

The Study of Open Source Business Models: An Investigation into the Economic
Viability and the Strategies of Open Source Software Companies

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A Dissertation entitled

“The Study of Open Source Business Models: An Investigation into the Economic Viability and the Strategies of Open Source Software Companies”

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ABSTRACT

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By

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In recent years, many software companies have built their businesses around open source software (OSS) and some projects such as Linux and Apache Server have seen a phenomenal success. OSS companies either generate revenue from professional services such as consultancy and customisation or by selling premium versions targeted for enterprises or both. This research investigates critical success factors and viability of OSS businesses.

The research was based on a theoretical model developed after reviewing existing literature and previous research on OSS companies. The research was conducted using various qualitative and quantitative methods to grasp a deeper understanding of the subject. The information was collected from two interviews, two case studies and surveys regarding business models and community contributions.

The theoretical model was tested using various statistical tests and it was found that well funded OSS companies tend to adopt hybrid business model, which involves selling premium version of the software having additional features designed for enterprises. There was no specific evidence found regarding the impact of hybrid business model on community contributions. But, it was found that OSS companies can

use fair and consistent governance policies and appropriately mix key product features in the community edition for encouraging and sustaining community contributions.

The study analysed various challenges, critical success factors and strategies commonly used by OSS companies. A framework model was developed by integrating the results of both qualitative and quantitative analysis. This framework can be very useful in understanding various factors that influence business model and how OSS businesses can develop sustainable competitive advantage using project governance policies and implementing appropriate product and community strategies.

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Chapter 1. Introduction

1.1 What is Open Source Software?

A computing device consists of hardware and software components for controlling or using that device. Software refers to the set of instructions that tells a computer what to do and hardware refers to electronic components such as processors and memory that execute the instructions in the software. Software programs are normally written in high level programming languages, known as “source code”, which is then compiled to a “binary code” that a computer can interpret. The technical terms used in this research paper are summarised in [Appendix I](#).

Proprietary software companies normally protect their software by only releasing the binary code. Although it is possible to reverse engineer the binary code, this is often a very complicated and time consuming task. Moreover, software companies may protect their software using patents. This model is often referred as “Closed Source” because the source code used for developing the software is protected. Proprietary software companies sell licenses for using their software under restricted terms and build a very profitable business.

In contrast, Open Source Software (OSS) is the software whose source code is freely made available for using, copying, modifying and distributing (Murray, 2009; Open Source Initiative, 2010a). OSS projects often involve voluntary programmers who collaborate and develop or enhance the software and users who contribute by reporting issues and requesting useful features (Shah, 2006). Users can very often find solutions to their problems through discussion forums where other users may share their

knowledge and provide suggestions. This kind of community support is available at no cost and reduces overall project costs significantly for price sensitive users.

In recent years, OSS projects have seen a phenomenal success (Dwan, 2004; Shah, 2006). For example, Apache Web Server dominates the web server market (Dwan, 2004; Netcraft, 2010), while most emails sent across the Internet are sent using SendMail (Dwan, 2004). Based on a survey of websites, Netcraft (2010) found that over 66% of the top servers across million busiest websites were using Apache Web Server.

Considering this success, many software companies have recently built their businesses based on OSS projects. Even the largest software companies such as Microsoft and Google have taken serious note of OSS projects and have aligned their strategies accordingly. For example, Microsoft has adopted open standards for office documents and now actively supports several OSS projects (Microsoft, 2010; Foley, 2008), while Google has been at the forefront in actively supporting and developing several OSS projects such as Chromium browser and Android platform for mobile devices (Google, 2010).

1.2 Brief History of Free Software and Open Source Software

During 1950s and 1960s IBM and other manufacturers used to give away their software along with source code for free. This strategy was seen as a marketing initiative to make the hardware more saleable. In 1964, IBM released System/360 that covered a range of small to large scale systems making it possible for medium sized businesses to own their business computers for the first time. But, they lacked resources for developing the software they needed and this gap was filled by software

product companies. At that time, software development was quite expensive as it required a mainframe computer and a team of highly skilled software programmers. Naturally, software companies were concerned about competitors and did not want to share their source code. Over the next few decades, the software companies continued protecting their source code. In 1983, IBM adopted “object code only” policy and completely stopped disclosing the source code of their software. (Campbell-Kelly, 2008).

However, researchers in academic and corporate research institutes such as MIT and Bell Labs enjoyed autonomy and until 1970s, the programmers shared source code and cooperated to develop operating systems such as UNIX that could run on multiple platforms. In 1979, Usenet computer network began linking programmer community together. This further accelerated the sharing of source code across various organisations. (Lerner & Tirole, 2002).

