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An Extended Framework for Evaluation of Open Source Software Adoption in Small Businesses

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ABSTRACT

The growing popularity of Open Source Software (OSS) as an organisational Information Technology (IT) infrastructure has made it important to explore and understand the key determinants of its adoption by Small Businesses (SMBs). Existing research of OSS adoption have ignored the relevance of applying widely accepted theories in the field of Information Systems (IS). This study presents an extended version of the Decomposed Theory of Planned Behaviour (DTPB) for modelling the adoption of OSS by SMBs. That framework is based on an augmentation and critical analysis of the literature of OSS adoption and the adoption of Information and Communication Technology (ICT) in small businesses and an appraisal of relevant theories for organisational adoption for of ICT. We show that our proposed framework provides useful concepts for identifying factors and advanced valid explanations of their influences on the adoption of OSS. We discuss the useful implications of the framework from the perspectives of research and practice, within the contexts of direct utilisability, foundation for justification and general frame of reference. The dearth of research in the area of OSS adoption has suggested that this study is among the first to develop a theory-grounded framework for the evaluation of OSS adoption in small businesses.

Key words: Information systems, implementation, technology acceptance and diffusion, innovation characteristics, decomposed theory of planned behaviour

INTRODUCTION

There is a growing popularity of Open Source Software (OSS) as an important part of organisations Information and Communication Technology (ICT) (Fitzgerald, 2006; Forrester Consulting, 2007; Hedberg *et al*., 2007; Lakhani and von Hippel, 2003; Mindel *et al*., 2007). Therefore exploring and understanding the issues influencing the decisions to use OSS are relevant. Studies suggests that factors influencing organisational adoption of the general ICT are complex and subjective and that seems to be the case in the organisational adoption of OSS (Fitzgerald, 2006; Forrester Consulting, 2007; Holck *et al*., 2005). The development of models and theories of influencing factors and common explanations and understanding of their influences are therefore relevant for the research and practice of OSS adoption.

In focusing on Small Business (SMB) adoption of OSS, we argue that contextual exploratory and explanatory frameworks of adoption are important for SMBs, who are likely to benefit from the use of OSS and the participation in OSS communities and who often face challenges in their adoption of ICT in general (Darch and Lucas, 2002; Dutta and Evrard, 1999; Gelinas and Bigras, 2004). Studies of the general adoption of ICT among SMBs (Gelinas and Bigras, 2004; Martin, 2005; Robert *et al*., 2003; Stockdale and Standing, 2004) have enabled us to gain some insight into

the organisational characteristics of SMBs which influence their adoption of ICT in general and are likely to influence their adoption of OSS. However, a paucity of research in the area of OSS adoption (Agerfalk *et al*., 2006; Dedrick and West, 2003; Fitzgerald and Kenny, 2003) indicates that there is limited knowledge and understanding of the potential benefits from the use of OSS and the understanding of factors and their influences on the adoption of OSS by the relevance of the adoption of OSS by SMBs and the gaps in this research area has led us to the broad question: What factors influence the adoption of OSS by SMBs and why? In addressing this question, the key objectives of this study are (1) To identify factors relevant to the adoption of OSS by SMBs and (2) To model valid explanations of the factors and their influences, using a theory-grounded framework.

LITERATURE REVIEW

A comparative analysis of the literature has led us to argue that factors influencing the adoption of OSS by SMBs are likely to be complex and subjective. Previous research studies have investigated the use and the spread of OSS in many contexts including large enterprises (Dedrick and West, 2003; Holck *et al*., 2005; Overby *et al*., 2006), public sector areas (Valimaki *et al*., 2005), developing economies (Kshetri, 2004; Mindel *et al*., 2007) and health-care industry (Fitzgerald and Kenny, 2003). The diversity of areas and contexts of the use of OSS implies that different adopters are likely to have varying needs, different levels of assimilation and different perceptions about the use of OSS.

Previous studies have also discussed diverse perceptions about the use OSS (see summary of factors in Fig. 1). Benefits including cost saving (Forrester Consulting, 2007; Giera and Brown,

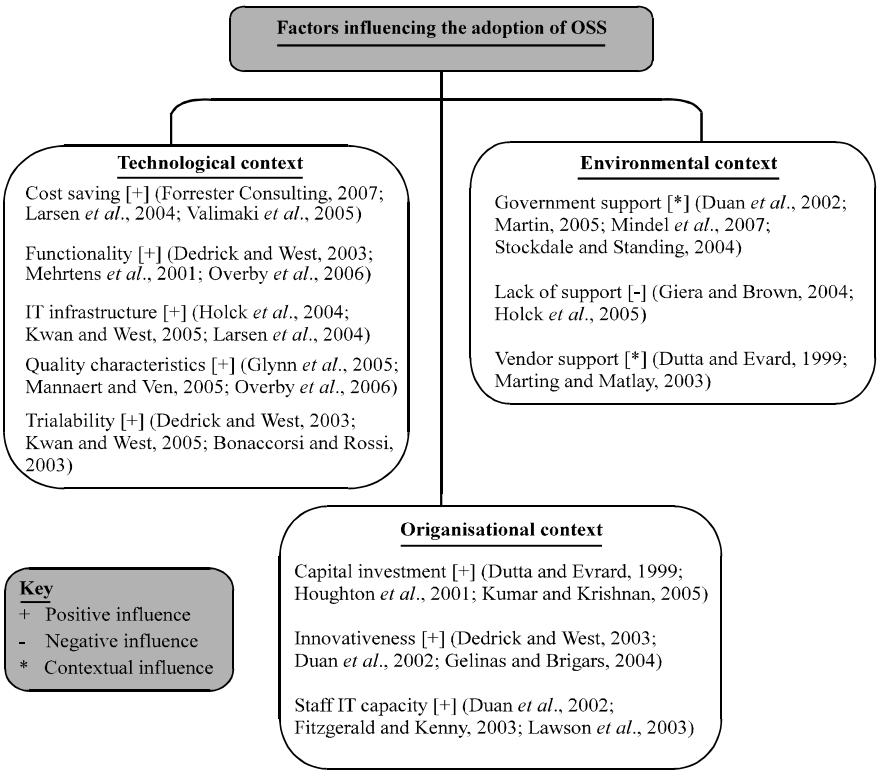

Fig. 1: A semantic framework of factors influencing OSS adoption by SMB

2004; Valimaki *et al.*, 2005), functionality (Dedrick and West, 2003; Overby *et al.*, 2006) and quality characteristics (Bonaccorsi *et al.*, 2006; Economides and Katsamakas, 2006; Overby *et al.*, 2006); barriers such as a lack of drivers (Giera and Brown, 2004; Holck *et al.*, 2005) and limited support from government bodies (Duan *et al.*, 2002; Martin, 2005; Mindel *et al.*, 2007; Stockdale and Standing, 2004) costs and inhibitors including innovativeness (Dedrick and West, 2003; Duan *et al.*, 2002; Gelinas and Bigras, 2004), capital investment (Dutta and Evrard, 1999; Kumar and Krishnan, 2005; Robert *et al.*, 2003), IT infrastructure (Holck *et al.*, 2004; Kwan and West, 2005) and staff IT-capacity (Duan *et al.*, 2002; Fitzgerald and Kenny, 2003; Stockdale and Standing, 2004). The diversity of factors suggests that there is a broad scope of factors influencing the adoption of OSS. The positive, negative and contextual/subjective influences of factors, as illustrated in Fig. 1, implies that the adoption of OSS by SMBs is likely to be complex and subjective. Based on that, we argue that it is important to apply a relevant framework which is capable of representing complex and subjective factors and enhances common understanding by allowing us to frame valid explanations of the influences of the complex and subjective factors.

