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ABSTRACT

Open source software (OSS) support creates major barriers to increases in its market share. Drawing on the relationship marketing theory, we develop and empirically test a model to examine the influence of OSS support on OSS market share. Using a survey data of 151 IT professionals working in the US, we find that OSS support positively influences its market share. It also indirectly influences OSS market share through OSS investment decision and need based use for OSS. The results of this study indicate that OSS support plays a central role in improving popularity of OSS. The study informs managers on developing strategies to market OSS based on support and costs.

Keywords

Open source software, market share, relationship marketing, need based, investment.

INTRODUCTION

Open source software (OSS) are programs that allow end-users to view and modify the source code and permit free distribution (Macredie and Mijinyawa, 2010). This is opposed to proprietary software (PS), which is built with source code that cannot be edited without the prior permission of the owner (Lerner and Tirole, 2005).

OSS solutions provide 'stiff' competition to their proprietary counterparts as they offer several advantages (Casadeus and Ghemawat, 2006; Nagy et al. 2010). Freedom to customize and audit OSS source code, improved total cost of ownership, greater return-on-investment, and avoidance of vendor lock-in are some of the major benefits of OSS over PS (Boulanger, 2005; Stamelos et al. 2009). Yet, OSS still lags PS in installed-base and is not ubiquitous (Gartner, 2011b).

To a large extent, a software solution's wide acceptability among end-users may be determined by the support services, mostly, technical support provided to its users (Cusumano, 2008; Nelson et al. 2000). OSS products are no exception. Popular OSS such as Linux and Apache appeal to end-users because they offer very 'rich' support (Dean 2011).

Academic literature provides anecdotal accounts of reluctance to accept OSS due to lack of technical support. For example, several scholars (Fitzgerald, 2006; Krishnamurthy, 2003) have noted that a major barrier to increase in OSS's market share may be due to lack of committed, reliable, and efficient technical support. A Gartner report suggests that OSS database management software market penetration remains 'inhibited' (Gartner, 2011a). Another Gartner report published in the same year mentions that OSS solutions in the realm of technology operations management systems remain unpopular (Gartner, 2011b). Both these reports cite lack of competent and committed technical support as the primary reasons for OSS not being omnipresent.

Given that technical support plays a critical role in OSS becoming pervasive, or, in others words, impacts OSS's share of the software market, it is appropriate that scholars turn their attention to conduct an empirical investigation on this topic. To this end, our study focuses on the importance of software product support in the context of OSS. The key question that this research attempts to empirically investigate is: Does technical support for OSS improve its market share? An empirical

investigation of this nature will enable scholars to comprehensively understand the role of technical support in increasing the installed user-base of OSS. Findings of the study may help guide managers in the field of OSS to use strategies to reach OSS to end-users.

The paper is organized as follows. We begin by discussing the literature relevant to product and technical support in the context of OSS. Subsequently, we explain the underlying theoretical framework of our proposed research model and outline the hypotheses. Next, the paper describes the exploratory study and results of the confirmatory analysis that was conducted using a sample of IT professionals working in the United States (US). Finally, we conclude by discussing the implications of our findings and directions for future research.

LITERATURE REVIEW

Product Support

Merely 'selling' and 'order taking' does not create value for customers. It is imperative that firms transform customer relationship into one of solving customer problems in a timely and efficient manner (Sawy and Bowles, 1997). The conventional view of product support is the after-sales support activities directed towards improving overall customer satisfaction, after customers have bought the product and started to use it (Goffin and Colin, 2001). It encompasses activities such a product delivery, packaging, installation, maintenance, problem-solving or repair, dispute resolution, and complaint handling (Sawy and Bowles, 1997).

Technical Support for OSS Products

In general, technical support takes the form of advice to users on changes to the product and how it may be used for maximum benefit (Das, 2003). When OSS users need assistance, they may send requests for support to forums (for example, bulletin boards and mailing lists) and wait for the OSS developer community to respond. Organizations sometimes might seek technical support services from third-party providers knowledgeable about OSS products. For example, Hewlett Packard and International Business Machines provide support for Linux. Most businesses are unwilling to rely on support from the OSS community as there is no assurance that response will be timely. They may also be disinclined to pay the service-fee charged by third-party providers (Fitzgerald, 2006). Further, he notes that support for OSS is imperative for increasing its installed user-base. However, OSS technical support is disorganized, at best and thus far empirical research on consequence of lack of OSS support is scarce. Goode (2005) surveyed managers from organizations based in Australia and showed that, among other reasons, OSS was rejected due to lack of reliable technical support.

