being able to have the program talk to you [...] But also in terms of the mailing lists and forums and things, happening in your language	Suggests that some distributions use Internet media such as multi-language mailing-lists and forums to help end-users

Self-efficacy		
Factor	**Related Data Extract**	**Memo**
Core IT-skills	I would never suggest um to a novice user, that they dive straight into the deep end, and start using Debian. Debian is a heaving techies system. Um And is great for like of me, and would be a royal pain in the neck for anybody else (.) for a novice user [...] what people need to be persuaded on is not the differences, but the similarities [...] And there are an awful lot of similarities. In fact, the vast majority of it will (.) they will feel completely at home with. There will be all sorts of wrinkles, and it explains slightly different labels, it doesn't say Internet Explorer, it says Konqueror, Firefox. You know, its that sort of level of difference	suggests that core IT-skills are needed for some complex tasks using OSS applications. However, new users are able to apply their existing IT-skills in new OSS environments because of the similarities between common OSS and non-OSS applications .
IT support	heaving techies want access to you know, detailed information that means all sort of things. Um End-users just want to get back up running again. Um And their (.) their need is much simpler in that respect. But the help-desk system you need, or help support system you need for the two are different	suggests there is a variation in the IT support needs of highly-skilled and basic users, which must be supported by a flexible help-desk
Management support	I think the appreciation of IT and its ramifications (.) and again you can go back to the (.) this mess with the HMRC and their twenty-five million records. The problem was, I believe, that the senior management didn't understand the consequences of the decision they were being asked to make	suggests that the involvement and decisions of top management are important and influence the appreciation of IT and its ramifications

Innovativeness	you've got to learn to navigate your way round to finding the right person. Now that takes a little bit of doing, but once you get used to doing it, its not that difficult [...] The major skill is (.) is the ability to go out and find things that solve your problem. One of the things you get used to in the Open Source world, is the idea that very probably, somebody has already solved this problem. So, I'll go out and look for that, rather than trying to solve the problem [...] its an attitude of mine that says lets assume that somebody has already done this or something very like this. Lets go and look for it and see if its useful to us [...] And what more, you can do it as an (.) apart from your time in evaluating it, at almost no cost operation	suggest that a major skill is an innovativeness to seek out OSS solutions to own problems, at no more cost than the time of evaluating the OSS

Resource facilitating conditions		
Factor	**Related Data Extract**	**Memo**
Capital investment	doing something and planning it with them, doing it at a time which is, you know, an easy time of the year or whatever for them, um doing it when they've planned around things, moved things out of the way, giving themselves a little time to learn the new stuff [...] if you pick a time which suits them, then yeah, they can move, and that really isn't a great problem	suggests that adequate time management for deployment and training is an important issue Time is seen as a capital.

Technology facilitating conditions		
Factor	**Related Data Extract**	**Memo**
Internet connectivity	increasingly, most of that sort of material is on-line material. Um And you (.) now, you are getting people like universities putting their courses off on-line. So, um there are generally quite a lot of tutorials and things on-line. um Obviously, you need to be shown how to get yourself on-line. Um But once you are connected with a browser, uh generally that's pretty straight forward, Um then, um finding your way is the same way to, is the usual sources like Google, um which gets you to the right thing	suggests that the Internet is an important technology for accessing most of the informational materials and other resources on OSS

Note:

The notation [...] represents omitted segments of the dialogue, or a combination of related segments of the dialogue. The notation (.) represents a pause in dialogue.