In line with earlier studies of the general adoption of ICT and the adoption of OSS (Dedrick and West, 2003; Glynn *et al.*, 2005; Houghton *et al.*, 2001; Kuan and Chau, 2001; Overby *et al.*, 2006; Robert *et al.*, 2003), the analytical framework illustrated in Fig. 1 was developed using the semantic contexts of technology, organisation and environment. The technology context represents factors about the focus innovation (OSS) and the internal and external technologies relevant and already assimilated by a SMB (Chang *et al.*, 2005; Raymond *et al.*, 2005; Zhu *et al.*, 2003). Figure 1 show that factors that fit under this context include cost savings, functionality, IT infrastructure, quality characteristics and trialability. These factors were identified as occurring frequently in the literature, suggesting that they may be relevant in the adoption of OSS by SMBs. The organisational context pertain to a SMB's 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 supporting the adoption of OSS (Hung *et al.*, 2003; Xu *et al.*, 2004; Zhu and Kraemer, 2005). As summarised in Fig. 1, the factors pertaining to this context and also identified as occurring frequently in the literature include capital investments, innovativeness and staff IT-capacity. The environmental context of factors refers to external influences in the arena in which a SMB adopts OSS which may be pressures from a SMB's business partners, its industry, or competitors; access to resources from its suppliers and its dealings with government bodies (Raymond *et al.*, 2005; Xu *et al.*, 2004; Zhu and Kraemer, 2005). The factors pertaining to this context and identified as common examples in the literature are illustrated in Fig. 1 and include limited government-support, lack of support and vendor support.

Although, the technology, organisation and environment contexts allow for a semantic analysis of influencing factors, the framework of Fig. 1 developed from these contexts lack the construct validity and the capabilities of proven ICT adoption theories: A view which has been argued in the literature (Dedrick and West, 2003). While the framework allows to present factors in three contexts, there is limited explanation of the nature of factors within each context. The complexity and subjectivity of factors implies that explanations of factors within a common context are likely to have limited validity and generalisability. An example is the technology context which encompasses issues of technology. Such issues can be associated with the focal technology (such as OSS) and/or other technologies supporting the use of OSS (such as Internet and computing hardware infrastructures). However, the framework in Fig. 1 seem to lack the theoretical concepts for differentiating between these technologies and their influences on the decisions to use OSS.

That limitation may lead to invalid identification, analysis and explanations and reporting of factors and their influences. However, studies of the literature suggests that the use of theoretical concepts improves the validity and the generalisability of research design and empirical findings (Benbasat and Moore, 1992; Miles and Huberman, 1994; Patton, 1999; Yin, 1994). Because the limitations of Fig. 1 are relevant, the use of theoretical concepts in developing a framework would enhance the validity of the analysis of influencing factors and the generalisability of a framework of the factors and their influences on the adoption of OSS by SMBs.

Studies of the literature suggests that there has been little use of existing ICT adoption theories in the research area of OSS adoption. That paucity of theory application in earlier research studies of OSS adoption is consistent with the shared view that this research area is still in its infancy (Agerfalk *et al*., 2006; Dedrick and West, 2003; Fitzgerald and Kenny, 2003). This assertion has led us to undertake an evaluation of existing theories relevant to the adoption of ICT in general.

SUITABILITY OF THE DTPB FOR EVALUATION OF ORGANISATIONAL ADOPTION OF OSS

Many research studies in the field of information systems have applied validated theories to enhance the reliability of their research design and the validity and generalisability of empirical findings (Agarwal, 2000; Burton-Jones and Hubona, 2005; Kuan and Chau, 2001; Lin, 2007; Shih and Fang, 2004). Following in the path of such studies, we seek to evaluate existing ICT adoption theories and select one most suitable for exploring factors and framing valid and generalisable explanations of their influences on the adoption of OSS by SMBs, for developing a reliable theoretical framework that will enhance the reliability of empirical research design and the validity and generalisability of research findings. For this reason, a variety of adoption models and theories will now be examined.

The theories being evaluated in Table 1 are all based on a beliefs-intention-behaviour structure. The characteristics of this structure in each theory differs and represents the exploratory and explanatory capability of a particular theory. Using the features of characteristics as criteria, we compare the exploratory and explanatory capabilities of the theories in Table 1. That comparison has led us to select the DTPB for exploring factors and explaining their influences on the adoption of OSS by SMBs. Three important reason will now be discussed to justify the selection of the DTPB.

The first reason is that the DTPB and the 'pure' TPB, as shown in Table 1, comprise of all three determinants of intention (Taylor and Todd, 1995). The advantage of having more determinants

Table 1: Appraisal of relevant theories of the adoption of ICT

Theories	Determinants of intention			Scope of decomposition	References
Decomposed Theory of Planned Behaviour (DTPB)	Attitude	Subjective norms	Perceived behavioural control	Attitude, subjective norm and perceived behavioural control	Taylor and Todd (1995)
Theory of Planned Behaviour (TPB)	Attitude	Subjective norms	Perceived behavioural control	N/A	
Technology Acceptance Model (TAM)	Attitude	N/A	N/A	Attitude	Davis (1989)
Theory of Reasoned Action (TRA)	Attitude	Subjective norms	N/A	N/A	Fishbein and Ajzen (1975)

of intention is that both theories are more applicable for exploring a wider set of complex and subjective factors influencing the adoption of OSS. Furthermore, each determinant of intention would provide an explanation of the influence of its associated factors.

The second reason which is illustrated in Table 1, is that the DTPB has its determinants of intention decomposed into their belief structures (Taylor and Todd, 1995; Venkatesh *et al*., 2003), comparatively, extending its exploratory capability beyond the other theories. That is relevant because it allows us to use the simpler theoretical concepts to identify factors more accurately and to develop valid explanations of their influences.

The third reason for the selection of the DTPB is that it has been validated, applied in empirical studies and recommended as a useful theory for exploring organisational adoption of ICT in general (Hsu and Chiu, 2004; Shih and Fang, 2004; Taylor and Todd, 1995). Furthermore, prior studies have also compared the three theories in Table 1 and conclude that the DTPB has the most exploratory and explanatory capability but was also the most complex and least parsimonious (Agarwal, 2000; Lin, 2007; Venkatesh *et al*., 2003). In this study, the exploratory and explanatory capabilities of the DTPB are important features, relevant for exploring complex and subjective factors and explaining their influences within the context of organisation adoption of OSS.