THEORETICAL BACKGROUND AND RESEARCH HYPOTHESES

We draw on the relationship marketing (RM) framework to provide a theoretical foundation for our proposed model (see figure 1). Our main focus is to understand the link between support for OSS and OSS market share. The central tenet of RM is that customer satisfaction with a product or service increases as customer support improves (Berry, 1995). High consumer satisfaction is increases consumer investment in the product and enhances product market share.
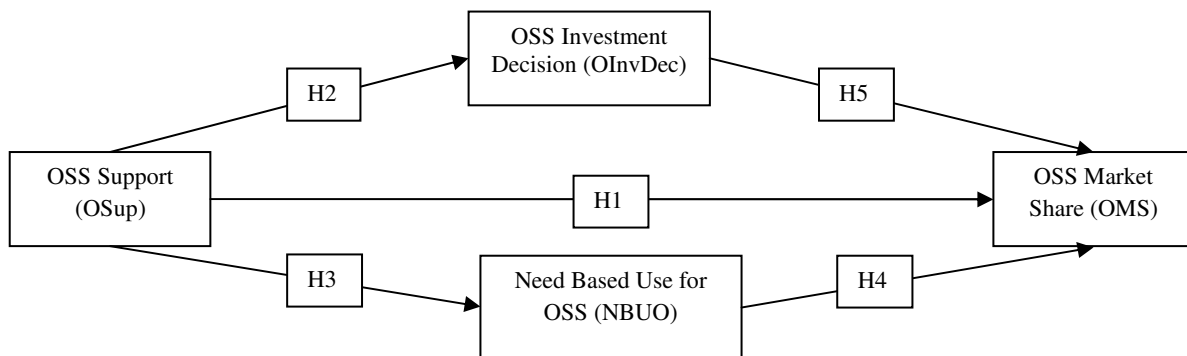

Figure 1: Model

Our research model also includes mediating variables, OSS Investment Decision, and 'Need Based' Use for OSS. These variables have been included in our model to obtain a more perceptive understanding of the factors that impact OSS market share. We define OSS Investment Decision as factors that influence an organization's willingness to put in effort (knowledge and monetary resources) to modify and use OSS applications. Individual preference for OSS may be need driven (Shah, 2006). People favor OSS over PS since it allows them to get rid of the constraints of PS, like dependability on the vendor, as well as to save on costs (Shah, 2006). We define Need Based Use for OSS as an organization's need driven preference for OSS for similar reasons.

Relationship Marketing Theory

Relationship marketing (RM) concept views the dyadic relationship between the customer and seller as a 'relational' or 'enduring' exchange rather than a 'transactional' experience for the parties involved (Berry, 2002). RM concepts have existed in the marketing literature for over 30 years (Berry, 1995). IS literature (for example, Goodhue et al. 2002; Karimi et al. 2001; Massey et al. 2001) has applied RM to understand impacts of IT-enabled customer support on firm performance. RM's theoretical roots lies in several theories (for list of the theories, refer Moller and Halinen, 2000). RM includes all activities directed towards attracting, maintaining, and enhancing customer relationships (Berry, 1995). Several marketing practices are included under the rubric of RM. Among them is the service support in form of warranties, after-sales support, and product maintenance (Bitner, 1995). Timely response to customer requests for services contributes to their satisfaction and willingness to continue doing business with the service provider.

RM Outcomes

RM strategies allow firms to establish long-term relationships with their clients and improve their satisfaction levels, which in turn leads to higher-levels of customer loyalty (Armstrong and Kotler, 2008). Loyal clients reward the firm by favoring them over other sellers, and making 'repeat' purchases. Research on understanding the outcomes of customer satisfaction and loyalty has found that they positively influence market share and profitability (Oliver, 1999; Rust and Zahorik, 1993). Several studies (for example, Goodhue et al., 2002; Massey et al., 2001) on impact of IT-enabled RM practices exist in the realm of IS literature. The major outcomes documented are increase in firm profitability and market share.