C.10 Data Analysis of Case C10

Demographic information: Web services and software developers

Technologies: Linux, Mozilla Firefox, OpenOffice, MySQL, PhP

Relative Advantage		
Factor	**Related Data Extract**	**Memo**
License cost-saving	suggests that using Open Office eliminates recurrent licensing cost that is common with using proprietary alternatives	
We use OpenOffice [...] I mean OpenOffice everything on it [...] We use it all the time [...] We just don't use MS Word at all [...] you can redistribute copies of it [...] You don't have recurrent licensing costs. It (.) it eliminates recurrent licensing costs [...] It levels the playing field so that smaller firms can compete for projects [...] You know, small firms can compete for software projects because they don't have the large licensing costs		
Security standard	suggests that the participant has high confidence in security standard because of continuous monitoring by large OSS community suggests that continuous monitoring, is a cause of, security standard Therefore, security standard, is a cause of, level of security, which is an advantage over non-OSS software, because of the continuous monitoring by a large OSS community	
I am reasonably confident about the level of security [...] these software projects are continuously monitored [...] if something is discovered, eh that you know, there is a piece of security of it, there is a large community out there who can eh (.) test whether that you know (.) there is (.) actually to know about (.) they can try and replicate [...] eh the security breach		
Extensibility	You can run the program for any purpose [...] Right? Um you can also study the program how it works because it is free. You can adapt it to your own needs	suggest that OSS allows users control to use OSS for any purpose such as using it, studying it and adapting or extending it to own needs.
Independent verification	Because it is Open Source, there is a community out there verifying it. Where as if it is single source, you can't verify its functionality. With MS for example, you are dependent on MS to verify its functionality and security [...] the functionality of the software can be verified by a number of people. They are not (.) These are people who are independent. They are not dependent on being paid by the manufacturer of the software. These are people who have access to the source code [...] and they can (.) they test the source code for its functionality [...] and also security [...] you really need to have access to the source code [...] MS will not let you have the source code. So, you can't (.) you can't verify security or functionality	suggests that OSS qualities are independently verified compared to potentially biased verification in the case of proprietary software, and that this is enabled by the free access to the source code
Flexible support	You are not being tied to a particular vendor [...] being forced to wait for a vendor upgrade cycles [...] if I take out eh (.) supposing I wish to use MS Word, um I need to (.) I am dependent on MS. I am tied into MS [...] If I want an upgrade or there is something not working with it, I need to wait on MS fixing it [...] Where as um if its Open Source, I just tell the Open Source community there is a problem. And other people will check whether there is (.) you know, there is a problem, as well. And if its a serious problem, they will fix it. Quite quickly. Far quicker than having to wait on eh MS or you know, other vendors [...] there is a lot of wide Open Source community	suggests that due to concerns about vendor lock-in, the participant thinks that the flexibility of having quicker response to problems, which is offered by a wide OSS community, is a better alternative

Compatibility		
Factor	**Related Data Extract**	**Memo**
Functionality	It has got spreadsheet (.) eh its got text document. And you can do presentations and you can do drawings, and a software database [...] its probably not quite as good as eh MS Office. But its nearly as good	suggests that the functionality of OpenOffice applications offers solutions for various office IT needs, and the functionality are nearly as good as alternatives from a proprietary vendor
Supports legacy-hardware	you don't need new hardware [...] So if you are limited by space (.) by memory for example [...] eh you can install what's called a cut down version [...] of the OSS [...] I haven't had any problem in the past (.) of installing OSS, eh (.) you know, from having (.) you know, having a hardware problem	suggests that new hardware is not necessary for deploying OSS because flexible deployment can be applied for limited-capacity or legacy computing infrastructure

Peer influences		
Factor	**Related Data Extract**	**Memo**
Peer initiation	through a word of mouth [...] You know, somebody mentioned it to me and I (.) um had a look at it to see whether there was anything in it or not [...] this was a colleague at work	suggests that peers such as colleagues share useful information about OSS, and this may be through verbal or face-to-face communication
Lack of government support	the government (.) the British government, they just (.) they just don't give out any information on Open source, or very little. they tend to be (.) they tend to go more for um eh promoting companies like MS and Sun Microsystems [...] I don't think that is fair. I think the government is being biased towards eh the non Open Source companies. That's probably because some of these companies donate large sums to political parties, they donate large sums to um academic institutions	suggests that government is doing very little or nothing to give out information on OSS, and tend to biased towards large non-OSS vendors

Superior influences		
Factor	**Related Data Extract**	**Memo**
Print media	there is quite a number of magazines. The two main ones. Eh that's um 'Linux Magazine' [...] the other magazine is 'Linux Format' [...] they promote Linux and other OSS [...] it does keep you up-to-date on new applications that are coming out	suggests that there are various printed media on OSS, which promote the use of OSS, and also provide useful information about progress in the OSS community
Web media	Because you can (.) for example, if (.) if there was a problem using eh OSS such as OpenOffice, um there is a web site for OpenOffice and you log on to that um there is a (.) in the forum (.) help forum [...] Eh you can log on there and leave a message [...] Eh about the details of your problem. And usually within a day, somebody will get back to you	Suggests that end-users are able to use Internet media such as websites or forums to access OSS support and information