CONTEXTUAL OPERATIONALISATION OF THE DTPB

Having justified the selection of the DTPB in the previous section, its operationalisation for evaluation of OSS adoption by SMBs will be presented in this section. The operationalisation will demonstrate a contextual exploratory and explanatory capabilities of the DTPB. Thus, factors identified in the literature of OSS adoption and the adoption of ICT in general, are discussed to provide context and strong justification for the complex theoretical concepts of the DTPB which will be now be operationalised.

Exploring the actual use of OSS: The 'behaviour' concept of the DTPB refers to the actual usage of OSS (U) and is defined as the implementation of an OSS and the confirmation of its use in the organisation. This definition stems from the fundamental definition of adoption (Benbasat and Moore, 1992; Rogers, 1995; Taylor and Todd, 1995) which led us to define OSS adoption as the process through which an SMB passes from first knowledge of OSS, to forming attitudes towards its use, 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 within this study. The definitions will also show that OSS adoption is a multi-stage decision processes and the multiple stages allows us to explain the effects of influencing factors on the usage of OSS by SMBs. The components in the decision processes will now be discussed in the context of the concepts that will be operationalised for modelling the adoption of OSS by SMBs.

The first decision process is gaining knowledge of OSS and that fits with the need for self-efficacy that may stem from an internal awareness about how OSS is suitable for an SMB, the potential benefits and challenges in using it and the resources required for its successful implementation. The second process is formation of attitude and fits with the cumulative effect of knowledge about OSS, leading to formation of beliefs that the use of the OSS in question is favourable or unfavourable. The third process is the decision to use or reject, following the formation of attitude and a consideration of the perceived control or organisational capability that enables its use and the subjective influences of social and environment factors which affect the

organisational perceptions that using the OSS is good or bad. That decision to use or reject the OSS fits with the formation of intention to use or not use the particular OSS. The last process is the implementation and confirmation of use and refers to the actual usage of the particular OSS. This final stage of adoption is dependent on the outcomes from the previous stages of decision processes. Therefore, the adjacent stage, intention, will now be discussed and the associated theoretical concept will be operationalised.

Framing the intention to use OSS: The construct, intention, is defined as an SMB's evaluations or judgement that using an OSS is good or bad for the organisation (Ajzen, 1991; Davis, 1989; Taylor and Todd, 1995; Venkatesh *et al.*, 2003). This definition suggests that the cumulative influence of all belief components contributes to the formation of intention, leading to the evaluations or judgement that using OSS is good or bad for the SMB.

As illustrated in Fig. 2, the DTPB posits that the outcomes of an SMB's intention has a direct influence on the actual use of OSS because intention is an immediate determinant of behaviour (Ajzen, 1991; Taylor and Todd, 1995). Thus, we propose that: (I) An SMB's intention to use an OSS has a direct influence on actual usage.

The proposition above provides an explanation for the influences of an SMB's evaluations or judgement about using OSS, showing that intention is a strong determinant of the actual use of OSS in an organisation. The DTPB shows that the evaluations and judgement about using OSS are determined by the influences of factors from belief components-attitude, subjective norms and Perceived Behavioural Control (PBC). Therefore, these belief components and their influences on intention will be discussed and operationalised in turn.

Formation of attitude towards the use of OSS: The first belief component in Fig. 2 is attitude and is defined as the perceptions (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, 1995; Venkatesh *et al.*, 2003). This definition suggests that attitude may be influenced by complex attitudinal factors because perceptions favourable to the use of OSS may develop from the positive influence of attitudinal factors and perceptions unfavourable to usage may develop from the negative influence of attitudinal factors. However, the DTPB posits that an emergent positive or negative attitude to the use of OSS has a direct influence on intention (Ajzen, 1991; Taylor and Todd, 1995; Venkatesh *et al.*, 2003). This relationship has led us to the following proposition: (A) An SMB's attitude towards the use of an OSS has a direct influence on intention.

The proposition above allows us to explain the influence of attitude, formed from the positive or negative effects of complex attitudinal factors. For a more accurate identification of complex attitudinal factors, the DTPB provides three decomposed attitudinal belief structures: Relative advantage, complexity and compatibility. It is our view that other key theoretical concepts, pertaining to the formation of attitude, may be relevant in the context of OSS adoption by SMBs. Furthermore, studies of normative theories of technology adoption suggests that attitude is the single most important concept influencing the adoption of ICT in general: See, for details, the diffusion of innovation theory DOI (Rogers, 1995) the theory of reasoned action TRA (Fishbein and Ajzen, 1975); the theory of planned behaviour TPB (Ajzen, 1991); the technology acceptance model TAM (Davis, 1989) and the unified theory of acceptance and usage of technology UTAUT (Venkatesh *et al.*, 2003). Therefore, in addition to the three attitudinal belief structures mentioned, other innovation characteristics including voluntariness of use, image, result demonstrability,