In early 1980s, AT&T began enforcing its intellectual property rights related to UNIX. In response, Richard Stallman began working on GNU project (an operating system compatible with UNIX) in 1983 (Lerner and Tirole, 2002) and later founded Free Software Foundation in 1985 (Rosén, 2008). Stallman (n.d. cited in Rosén, 2008) insisted on freedom of software and explains the term, “free as in free speech and not as in free beer”. One of the important innovations was the release of GNU General Public License (GPL) that imposed conditions on software developers to make their changes freely available under identical terms (Lerner and Tirole, 2002). It still remains the most used license for OSS projects (Onetti & Verma, 2009).

Rosén (2008) states that the business world was still concerned about “free software”. Free Software Foundation continued to stress on the ideology while giving second priority to the practicality. Eric Raymond sensed the need of addressing commercial concerns regarding “free software” (Rosén, 2008). He analysed the practices of the hacker community in his famous essay, “The Cathedral and the Bazaar” (Raymond, 1998b). Raymond (1998b) discussed the programming style used by Linus Torvalds for the development of Linux operating system and argued that with large number of beta-testers and co-developers, it is possible to find and fix all kind of software bugs.

In February 1998, a strategy session was held at Palo Alto, California to discuss the tactics for making a more pragmatic business case for “free software”. In that session, Chris Peterson coined a new term, “Open Source”, which Eric Raymond later announced to the public (Open Source Initiative, 2010c; Raymond, 1998a). Soon thereafter, Raymond and Bruce Perens co-founded Open Source Initiative (Open Source Initiative, 2010c). The significance of the “Open Source” term was that it was better understood by the business community and allowed better marketing of the OSS (Rosén, 2008; Open Source Initiative, 2010c).

At the time of publicly announcing the new term, Raymond (1998a) maintained that there was no problem with the concept of “Free software”, except that it was confusing to the business people. Considering several commonalities between “Open Source Software” and “Free Software” Ghosh later coined another term, “Free/Libre and Open Source Software (FLOSS)”, which was first used in a comprehensive report on Open Source software published by European Commission (International Institute of

Infonomics, Berlecon Research & ProActive International, 2002). Throughout this document, the term “Open Source Software” (or simply, OSS) is used to represent both, Open Source and Free Software.

1.3 Hackers and Crackers

The software programmers who develop OSS projects are often referred as “hackers” (Raymond, 2001). They share a common culture and find fun in solving problems. This term should not be confused with computer criminals that break into a computer system by circumventing its security. Raymond (2001) insists that the original term for such computer criminals is “crackers” and blames the media for incorrectly using “hacker” term for cyber-criminals. Raymond’s (2001) essay on, “How to become a hacker?” provides detailed discussions on the hacker culture.

1.4 Open Source Licenses

Open Source Initiative (2010a) insists that software should be freely available for redistribution and should include the source code. Open Source Initiative (2010b) has approved about 67 licenses at the time of this writing. It is beyond the scope of this research to discuss the implications of each of these licenses. However, from the perspective of understanding strategic importance for businesses, following trends are noteworthy:

- Free Software Foundation (2010) insists that modified software must also be released back to the community under identical license terms (Jaokar and Gatti, 2009). These licenses are referred as “copyleft” licenses. For example, General Public License (GPL) is a “copyleft” license.

- In contrast, “non-copyleft” licenses do not insist on releasing the derivative work. Thus, a developer (or a company) may modify the source code of original OSS, bundle that with some proprietary software and sell the commercial license of the derivative work. For example, BSD license is a non-copyleft license. (Jaokar and Gatti, 2009).

These differences are important because Open Source Initiative (2010a) allows both “copyleft” and “non-copyleft” licenses, and implicitly encourage businesses based on hybrid business models.

1.5 Are Open Source Proponents “Modern-day Communists”?

Many OSS projects rely on donations and voluntary programmers who modify the code at no cost (Shah, 2006) giving an impression that OSS projects do not make any economic sense for commercial software companies. In an interview, Bill Gates (2005, cited in Kanellos, 2005), the co-founder of Microsoft, insisted that intellectual property (IP) rights help in creating competitive economy because it provides an incentive system for the products of the future. He further commented that OSS supporters are “modern-day communists”. These views provoked debate regarding economic sense of OSS. Although this research does not directly address this debate, it aims to investigate whether business models based on OSS can be sustainable.

1.6 Aims and Objectives

OSS companies require generating revenues from premium edition of the software or from professional services such as consultancy, training, installation and maintenance contracts. These business models also rely on the involvement of

voluntary programmers who can reduce the overall development cost significantly (Shah, 2006). So, it is interesting to study the functioning of OSS firms and investigate whether such firms can build sustainable competitive advantage and survive against closed source software firms. The aim of this dissertation is to investigate the critical success factors and the viability of the business models based on OSS projects.