Hypotheses

OSS Support and OSS Market Share

When product support is of high quality, customers will continue to approve the product(s), enabling the seller to improve profitability through increase in sales volume (Nwakanma et al., 2007). Numerous examples of how companies have won market share through efficient product support have been documented in research studies (Hull and Cox, 1994; Verhoef, 2003). OSS attributes such as 'openness' of source code and flexibility, makes it a very viable alternative to PS. End-users might still feel inhibited in selecting OSS due to lack of committed and efficient support. Drawing on the ideas of RM, we propose that when business users working in an organization perceive support services for OSS products to be efficient, they will make OSS their first choice. Consequently OSSs' market share will increase. Hence:

H1: Support for OSS increases market share of OSS

OSS Support to OSS Investment Decision

A customer's decision to invest in a product may be influenced by the service-support available for the product (Khavul et al. 2010). Higher the quality of support for the product, greater the likelihood the buyers will be inclined to invest in the product (Leung and Li, 1998).This may be explained by the rational choice theory often applied to understand consumer behavior (Hechter and Kanazawa, 1997). According to this theory, individual buying decisions are made through a rational process. Customers assign a value to each desired service offering (or product) based upon their evaluation of the ability of that offering to meet their needs. When OSS end-users view software service-support as favorable; this positively reinforces their decisions towards investing in OSS.

H2: Support for OSS increases OSS Investment Decision

OSS Support to Need Based Use for OSS

A key component of RM; quality of support service offerings which fulfill specific needs and demands of customers, is considered to be important for consumer satisfaction (Hennig-Thurau, Thurau, 2003). RM emphasizes that, as value-added support services associated with a product become customer-centric, consumers' need driven demand for the products tend to increase. The rational is that customers favorable product experiences give them confidence about using the product in a way that meets their requirements. Firms wanting to minimize their dependency on PS and reduce costs associated with PS may lean more towards OSS products when technical support is available. Thus:

H3: Support for OSS increases need based use for OSS

Need Based Use for OSS and OSS Market Share

The association between need based use for OSS and OSS market share can be argued from the perspective of self-interest theory (Miller and Ratner, 1996). This theory posits that need based interests lead people (or organizations) to act in ways that will facilitate fulfillment of such interests. For example, individuals (or companies) make anonymous donations to serve their interests, such as enhancement of self-esteem (or organizational reputation). When OSS allows firms to become independent of PS vendors and save costs, its employees will frequently use OSS. As a consequence, OSS popularity and market share will improve. Carpenter and Nakamoto (1989) illustrated that shifts in consumer need based preferences allows sellers to gain substantial share of buyer's choice. Hence:

H4: Need Based Use for OSS increases OSS Market share

OSS Investment Decision and OSS Market Share

The relationship between investment and market share has been well document in economic and marketing literature. Szymanski et al. (1993) studied factors that improve firm's market share. Their model outlined investment (monetary and knowledge based) as antecedents of market share. Investment had a positive impact on product market share. Thus:

H5: OSS Investment Decision increases OSS Market share

RESEARCH METHOD

We were unable to find any previously validated instruments within the context of OSS for measuring the constructs in our research model. Therefore, an initial item pool for measuring the constructs was developed based on our reading and interpretation of prior OSS literature. To be certain that all the survey questions were understandable and unambiguous, we requested 14 OSS users to provide their inputs. Some items in the survey needed to be re-worded based on the feedback from these individuals. A survey methodology was used to collect the data for the study. A list of IT professionals was obtained from a professional organization. All the individuals included in the list worked for organizations located in the southern region of the US. Some of these organizations had offices all across the US.

The survey participants were initially contacted over email in the middle of February 2011. The targeted IT professionals had used OSS at their workplace, as recent as, last 5 months. Emails were sent to 1500 such individuals. The email invitation included a request for participation in the study and a link to the survey. Potential respondents were informed that it would take about 14 minutes to complete the survey. Subjects were assured of anonymity it was stated that researchers would be willing to share the summary of findings of the study. Reminder emails were sent in the first week of March to those who were initially contacted. A second reminder email was sent soliciting participation, two weeks after the first reminder. No reminder emails were sent to individuals who had opted not to participate in the survey. The data collection procedure was concluded in the first week of April 2011. There were no significant differences in responses among the 1st, 2nd, and 3rd wave of respondents. This eliminates issues of non-response bias.