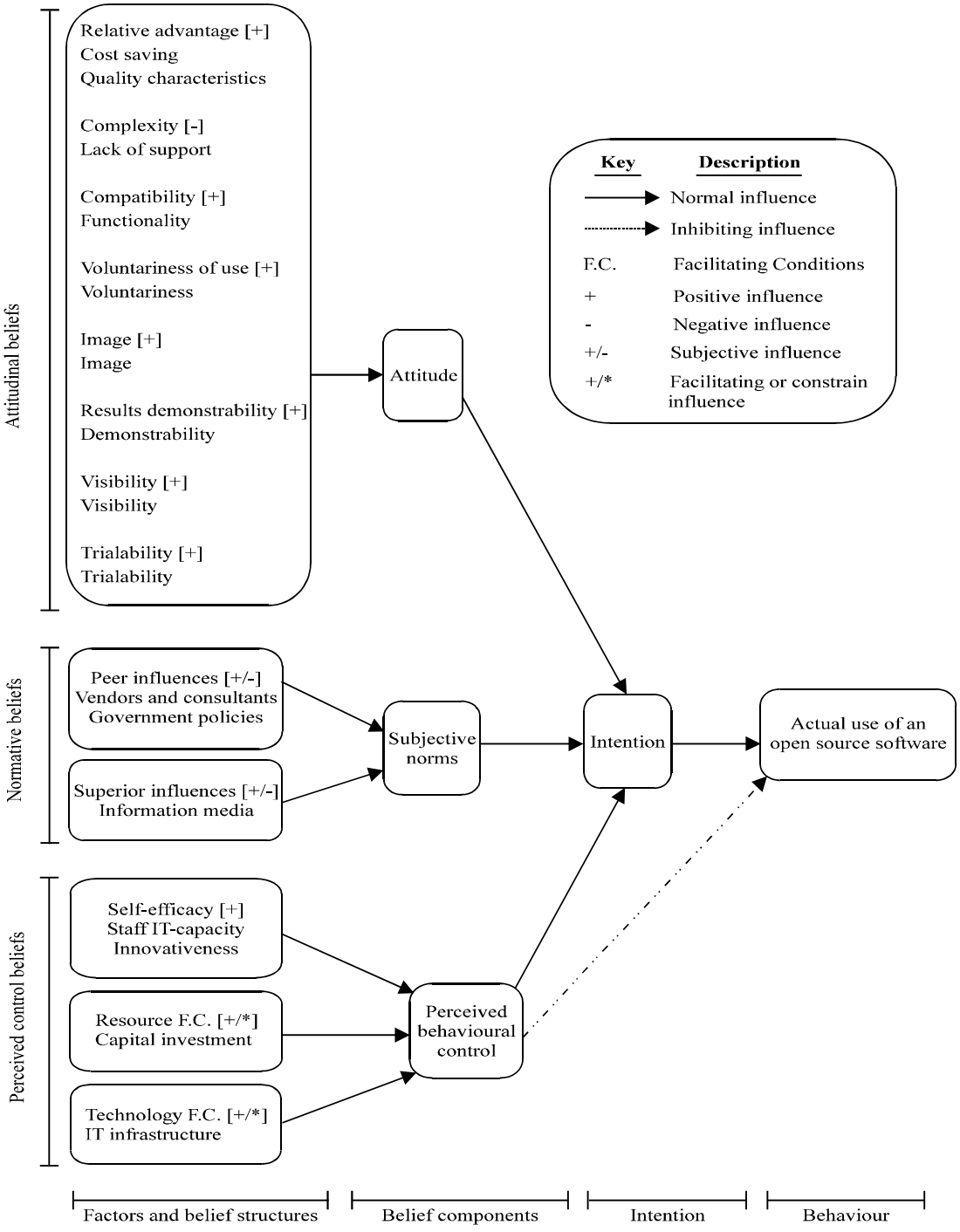

Fig. 2: Framework for evaluation of open source software adoption by SMBs

visibility and trialability can enhance the understanding of issues related to attitude towards the use of OSS (Agarwal and Prasad, 1997; Rogers, 1995; Venkatesh *et al*., 2003). All these eight innovation characteristics relevant to the formation of attitude towards the use of OSS will now be operationalised.

Relative advantage from the use of OSS: The first innovation characteristic is relative advantage, 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, 1995). The diverse features of relative advantage are important and useful for identifying particular factors that are related to the benefits of using OSS. This belief structure is relevant because analysis of the literature suggests that factors such as cost saving and quality characteristics are perceived as benefits which motivate the use of OSS. The example factors will now be discussed within the context of OSS adoption, to justify the relevance and the operationalisation of the belief structure-relative advantage.

Cost saving is the first example and fits with an economic benefit (Fitzgerald, 2006; Forrester Consulting, 2007; Giera and Brown, 2004; Valimaki *et al*., 2005; Von Krogh and von Hippel, 2006). This factor is related to the 'zero cost' of OSS licenses, resulting in a saving in the cost each license of an OSS. This factor is relevant, particularly to SMBs which are sensitive to the need for capital investment in ICT adoption (Dutta and Evrard, 1999; Houghton *et al*., 2001; Kumar and Krishnan, 2005). The second example of relative advantage in Fig. 2 is quality characteristics. Studies suggest that there are different types of benefits associated with the diverse quality characteristics of OSS (Economides and Katsamakas, 2006; Haefliger *et al*., 2008; Overby *et al*., 2006; Raja and Barry, 2005). The diverse features of relative advantage allows to more accurately identify such diverse benefits from the quality characteristics of OSS: For example, OSS reliability fits with the feature of satisfaction benefit; OSS reconfigurability and Open-Standards fits with convenience benefits and OSS efficiency fits with the feature of performance benefit.

These examples discussed above show that the diverse features of relative advantage are relevant for better identifying complex benefits associated with use of OSS. However, fitting with relative advantage means that these factors have a positive influence on the decision to use OSS. Based on that argument and the relationship between relative advantage and attitude, we offer the following proposition: (RA) Relative advantage in using OSS has a positive influence on an SMB's attitude.

The proposition above means that relative advantage can be used in identifying factors associated with economic benefits, image enhancement, convenience, satisfaction and performance benefits from the use of OSS. The proposition also provides an explanation of how factors of such benefits influence an SMB's attitude towards the use of OSS.

Complexity in the use of OSS: The second innovation characteristic in Fig. 2 is complexity and is defined as the degree to which an SMB perceives an OSS to be difficult to understand, learn or use (Rogers, 1995; Taylor and Todd, 1995; Venkatesh *et al*., 2003). The features of complexity allow for more accurate identification of factors associated with the complexity belief structure. Lack of support for OSS is one example factor which will now be discussed and used in justifying the operationalisation of the belief structure-complexity.

A lack of support for an OSS can have a negative influence on an SMB's decision to use an OSS because it increases the difficulty of using an OSS (Dedrick and West, 2003; Giera and Brown, 2004; Holck *et al*., 2005; Raja and Barry, 2005). Such difficulty fits with the feature of 'difficulty in use' of OSS, suggesting that lack of support is a complexity factor and that 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: (CPX) Complexity has a negative influence on an SMB's attitude towards the use of an OSS.

Based on the proposition above, complexity can be used in identifying factors that represent a difficulty in understanding, 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 of the use of OSS: Figure 2 shows that compatibility is the third innovation characteristic 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, 1995; Venkatesh *et al.*, 2003). Similarly, the features of compatibility allow more accurate identification of factors associated with the fit of OSS to an SMB's existing value, previous organisational experiences or current needs. The factor, functionality, will now be discussed to give a context to the compatibility concept and justify its operationalisation within the context of OSS adoption by SMB.

Studies suggests that functionality of an OSS is an important factor that influences the decisions to adopt it. A reason for that view is that an OSS would be more appealing to an SMB if its capability and usefulness meets the SMB's business values and needs (Dedrick and West, 2003; Economides and Katsamakas, 2006; Overby *et al.*, 2006). In this context, the fit of the particular OSS to the SMB's business values or needs fits with the compatibility feature of 'existing values or needs'. Thus, functionality of OSS is a compatibility factor and that contributes, positively, to the decision to use the OSS. Based on this argument and the relationship between compatibility and attitude, the following proposition is offered: (CMP) Compatibility has a positive influence on an SMB's attitude towards the use of an OSS.

This proposition suggests that the belief structure, compatibility, can be applied in identifying factors relevant to the fit of an OSS to an SMB's existing values, previous experiences or current needs. The proposition also provides an explanation of how such compatibility factors influence and contribute to exploring an SMB's attitude toward the use of OSS.