Self-efficacy		
Factor	**Related Data Extract**	**Memo**
Lack of awareness	there is a lot of problem persuading other people to use it [...] people have a reluctance to take something which is free. They just don't believe it will work. Because (.) 'there must be something wrong with it. How can you give it away for nothing?' [...] there is documented tendency not to accept something that is free	suggests that it is difficult to persuade people to use OSS because of a lack of awareness about OSS, and a reluctance to try it

Technology facilitating conditions		
Factor	**Related Data Extract**	**Memo**
Internet connectivity	if there is a serious problem, you have to go to the Internet, and um log on to one of the (.) sort of self-help groups [...] the Internet is far more useful than magazines [...] Yes, much more useful [...] you've got instant communication [...] Because you can (.) for example, if (.) if there was a problem using eh OSS such as OpenOffice, um there is a web site for OpenOffice and you log on to that um there is a (.) in the forum (.) help forum[...] Eh you can log on there and leave a message [...] Eh about the details of your problem. And usually within a day, somebody will get back to you	suggests that the Internet is an important, fast, and efficient electronic channel for accessing information and support from OSS communities

Note:

The notation [...] represents omitted segments of the dialogue, or a combination of related segments of the dialogue. The notation (.) represents a pause in dialogue.

Appendix D – Cross-Case Analysis of Factors

D.1 Cross-Case Analysis of Relative Advantage Factors

Case	C01	C02	C03	C04
Factors	License cost-saving License-audit cost-saving Extended use of hardware Maintenance cost Extensibility Reliability	License cost-saving Environmental cost-saving Energy cost-saving Costs of complex IT-needs Ease of use Positive image Flexible support Ease of modification Total cost of ownership Extensibility	License-audit cost-saving Extensibility Reliability Server hardware support Training aid Diverse documentation Flexible support	License cost-saving Security Ease of maintenance Ease of use Flexible IT-solutions Flexible support Trialability
Case	C05	C06	C07 – NON-OSS	C08
Factors	License cost-saving Ease of maintenance Flexible support Extensibility Trialability	Flexible support License cost-saving Reliability Extended use of hardware	Limited cost-saving Limited free-support Reliability Flexible IT-choice Basic modifications	License cost-saving Extensibility Reliability
Case	C09	C10		
Factors	License-audit cost-saving Extensibility Flexible support Backward compatibility Flexible IT-solutions Trialability	License cost-saving Security Extensibility Independent verification Flexible support		

D.2 Cross-Case Analysis of Complexity Factors

Case	C01	C02	C03	C04
Factors	Lack of drivers Lack of applications	Lower quality of user interfaces Poor interoperability Scalability Desktop maturity Lack of drivers Lack of applications	Lack of drivers	
Case	C05	C06	C07 – NON-OSS	C08
Factors		Lack of documentation Lack of drivers	Software defect Legal restrictions	Complex to deploy Lack of drivers
Case	C09	C10		
Factors	Lack of local-support Lack of drivers			

D.3 Cross-Case Analysis of Compatibility Factors

Case	C01	C02	C03	C04
Factors	Server platform Interoperability Functionality Supports legacy-hardware	Multi-platform applications Functionality Supports legacy-hardware	Functionality Software maturity	Functionality Server platform Hardware compatibility
Case	C05	C06	C07 – NON-OSS	C08
Factors	Hardware compatibility Functionality	Hardware compatibility	Hardware compatibility	Hardware compatibility Server platform
Case	C09	C10		
Factors	Functionality Standard user interface Hardware compatibility Multi-platform applications	Functionality Supports legacy-hardware		

D.4 Cross-Case Analysis of Peer Influence Factors

Case	C01	C02	C03	C04
Factors	Flexible community Growing OSS-community Lack of government support Software monopoly	Social interaction issues Lack of government support Software monopoly Loss of OSS developers	Lack of government support	Flexible community
Case	C05	C06	C07 – NON-OSS	C08
Factors	Flexible community National IT-security	Flexible community Government IT-policies	Good vendor-relationship	Government IT-policies
Case	C09	C10		
Factors	Flexible community Social interaction issues Multi-language support Lack of government support	Peer initiation Lack of government support		

D.5 Cross-Case Analysis of Superior Influence Factors

Case	C01	C02	C03	C04
Factors			Print media Web media	
Case	C05	C06	C07 – NON-OSS	C08
Factors	Web media	Web media	Web media	
Case	C09	C10		
Factors	Web media	Print media Web media		