1.7 Research Questions

This research addresses the following questions:

1. What are the revenue sources and the business models available to OSS companies and whether company's financial resources have an influence on its business model?
2. What are the critical success factors and risks for OSS companies?
3. What are the common strategies used by OSS companies and can they help in building sustainable competitive advantage over their rivals?

Chapter 2. Literature Review

2.1 Introduction

. In this chapter, existing literature regarding OSS firms and their business models is reviewed. This can be broadly categorised into five major streams: benefits of using OSS, motivation of community members, management of OSS projects, software licenses and business models used by OSS companies. In addition, this chapter also discusses literature on some general management related topics such as leadership and strategy formations.

2.2 Benefits of Open Source

Media often reports various benefits of OSS such as lower cost, reliability and less vulnerability to attacks. However, most of these reports are anecdotal with very little systematic research to support certain claims. On the other side, some corporate funded researches are very likely to be biased. Portelli (2010), the CEO of CollabNet, cites reports from Gartner and Forrester Research to underline the benefits of OSS and asserts that OSS projects consistently deliver greater value and desired ROI to the enterprises. Forrester Research (n.d. cited in Portelli, 2010) found that about 92% of the respondents felt that OSS met or exceeded their expectations. In another research by Veracode (2010, cited in Portelli, 2010), it was found that OSS communities fixed security vulnerabilities twice as quickly as commercial software vendors. This is essentially due to the fact that source code gets inspected by thousands of programmers around the world. Raymond (1998b) who was inspired by Linus

Torvalds's style of development sums this up in "Linus's Law" which states, "Given enough eyeballs, all bugs are shallow".

In a more systematic research, Morgan and Finnegan (2007) interviewed managers in 13 European companies to investigate the benefits and drawbacks of the OSS. Their research highlighted several technical and business benefits of using OSS. Among technical benefits most managers reported reliability, security, quality, performance, flexibility, availability of developer and tester communities as the most important benefits, whereas business benefits included low cost, flexibility of licenses, escaping vendor lock-in, increased collaboration, encouragement to innovation, improved productivity and communication and following de facto standards. The respondents also reported some technical drawbacks such as minor compatibility issues, lack of expertise in some cases, poor documentation, proliferation of interfaces, lesser functionality and lack of roadmaps. The drawbacks from business perspective included lack of support and ownership, management concerns about OSS due to lack of widespread knowledge and insufficient marketing. Some respondents also reported higher investment requirements for training and difficulty in finding competent staff to work with OSS alternatives. (Morgan & Finnegan, 2007).

Using analytical derivations and simulations, Haruvy, Sethi and Zhou (2008) showed that OSS becomes viable alternative to closed source software only above certain critical level of community involvement. Haruvy, Sethi and Zhou (2008) further found that the quality of OSS increases continuously as the network size of users increases, whereas the quality of Closed Source software may decrease towards the end of life of

the product due to lower salvage value perceived by managers. Anderson (n.d. cited in Dwan, 2004) explains this by adding that commercial software firms often put pressure on programmers for releasing the software to meet deadlines, which results in behaviours where managers undermine some serious bugs and attempt to release the software as soon as it becomes “good enough”.

Anderson (n.d. cited in Dwan, 2004) points out that OSS is a double-edged sword as it allows attackers to find bugs easily and exploit those bugs and carry out more sophisticated attacks. Anderson (n.d. cited in Dwan, 2004) further argues that both closed source and open source are on equal footing with respect to security. So, viability of OSS depends on the support of hacker communities in continually finding and fixing critical bugs very quickly.

2.3 Community versus Lone Development Model

Earlier work produced by several authors regarded OSS development as communal product development system, which is clearly reflected in their focus of research. Raymond (1998b) explains how “bazaar” style of development works despite each participant having different agendas and approaches. In an interview with First Monday, Linus Torvalds (1998 cited in Ghosh, 1998a) echoes similar views and states that users also contribute implicitly by reporting bugs and providing useful suggestions. Ghosh (1998b) explains the economic model based on intangible community values such as reputation that cannot be expressed in monetary terms.

Ghosh and Prakash (2000) researched 12,706 OSS projects, which surprisingly revealed that the contribution from top 10 authors was nearly 20%, while top decile authors contributed more than 72% of the code. In another research on Linux project, Moon and Sproull (2000) found that 2% of the contributors posted more than 50% of the messages. Krishnamurthy (2002) studied OSS projects available on Sourceforge.net by categorising each project based on their product development stage and found that only a small fraction of projects were in “mature” stage. Assuming that mature stage projects must have a larger community support, Krishnamurthy (2002) further researched 100 OSS projects in mature stage and found that vast majority of those projects were actually developed by a small number of individuals. Only 29% of the projects had more than five developers, while 51% projects had only one administrator. Despite large number of contributors involved on Linux project, Linus Torvalds wrote nearly half of its core parts (Yamagata, 1997 cited in Moon & Sproull, 2000). So, Krishnamurthy (2002) concludes that OSS projects follow “lone or cave” development model rather than a community based model.