Voluntariness of use in the use of OSS: As shown in Fig. 2, the fourth innovation characteristic is voluntariness of use, defined as the degree to which use of an OSS is perceived as being voluntary or of free will (Moore and Benbasat, 1991). An important issue around this concept and pertaining to its feature is that the use of a particular OSS may be mandatory in one setting but voluntary in another. Studies suggests that managerial interventions to leverage the OSS brand may mandate its use as part of an organisational IT policy (Fitzgerald, 2006). Another related view is that enterprise may mandate the use of OSS as an approach for contributing to national security, gaining greater IT independence and software code transparency (Kshetri, 2004; Mindel *et al.*, 2007). Thus, an SMB's IT policy may mandate the use of particular enterprise or 'back-office' applications such as database servers and web engines while giving staff the freedom of choice of 'front-office' or user-end applications such as document editors and web browsers. Similar subjective, contextual views are echoed in the literature that there might be a differential influence of voluntariness of use in the contexts of the initial acceptance and current use and the intentions for future use (Agarwal and Prasad, 1997; Moore and Benbasat, 1991).

The arguments presented above suggests that the voluntariness of use of OSS is a relevant issue in organisation adoption of OSS. Because this study is more focused on exploring initial acceptance and adoption of OSS by SMBs, we take on the assumption that voluntariness of use will

help mangers reduce the risk of staff resistance to change (Dedrick and West, 2003; Fitzgerald and Kenny, 2003) and also allow users to voluntarily explore the benefits of using OSS, an approach that is likely to have positive implications for their intentions for future use (Agarwal and Prasad, 1997). The discussion so far and the relationship between voluntariness of use and attitude has led us to propose that (VOL) Voluntariness of use has a positive influence on an SMB's attitude towards the use of an OSS.

The proposition presented above provides the context for exploring voluntariness of use in the adoption of OSS by an SMB. It also allows to explain how issues pertaining to voluntariness of use allow us to explore an SMB's attitude towards the use of OSS in the organisation.

Image enhancement from the use of OSS: The fifth innovation characteristic illustrated in Fig. 2 is 'image' and is defined as the degree to which use of an OSS is perceived to enhance the image or status of the adopting SMBs within their social system (Moore and Benbasat, 1991). The features of the construct, image, including gaining social status have provided interesting debate in the literature pertaining to the factors driving the motivations of developers of in OSS projects and communities. It appears that organisations may apply innovative management and highly skilled IT personnel in contributing to OSS projects, FLOSS movements and advocate the use of OSS and they enjoy more gratification from peer recognition and respect within OSS and general IT community than their closed-source counterparts (Fitzgerald and Agerfalk, 2005; Glynn *et al.*, 2005). This is consistent with the view that technical supremacy is highly appreciated in OSS communities and that developers and popular contributors to prestigious and highly popular OSS projects and communities hold high status of good reputation, respect and trust within their OSS communities (Bonaccorsi and Rossi, 2003; Ye and Kishida, 2003).

On the other hand, there can be a less promoting image from the use of OSS because staff see the migration to OSS as signs of management interventions measures to address issues related to shrinking scarce resource which may be related to the beliefs that employees and their roles are under-valued if mandated to use cheap software (Glynn *et al.*, 2005). Again while there may be alternative views on the general issue of image enhanced owing to the use of OSS, we assume that image has a positive effect in the context of this framework (Agarwal and Prasad, 1997; Moore and Benbasat, 1991). This assertion and the relationship between image and attitude has led us to the following proposition: (IMG) Image has a positive influence on an SMB's attitude towards the use of OSS.

This proposition allows us to explore issues pertaining to a SMB's perceived enhancement in image owing to the use of OSS. It also provides a theoretical explanation of how such issues may influence an SMB's attitude towards the use of OSS.

Result demonstrability of the use of OSS: As illustrated in Fig. 2, the sixth innovation characteristic is result demonstrability, defined as the degree of tangibility, including observability and communicability, of the results of using an OSS (Moore and Benbasat, 1991). The features of observability and communicability, pertaining to the demonstrability of the results of using an OSS, are important for identifying related factors. Studies suggests that researchers have observed the use of OSS in different context, for example, in large enterprises (Dedrick and West, 2003; 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). The identification of technological, organisational and environmental-factors and the discussions of benefits and challenges in the use of OSS in such studies suggests that the results of using OSS were observable, recordable and communicable.

Furthermore, some factors of relative advantage such as reliability and security are exemplary arguments for the result demonstrability of the use of OSS. Based on this argument and the theoretical relationship between result demonstrability and attitude, we propose that (RD) result demonstrability has a positive influence on an SMB's attitude towards that use of OSS.

The discussions and proposition above means that result demonstrability can be used in identifying factors associated with the tangibility, including observability and communicability, of the results of using an OSS. The proposition also provides an explanation of how factors influence the formation of attitude towards the use of OSS.

Visibility of the use of OSS: The seventh innovation characteristic in Fig. 2 is visibility which is defined as the degree to which an OSS and its use are visible and communicable to others (Moore and Benbasat, 1991). This definition suggests that the key features of visibility are that an OSS and its use in the adoption context are visible to the potential adopter. We argue that the availability and ease of access to OSS Live CD and the video demonstrations of the use of an OSS (from sources such as 'YouTube') extends the existing foundations of visibility of the OSS: These media allows novice adopters to see and learn about a new OSS innovation. However, the concept of visibility of OSS appears to be multi-faceted: A software perspective-the openness of the source code (Bonaccorsi and Rossi, 2003; Open Source Definition Version 1.9) and a usage perspective-use of the OSS is visible to others (Fitzgerald, 2006; Glynn *et al*., 2005). Furthermore, there appears to be a differential between the visibility of OSS 'back-office' servers and that of 'front-office' desktops (Fitzgerald, 2006; Fitzgerald and Kenny, 2004) and the influence of visibility in the context of the current use and the future use of an OSS (Agarwal and Prasad, 1997).

While we acknowledge that software is less tangible than hardware (Fitzgerald and Agerfalk, 2005; Rogers, 1995), we also argue that OSS are relatively more tangible and open to the public than the closed-source software alternatives (Fitzgerald and Agerfalk, 2005; Bonaccorsi and Rossi, 2003). This argument is consistent with the Open Source Definition (Open Source Definition Version 1.9): The OSS binary must include source code and the OSS license must allow distribution in source code as well as compiled format. We draw attention to this multiple perspective of visibility and suggest that there is a need for better understanding which could have research and practical implications for the observations, measurements and evaluation of this concept.

The discussions and arguments above provide context for better understanding visibility in the context of OSS adoption. This assertion and the relationship between visibility and attitude in the context of OSS adoption leads to the proposition that (VIS) visibility has a positive influence on an SMB's attitude towards the use of an OSS.

Based on the proposition above, visibility can be used in identifying factors pertaining to the perceptions that the potential adopter is able to see the OSS and communicate its use to others. The proposition also helps to explain how visibility related factors contribute to the formation of attitude towards the use of an OSS.