D.6 Cross-Case Analysis of Self Efficacy Factors

Case	C01	C02	C03	C04
Factors	Core IT-skills Resistance to change Lack of awareness Management support	Innovativeness IT support Management support	Lack of awareness Core IT-skills Resistance to change	Core IT-skills Management support IT support
Case	C05	C06	C07 – NON-OSS	C08
Factors	IT support Core IT-skills Lack of skilled IT staff Innovativeness	Innovativeness Core IT-skills	Core IT-skills IT support	Core IT-skills Resistance to change IT support Management support
Case	C09	C10		
Factors	Core IT-skills IT support Management support Innovativeness	Lack of awareness		

D.7 Cross-Case Analysis of Resource Facilitation Condition Factors

Case	C01	C02	C03	C04
Factors	Capital investment		Capital investment	
Case	C05	C06	C07 – NON-OSS	C08
Factors	Capital investment		Capital investment	Capital investment
Case	C09	C10		
Factors	Capital investment			

Appendix E – Frequency Analysis of Factors

E.1 Frequency Analysis – Relative Advantage

Factor	Sources	Frequency
Extensibility	C01, C02, C03, C05, C08, C09, C10	7
Flexible support	C02, C03, C04, C05, C06, C09, C10	7
License cost-saving	C01, C02, C04, C05, C06, C08, C10	7
Reliability	C01, C03, C06, C08, (C07)	4
License-audit cost-saving	C01, C03, C09	3
Security standard	C01, C04, C10	3
Trialability	C04, C05, C09	3
Extend use of hardware	C01, C06	2
Flexible IT-solutions	C04, C09	2
Backward compatibility	C09	1
Costs of complex IT-needs	C02	1
Diverse documentation	C03	1
Ease of maintenance	C04	1
Ease of modification	C02	1
Ease of use	C02	1
Energy cost	C02	1
Environmental cost	C02	1
Independent verification	C10	1
Positive image	C02	1
Server hardware-support	C03	1
Total cost-of-ownership	C02	1
Training aid	C03	1

E.2 Frequency Analysis – Complexity

Factor	Sources	Frequency
Lack of drivers	C01, C02, C03, C06, C08, C09	6
Complex to deploy	C08	1
Desktop maturity	C02	1
Lack of applications	C01	1
Lack of documentation	C06	1
Lack of local support	C09	1
Lower quality of interfaces	C02	1
Poor interoperability	C02	1
Scalability	C02	1

E.3 Frequency Analysis – Compatibility

Factor	Sources	Frequency
Functionality	C01, C02, C03, C04, C05, C09, C10	7
Hardware compatibility	C04, C05, C06, C08, C09, (C07)	5
Server applications	C01, C04, C08	3
Supports legacy-hardware	C01, C02, C10	3
Multi-platform applications	C02, C09	2
Interoperability	C01	1
Software maturity	C03	1
Standard user-interface	C09	1

E.4 Frequency Analysis – Peer Influences

Factor	Sources	Frequency
Lack of government support	C01, C02, C03, C09, C10	5
Support community	C01, C04, C05, C06, C09	5
Government IT-policies	C06, C08	2
Social-interaction issues	C02, C09	2
Software monopoly	C01, C02	2
Growing OSS-community	C01	1
Loss of OSS-developers	C02	1
Multi-language support	C09	1
National IT-security	C05	1
Peer initiation	C10	1

E.5 Frequency Analysis – Superior Influences

Factor	Sources	Frequency
Web media	C03, C05, C06, C09, C10, (C07)	5
Print media	C03, C10	2

E.6 Frequency Analysis – Self Efficacy

Factor	Sources	Frequency
Core IT-skills	C01, C03, C04, C05, C06, C08, C09, (C07)	7
IT support	C02, C04, C05, C08, C09, (C07)	5
Management support	C01, C02, C04, C08, C09	5
Innovativeness	C02, C05, C06,C09	4
Lack of awareness	C01, C03, C10	3
Resistance to change	C01, C03, C08	3
Lack of skilled IT staff	C05	1

E.7 Frequency Analysis – Resource Facilitation Conditions

Factor	Sources	Frequency
Capital investment	C01, C03, C05, C08, C09 (C07)	5

E.8 Frequency Analysis – Technology Facilitation Conditions

Factor	Sources	Frequency
Internet connectivity	C03, C05, C09, C10, (C07)	4
Hardware infrastructure	C03, (C07)	1
Ethernet technologies	C08, (C07)	1

Key:

(C07) is a case of non-adoption of OSS.