Out of the 1500 emails distributed, 605 were 'undeliverable', and 145 individuals opted out. There were 205 subjects who responded, of which 151 completed the survey. These accounted as usable responses resulting in an overall response rate of 20.1 percent. Majority or 88% of the respondents were males. Most (57%) of them were between 27 years and 44 years old. With regards to work experience, 54% of the sample had a minimum of 4 years of experience in the IT field. For 64% of the respondents, minimum education level attained was an Associate degree. About 51% of the individuals worked for firms that were either national or global. All individuals in our study used OSS in their workplace.

Data Analysis and Results

The measurement properties of the survey instrument were inspected by evaluating the construct validity, discriminant validity, and reliability (Hair et al. 1998). Factor analysis and Cronbach's alpha are tools used to evaluate these properties. Principal component factor analysis with a Varimax rotation was used to examine the validity of the items.

A separate factor analysis was conducted for the independent (OSS Support or OSup), mediating (Need Based Use for OSS or NBUO and OSS Investment Decision or OInvDec), and the dependent (OSS Market Share or OMS) variables rather than a single factor analysis, wherein the loadings of each indicator on several factors are examined. Initially we had 4 items to measure OSup, NBUO, and OInvDec and 5 items to measure OMS. Conducting a single factor analysis on all these 17 indicators simultaneously would result in a correlation matrix of over 289 relationships, which would not provide reliable or meaningful results (Kerlinger and Lee, 2000). It is recommended that the sample size to be at least four or five times the numbers of variables present in a factor (Hair et al., 1998). There are no more than 8 items in any of one factor analyses; therefore the sample size of 151 used in the study is adequate to carry out the analyses. The criterion of Eigen value greater than 1.0 was used while extracting the number of factors. The dimensionality of each of the factors extracted was evaluated by inspecting the factor loadings (Robinson et al.1991). A total of 14 items with factor loadings greater than 0.5 on the construct on which they are purported to load were retained. Items that were cross-loading (factor loadings less than 0.45) were removed. Refer to Tables 1, 2, and 3 for factor analysis results along with the Eigen values for each of the factors extracted.

Items	Component
	OSup
OSup1	0.785
OSup2	0.723
OSup3	0.837
Mean	2.523
Variance Explained	47.33%
Eigen Value	1.893
Cronbach's alpha	0.678

Table 1: Factor Analysis and Cronbach's Alpha for Independent Variable

Items	Components	
	NBUO	OInvDec
NBUO1	0.887	0.036
NBUO2	0.547	0.117
NBUO3	0.810	-0.012
NBUO4	0.829	0.005
OInvDec1	0.172	0.775
OInvDec2	-0.096	0.807
OInvDec3	-0.002	0.631
OInvDec4	0.094	0.635
Mean	3.696	3.483
Variance Explained	30.94%	25.86%
Eigen Values	2.475	2.069
Cronbach's alpha	0.767	0.781

Table 2: Factor Analysis and Cronbach's Alpha for Mediating Variables

Items	Component
	OMS
OMS1	0.727
OMS2	0.693
OMS3	0.691
Mean	2.592
Variance Explained	53.70%
Eigen Value	2.148
Cronbach's alpha	0.708

Table 3: Factor Analysis and Cronbach's Alpha for Dependent Variable

The reliability of each factor was examined. Cronbach's alpha is widely used to examine the reliability. A Cronbach's alpha of 0.7 is generally considered acceptable (Nunnally, 1978), though 0.6 may be acceptable for newly defined scales (Gefen and Straub, 2005). Measurement scales for NBUO, OInvDec, and OMS had a Cronbach's alpha of above 0.7 while OSup had a Cronbach's alpha of 0.678.

Confirmatory factory analyses (CFA) using partial least square technique (Smart-PLS) was used to test the relationships between the constructs in the proposed model.

In IS research, PLS technique is widely used for theory development and theory testing (Ringle et al., 2012). In this study, we are developing and empirically testing the model. Further, PLS has the ability to assess a series of inter-related relationships simultaneously, that is, test complex models. These advantages make PLS a suitable statistical technique for data analysis in our study.

The minimum sample size required for employing PLS effectively is one that is 10 times the number of independent variables influencing a single dependent variable (Chin, 1998). Our proposed model does not have more than 3 variables influencing a single dependent variable. Thus, a sample size of 151 was adequate to conduct the statistical analyses.

PLS provides the analysis for two models: (1) a measurement model and (2) a structural model. The measurement model checks for the reliability and the validity of the instrument, whereas the structural model provides the relationship between the theoretical constructs (Huck, 2004).