Trialability in the use of OSS: Trialability is the eight innovation characteristic in the framework in Fig. 2 and is defined as the degree to which an OSS may be experimented with before its actual use in the organisation (Moore and Benbasat, 1991). The key feature of this theoretical

concept is the ability to try, trial and experiment with an OSS. However, the trialability of OSS is an important innovation characteristic, allowing SMBs the trial of an OSS including the binary and the source code (Krishnamurthy, 2003; Open Source Definition Version 1.9), to determine its suitability for their needs. Unlike cases of most proprietary alternatives, trialability may have a unique meaning in the context of OSS adoption because there is no restrictions in the trial of particular OSS features and functionalities (Dedrick and West, 2003), no vendor mandated time-limit of trials, no restrictions in the trial of multiple OSS licenses and no restriction of the trial of full support from the OSS communities (see Open Source Definition Version 1.9). Thus, the level of freedom and flexibility in the trial of OSS appears to be distinct from that which is commonly associated with the trial of a proprietary software.

The trialability of OSS also represents a strategic use of it as an enterprise IT infrastructure. The insight here is that an OSS can be used as a fully functional test system while not yet part of a core production systems. The satisfactory results of temporary and potentially long running evaluations may lead to a permanent operational role for a trialled OSS (Kwan and West, 2005). Similar approach has been applied in evaluation of the viability and competitiveness of OSS in a range of government departments and public bodies (Glynn *et al*., 2005; Holck *et al*., 2005; Kshetri, 2004; Valimaki *et al*., 2005). These examples are consistent with the argument that innovations are more likely to be adopted if the potential adopter is able to trial and experiment with it to ascertain its usefulness (Rogers, 1995).

The discussions so far suggests that trialability of OSS is more complex than the trialability commonly associated with other types of innovation. Thus, it is important to have a deeper understanding of the features and characteristics of OSS and how that affects its trialability. However, the operational definition presented and the context of trialability discussed provide useful insight to better understanding this concept within the context of OSS adoption by SMBs. This understanding has led us to the following proposition: (TRL) Trialability has a positive influence on an SMB's attitude towards the use of an OSS.

The above proposition means that trialability can be applied to explore the extent which a potential adopter trials or experiments with OSS. The proposition also allows to explain the consequent effect of the trial, on the SMB's attitude towards the use of the OSS.

Subjective norms around the use of OSS: The second belief component in Fig. 2 is subjective norms, defined as the perception of the social pressures on the potential adopter to use or not use an OSS (Ajzen, 1991; Taylor and Todd, 1995; Venkatesh *et al*., 2003). The feature of social pressure from referent groups fits with environmental factors such as government support and software vendors and consultants (Martin, 2005; Mindel *et al*., 2007; Stockdale and Standing, 2004; Valimaki *et al*., 2005), because such factors originate from the social environment surrounding the use and adoption of OSS. This discussions show that exploring subjective norms and understanding their influences is relevant. Based on that assertion and the relationship between subjective norm and intention, we offer the following proposition: (SN) 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. The proposition explains and also allows to predict the combined effect of environmental factors that lead contribute to an SMB's intention to use or not use the OSS.

The diversity of referent groups including families, colleagues and media sources (Taylor and Todd, 1995) suggests that there can be a variation to comply with the social pressures from

particular referent groups and therefore, different referent groups are likely to have different level of influence on a potential adopter's decisions to use OSS or not use an OSS (Taylor and Todd, 1995; Venkatesh *et al*., 2003). The decomposition of the subjective norm into its belief structures-peer influences and superior influences-provides simpler concepts for identifying and differentiating between different referent groups. Therefore, peer influences and superior influences will now be operationalised for identifying environmental factors related to subjective norms about the use of OSS and explaining their influence.

Peer influences on the use of OSS: The DTPB defines peer influences 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 SMB (Taylor and Todd, 1995). The examples of peers from this definition provides features for identifying similar referent groups, such as vendors and consultants and government agencies which will now be discussed in the context of OSS adoption.

OSS vendors and consultants can provide facilities or professional information that aid the adoption of an OSS (Dutta and Evrard, 1999). Conversely, vendors and consultants may create situations that constrain the successful use of OSS by an SMB: The facilities and information provided by some vendors and consultants can be inadequate and ineffective for some SMBs (Dutta and Evrard, 1999; Martin and Matlay, 2003) or inhibit their flexibility and choice of OSS through product and/or service lock-in or monopoly (Blackburn and Athayde, 2000; Duan *et al*., 2002). However, organisational management may still feel pressured to comply with the advice of vendors and consultants who are believed to be more knowledgeable and trusted on the matter of OSS adoption. The second factor of peer influences in Fig. 2 is government policies, pertaining to government initiatives to promote ICT adoption in small businesses (Martin, 2005; Stockdale and Standing, 2004). This factor was also discussed in terms of government legislations, such as the measures to enforce the conformity to intellectual property laws (Mindel *et al*., 2007; Valimaki *et al*., 2005).

The discussions above have argued that IT vendors and consultants and government bodies can act as social pressures which influence the adoption of OSS. The discussions and the role of peer influences in the formation of subjective norms has led us to propose that (PI) Peer Influences have a subjective influence on an SMB's normative beliefs 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 relevant peers, explain and predict their influences on an SMB's decisions about the use of OSS.

Superior influences around the use of OSS: The second normative beliefs structure in Fig. 2 is superior influences, 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, 1995). The examples of different media of influencing information provides features for identifying factors of superior influences on a SMB's decision to use OSS.

The definition above suggests that information from secondary sources such as the Internet or other public media can influence OSS adoption, where an SMB is motivated to comply with such information. This view is consistent with the theory of communication channel as an important element in the diffusion of innovation (Rogers, 1995). Contextually, the Internet is an important communication channel for the adoption and diffusion of OSS because it is the primary source of OSS products, support information and services which are accessible from OSS communities.

Based on the discussions above and the role of secondary sources of information in the formation of an SMB's subjective norms about the use of OSS, we propose that (SI) Superior Influences have a subjective influence on an SMB's normative beliefs about the use of an OSS.

This proposition allows to explain effects of superior influences on the formation of subjective norms about the use of OSS. Furthermore, superior influences can be applied to identify an SMB's perceptions of the secondary information sources and predict their influence on the decisions to use or not use an OSS.

Perceived control over the use of OSS: The third belief component in Fig. 2 is Perceived Behavioural Control (PBC) and is defined as an SMB's perception of the control over the personal/internal or external factors that facilitate or constrain the use of OSS (Taylor and Todd, 1995; Venkatesh *et al.*, 2003). The features of personal/internal or external factors are important for exploring and understanding an SMB's capability or readiness in the adoption of OSS which have been referred to as organisational factors (Giera and Brown, 2004; Martin and Matlay, 2003). Therefore, this belief component appears to be relevant for exploring SMB's adoption of OSS. That assertion and the relationship between PBC and intention has led us to propose that (PBC) an SMB's perceived control over the use of OSS has a direct influence on its intention to use.

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 contribute to organisational capability and OSS readiness and the relevance of that on the intention to use OSS.

The diversity of the features of the PBC suggests a complexity in the factors that may influence an SMB's control over the use of OSS. The DTPB allows to address such complexity using the decomposed belief structures of the PBC-self-efficacy, Resource Facilitating Conditions (RFC) and Technology Facilitating Conditions (TFC) (Taylor and Todd, 1995; Venkatesh *et al.*, 2003). Therefore, the belief structures of the PBC will now be operationalised in turn.

Self-efficacy in the use of OSS: Self-efficacy is the first control belief structure illustrated in Fig. 2 and is defined as the SMB's personal/internal ability or confidence to use an OSS successfully (Taylor and Todd, 1995). The features of self-efficacy-personal/internal ability and confidence-allows to explore the perceptions of organisational capability and organisational readiness for using an OSS. This theoretical concept is also relevant because studies suggest that subjects with self-assured skills and confidence to use an OSS are more inclined to adopt it (Ajzen, 1991; Taylor and Todd, 1995). The examples of two organisational factors-staff IT capacity and OSS innovativeness-will now be discussed within the context of self-efficacy for the use of OSS.

The need for staff IT capacity appears to be a general issue influencing the decisions to use ICT (Duan *et al.*, 2002; Houghton *et al.*, 2001; Martin and Matlay, 2003; Stockdale and Standing, 2004). It was also identified as an organisational factor in the literature of OSS adoption (Fitzgerald and Kenny, 2003; Giera and Brown, 2004), associated with the personal/internal ability that enables the use of OSS in the organisation. The second example of self-efficacy in Fig. 2 is the innovativeness of the management and the staff within an SMB. This example fits with the feature of confidence of the top management to support the trial and continued use of an OSS by the staff in the organisation (Dedrick and West, 2003).

The discussions above suggests that understanding organisational self-efficacy is relevant to the adoption of OSS by SMBs. This assertion and the role of self-efficacy in organisational capability for use of OSS has led us to the following proposition: (SI) Self-efficacy has a positive influence on an SMB's perceived control over the use of an OSS.

This proposition allows us to explore the organisational factors that represent an SMB's ability or confidence to use an OSS. Thus, self-efficacy can be applied to explain the role of personal/internal factors contributing to the perceived organisational control over the use of OSS by SMBs.

Resource facilitating condition for the use of OSS: The second control belief structure in Fig. 2 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, 1995). Time and money resources appear to be the key features for identifying factors associated with resource facilitating conditions necessary for supporting the use of OSS. Thus, the feature of money fits with the factor-capital investment-and that has been reported as an important issue associated with learning and switching, adaptation, re-distribution and integration costs, maintenance costs (Bonaccorsi *et al*., 2006; Economides and Katsamakas, 2006; Haefliger *et al*., 2008), money resource necessary for supporting the use of an OSS (Kumar and Krishnan, 2005) and the use of ICT in general, by SMBs (Dutta and Evrard, 1999; Robert *et al*., 2003).

In the context of this study, capital investment is associated with resource facilitating conditions for supporting the use of OSS in the organisation. Based on this assertion and the role of resource facilitating conditions in organisation readiness for OSS adoption, we propose that: (RFC) having relevant resource facilitating conditions has a positive influence while the lack of them has a constraining influence on an SMB's perceived control over the use of an OSS.

The proposition suggests that the RFC is relevant for identifying the resource-related organisational factors necessary for supporting the use of OSS in the organisation. The proposition also allows us to explain why having relevant resources influences organisational capability and control over the use of OSS.

Technology facilitating condition for the use of OSS: The Technology Facilitating Conditions (TFC) is the third control belief structure in Fig. 2. This concept is defined as the technology compatibility issues that may facilitate or constrain the use of an OSS (Taylor and Todd, 1995). The feature of technology compatibility fit with the essential IT infrastructures (Holck *et al*., 2004; Kwan and West, 2005; Venkatesh *et al*., 2003), needed for supporting the use of OSS. That understanding suggests that technology compatibility issues may include access to hardware infrastructure such as computer systems, network hardware and Internet connection and the access to related software services and maintenance in general.

The discussions above provide justification for the role of TFC in exploring controllability factors in the context of OSS adoption by SMBs. Based on that assertion and the relevance of technology facilitating conditions in the organisational capability for the use of OSS, we propose that (TFC) having relevant technology facilitating conditions has a positive influence while the lack of them has a constraining influence on an SMB's perceived control over the use of an OSS.

The proposition suggests that the TFC can enable the identification of the technology compatibility issues relevant for supporting the use of OSS in the organisation. The proposition also allows us understand and explain why having technology facilitating conditions are essential, seemingly having a strong influence on organisational capability and control over the use of OSS.

The relationships in the DTPB suggests that the essential facilitating conditions of RFC and TFC can influence adoption beyond the perceived control over the use of OSS. As we have proposed in the last sections, having these facilitating conditions enhances perceived control over the use of

OSS and contributes to the formation of intention to use OSS but does not guarantee actual usage. However, the DTPB suggests that a lack of either facilitating conditions by the SMB can inhibit the actual use of OSS in the organisation (Taylor and Todd, 1995; Venkatesh *et al.*, 2003). This argument and the inhibiting influences of facilitating conditions, as illustrated in Fig. 2, has led us to the proposition that (FC) lack of facilitating conditions has an inhibiting influence on an SMB's actual use of the OSS.

The proposition above suggests that a lack of either facilitating conditions is a barrier to the actual usage of OSS in the organisation. It also shows that facilitating conditions are essential for actual usage of OSS and therefore, it also represents the critical failure factors in the adoption of OSS.

DISCUSSION

The framework presented in Fig. 2 encompass valid concepts of theory and contextual factors, offering an answer to the question of what factors influence the adoption of OSS by SMBs and why? The framework shows that OSS adoption in SMBs is influenced by complex and subjective factors pertaining to attitude, subjective norms and perceived control over the use of OSS. The underlying structures of these theoretical components of factors provide simpler concepts for more accurate identification of factors and valid explanations of the influences on the adoption of OSS by SMBs.

The theory-grounded framework in Fig. 2 is an important contribution, filling a gap in the paucity of theory-grounded models for evaluation of OSS adoption in general (Agerfalk *et al.*, 2006; Dedrick and West, 2003; Fitzgerald and Kenny, 2003). Furthermore, the framework extends the existing knowledge and the common understanding of theory and influencing factors within the context of OSS adoption in SMBs. That is owed to the augmentation of factors from multiple disciplines to extend knowledge of such factors in the research area of OSS adoption and the application of the DTPB (a widely-accepted theory of the general ICT adoption), in developing a generalisable framework that allows for common understanding of the factors and their influences on the adoption of OSS by SMBs. The generalisability of the framework in Fig. 2 is important for a shared and common understanding in the developing research area of OSS adoption (Holck *et al.*, 2005; Overby *et al.*, 2006) and has enabled us to address the issues of complexity and subjectivity of OSS adoption in general. The inclusion of additional theoretical concepts of innovation characteristics has allowed us to extend the scope of generalisability in the framework. That has also extended the exploratory and explanatory capabilities, useful for investigating diverse complex and subjective factors that influence the adoption of OSS by SMBs. Thus, it is argued that the emerged frameworks work in Fig. 2 is more comprehensive for evaluation of OSS adoption in SMBs than the initial DTPB and most other theories of ICT adoption in general.