Measurement Model

Convergent validity was assessed by observing the average variance extracted (AVE) and the composite reliability of the constructs (Huck, 2004). The AVEs for constructs NBUO and OInvDec were less than 0.5. We removed 2 items from NBUO and one item from OInvDec that did not have significant loadings on the corresponding constructs. After removing these items, the AVEs for NBUO and OInvDec were greater than 0.5. The AVEs of rest of the constructs were greater than 0.5, and the composite reliability of all the constructs were greater than 0.7 (refer Table 4), thus indicating adequate convergent validity.

Construct	AVE	Composite Reliability
OSup	0.58	0.80
OInvDec	0.57	0.79
NBUO	0.57	0.70
OMS	0.52	0.76

Table 4: Average Variance Extracted and Composite Reliability for the Latent Variables

Discriminant validity is assessed by inspecting the correlation among the constructs and the square root of the AVEs (Huck, 2004). The correlations among the constructs (non-diagonal elements) is less than the square root of all the AVEs (diagonal elements) thus indicating adequate discriminant validity (refer to Table 5).

Construct	AVE	OSup	OInvDec	NBUO	OMS
OSup	0.58	**0.76**			
OInvDec	0.57	0.40	**0.75**		
NBUO	0.57	0.22	0.03	**0.75**	
OMS	0.52	0.43	0.46	0.18	**0.72**

Table 5: AVE and Correlations among Latent Constructs

Structural Model (Hypotheses Testing)

In PLS, the structural model represents the relationship between the theoretical constructs. Figure 1 represents the results of the PLS analysis. As recommended by Chin (1998) bootstrapping with a sample size of 500 was used to carry out the PLS analysis

The hypotheses were evaluated using one-tailed t-test as they are unidirectional in nature. Table 6 gives the path coefficients, t-values, respective p-values for the hypotheses, as well as the summary of the results of the hypotheses testing.

Hypotheses	Path Coefficients	t- values	p- values	Result
H1 (OSup-OMS)	0.264	3.194	0.00***	Supported
H2 (OSup- OInvDec)	0.399	5.699	0.00***	Supported
H3 (OSup-NBUO)	0.223	1.755	0.04**	Supported
H4 (NBUO-OMS)	0.110	1.349	0.09*	Supported
H5 (OInvDec-OMS)	0.350	4.999	0.00***	Supported

***p<0.01, **p<0.05, *p<0.10
OMS R^2=0.29, OInvDec R^2=0.16, NBUO R^2=0.05

Table 6: Path Coefficients, t-values, p-values, and Result

Results provide evidence to support all the hypotheses proposed in the theoretical model. OSS Support (OSup) directly influences OSS Market Share (OMS). OSS Support (OSup) positively influences OSS Investment Decision (OInvDec) and Need Based Use for OSS (NBUO). Also, there exists a positive relationship between OInvDec and OMS and NBUO and OMS.

Summarizing, OSS support directly impacts OSS market share. It also indirectly influences OSS market share through OSS investment decision and need based use for OSS. Hence, OSS support appears to play a central role in improving OSS market share.

DISCUSSION

The proposed model is based on the RM concept. Empirical support for the relationships in the model clearly illustrate that factors which will improve OSS market share are support and organizational need driven factors such as independence from PS and cost savings.

RM framework emphasizes value of support services and competitive price which are perceived value to customers. We empirically show that there is a relationship between support and increase in OSS market share. This substantiates the anecdotal evidence that efficient technical support 'structure' allows OSS such as Linux and Apache to enjoy a large portion of the software market.

Tying into a PS vendor inhibits a firm's ability to use software for organizational specific needs. Our model demonstrates that when OSS support is present, companies can overcome their dependence on PS. OSS provides flexibility and cost savings, which are inherent advantages of OSS. These results are also supported.

Our research findings have implications. We have a developed a theoretical lens that can be used to test the impact of technical support on market share. An attempt has been made to measure OSS support. Results of this study will allow managers to develop strategies to market OSS based on support and costs. The study also draws attention to the importance of OSS community of developers, the need for specialists to provide OSS support, and the opportunities for entrepreneurs interested in OSS.

LIMITATION and FUTURE RESEARCH

Some limitations of the study are that the proposed model is simplistic and other factors such as organizational commitment to OSS need to be explored. In future, scholars should conduct studies to examine the business impact of OSS.

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