The framework presented in Fig. 2 and discussions from previous sections are important contributions in the developing area of OSS adoption (Dedrick and West, 2003; Fitzgerald and Kenny, 2003; Holck *et al.*, 2005). Three important research and practice implications of the framework will now be discussed, focusing on the issues of direct utilisation, frame of reference and justification for action (Agarwal, 2000; Agarwal and Prasad, 1997; Benbasat and Zmud, 1999). Following that, the limitations in the scope and design of the framework will be discussed. After that, future research work to address implement the framework will be proposed.

Implications for research and practice: Although, there are diverse theories applicable to study of general ICT adoption, their use for practical evaluation of ICT adoption requires that such

theories need to be operationalised within the contexts of the innovations, environments and organisations being evaluated (Taylor and Todd, 1995; Rogers, 1995; Venkatesh *et al*., 2003). For this reason, the framework presented in this study has direct utilisability for the evaluation of factors and understanding of their influences in the adoption of OSS by SMBs. The framework also presents future researchers with a useful and operationalised model for exploring factors and framing valid explanations of their influences within the context of their studies. The validity and generalisably of the underlying theory and the additional innovation characteristics should give added confidence to researchers who intend to apply the framework in their research studies. For the same reasons, practitioners may apply the framework as an underlying component, in whole or in part, to the design of a field instrument within the contexts of their evaluation exercise.

The second area of implication of the framework is its importance as a useful, generalisable frame of reference for understanding factors and theoretical concepts relevant to the adoption of OSS by SMBs. The factors identified from a comparative analysis of the prior literature has provided some insight into the diverse technological, organisation and environmental issues that may influence the adoption of OSS and the general adoption of ICT by SMBs. The major difficulty in that comparative analysis was due to a lack of established analytical and theoretical generalisability and therefore validity of the semantic, limited discussions of the factors. Researchers and practitioners are likely to benefit more from the discussions of example factors within the context of the presented theory-grounded framework and extended scope of validated innovation characteristics.

The third area of implication being discussed is related to the usefulness of the arguments to support the operationalisation of theoretical concepts in the framework presented in this study. The discussions of factors, concepts and theories from studies provide researchers and practitioners with foundation for understanding and justification of action pertaining innovation modelled by the factors, concepts and theories. This is even more important for new and contemporary innovations. The existing paucity of research in the area of OSS adoption implies that there is limited contextual, valid and generalisable, theories which help researchers and practitioners better explore factors and understand their influences on the adoption of OSS by SMBs. The discussions of factors and operationalisation of theoretical concepts within the context of OSS adoption by SMBs contributes to general understanding in this area of research and practice. Practitioners may apply the knowledge gained from such understanding to enhance their scope of influencing factors and adoption concepts and that is likely to have positive effects on their informed decisions-making and strategy about the use of OSS in their organisations.

Limitations of the emerged framework: The framework developed in this study is not without its limitations. Generally, conceptual models have limited validity on their representation of the empirical features, characteristics and behaviour of an innovation (Agarwal, 2000; Benbasat and Moore, 1992; Holck *et al*., 2004). The framework developed and presented in this study has similar limitations. However, the framework as presented in this study was developed based on validated and widely-accepted theoretical concepts-the DTPB and other of innovation characteristics-from prior studies of organisational adoption of ICT, in general. Furthermore, studies that have applied the DTPB and the innovation characteristics implemented in the framework presented in this study have achieved useful research findings from their use (Hsu and Chiu, 2004; Shih and Fang, 2004; Taylor and Todd, 1995).

Another limitation of the emerged framework is related to the empirical validity and scope of conceptual models (Benbasat and Moore, 1992; Holck *et al.*, 2004). Similarly, the framework presented in this study is likely to be limited in some scope, although it is generalised for OSS adoption and SMBs. However, the analytical generalisability of the framework presented in this study (owing to the generalisability of the underlying DTPB and the additional innovation characteristics) makes the framework flexible for context based evaluation of particular OSS, within the situation-specific context of the potential adopter. Furthermore, the flexibility of the framework allows us to amend the scope of theoretical concepts relevant for a particular evaluation exercise or study: Other relevant concepts can be added and concepts that are deemed less relevant for an evaluation exercise or study can be abstracted.

Proposed future research: The framework presented in this study provides a foundation for useful future research study. One area for future research is the application of the framework in a confirmatory study to test its applicability in evaluating factors and predicting their influence on OSS adoption across a wide sample population of SMBs. Another area of future study is a field evaluation of the significance of the underlying theoretical concepts and the technological factors, environmental factors and organisational factors. Such endeavour may lead to an optimised model of critical success factors for SMBs in the adoption of OSS.

CONCLUSION

The aim of this study was to explore factors influencing the adoption of OSS by SMBs and frame valid explanations of their influences. The framework developed and presented in this study addresses the aim set out and provides an answer to the question posed at the introduction section. The framework shows that, consistent with studies of general ICT adoption, the factors influencing the adoption of OSS are complex and subjective, however, the use of a relevant and valid, generalisable theory allows us to frame a common understanding of influencing factors and the nature of their influences. The aim set out at the introduction section of this study has led us to undertake an appraisal of the literature of OSS adoption, where we observed that there is a paucity of valid, contextual theories of OSS adoption in general. That gap in research was the foundation of this contribution-a theory-grounded framework for evaluation of OSS adoption by SMBs. The framework developed and presented in this study uses the DTPB as an underlying theory of ICT adoption, extending the DTPB with relevant theoretical concepts of innovation characteristics. That is relevant because attitude is single most important concept in exploring and understanding the adoption of ICT in general. By extending the attitude component of the DTPB, a framework with an extended exploratory capability for exploring attitude towards the use of OSS in SMBs was developed. The use of diverse, complex and subjective factors identified in the literature of OSS and the adoption of ICT in SMBs provided context for operationalisation of the extended DTPB model. The fit of the factors from the literature demonstrated the analytical generalisability of the emerged framework and also demonstrated the exploratory and explanatory capability of the framework for the evaluation of OSS adoption by SMBs. The applicability of the emerged framework for research and practice meant that it had useful implications in the areas of direct utilisation, frame of reference and justification. Owing to a paucity of theory-grounded research in the area of OSS adoption, this study may be the first to discuss the application of the DTPB and also to apply it in an extended form for modelling the adoption of OSS by SMBs.

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