Krishnamurthy’s (2002) research primarily focused on software developers and ignored an important point raised by Torvalds (1998, cited in Ghosh, 1998a) that the user communities are equally important for the success of OSS projects. Although few exceptionally good programmers write majority of the code, user communities implicitly assist development by finding problems, reporting bugs and providing suggestions. Torvalds (1998, cited in Ghosh, 1998a) further argues that while users should pay for the software, programmers should pay back to the users for testing their software and

providing feedbacks. This give and take relationship justifies the economic sense in making OSS freely available for everyone.

Sagers (2007) investigated the role of community members on the success of OSS projects and how their contributions can be sustained. It was found that larger OSS communities have more support and development communication activities and sustaining them depends on the viability and usability of the software (Sagers, 2007). Sagers (2007) further suggests that communication activities have some effect on the success of the community as well as the software. Thus, active communities are critically important in supporting and sustaining of OSS projects (Sagers, 2007).

2.4 Managing Open Source Projects

Previous studies have shown that the cost of software maintenance projects is positively related to the complexity of source code (Banker et al., 1993). Midha et al. (2010) researched complexity and maintainability of OSS projects and found that it affects the time taken to fix bugs and also discourages new developers from contributing. Midha et al. (2010) recommend that managers need to continually control the complexity of source code in order to attract contributions from new developers.

Raymond (1998b) observes that senior programmers need to spend significant time on careful inspection of code in order to get enough confidence. As a result, longer release periods often create disappointment when the long-awaited releases are not perfect. So, Raymond (1998b) insists on “releasing early, release often” policy, which allows quicker identification and fixing of the bugs.

Au et al. (2009) found that the performance of OSS projects is affected by the team size and their experience. Moderately sized teams were found to have best performance and their knowledge sharing and performance improved when developers participated in multiple OSS projects. Au et al. (2009) recommend that bugs should be assigned to developers based on their expertise and experience.

The Internet has made it possible to manage collaborative projects in distributed environment. But, management of OSS projects still remains a challenge due to the voluntary nature of programmers. Kirsch (1996) describes four modes of organisational controls – behaviour control, outcome control, clan control and self-control. In formal organisations, the behaviours and outcomes are measured for evaluating performance of employees and rewarding them accordingly (Eisenhardt, 1985 cited in Kirsch 1996). The clan control is an informal control where the behaviour of individuals can be controlled through social mechanisms (Ouchi, 1979, cited in Kirsch, 1996) and the self-control refers to the way individuals control their own actions in organisational setting (Kirsch, 1996).

Kirsch et al. (2002) research suggests that project leaders tend to exercise self-control when behaviours are not directly observable or when outcomes are highly measurable. OSS projects typically fit these criteria as programmers work in a distributed environment. Cho (2008) studied control mechanisms used in five OSS projects and found that the main difference was in the voluntary nature of programmers. Self-control regarding flexibility of selection of tasks and flexibility of developer's schedule was particularly observed with limited or no supervision.

The self-control behaviour suggests that software programmers working on OSS projects function similar to self directed work teams (SDWT). A self directed work team typically consist of “highly trained group of individuals that is fully responsible for creating a specified product” (Osburn et al., 1990 cited in Vecchio, 2006: 110). Team leaders need to facilitate meetings and build consensus rather than taking unilateral decisions (Vecchio, 2006:111). Yandrick (2001) points out that greatest challenge in forming SDWT is in setting and enforcing behavioural expectations. Bergmann and De Meuse (1996) recommend having a strong internal proponent or a champion in the early stages and that new champions need to be nurtured throughout the organization as the team concept evolves.

2.5 Leadership

Rost (1993) defines leadership as “an influence relationship among leaders and their collaborators who intend real changes that reflect their mutual purpose”. Rost (1993) further argues that influence works in either direction and there are no followers involved in this relationship. Leaders must be able to influence others without using any rewards or authoritarian powers.

OSS projects require collaborative work from community members and it is difficult to motivate individuals without effective leadership. When Linus Torvalds initiated Linux project in 1991, he requested other programmers to join the project (Moon & Sproull, 2000). Moon and Sproull (2000) discuss communication style of Linus Torvalds and point out that he never ordered anyone and even his suggestions were mild-mannered

hints. Moon and Sproull (2000) reckon that his management decisions and skills were as important as technical skills he possessed. This helped in attracting significant contributions from community members. By July 1995, nearly four years since his first appeal for help, there were more than 15000 contributors from over 90 countries (Moon & Sproull, 2000).

Lerner and Tirole (2002) insist that leadership and governance structure are very important determinants of the success of OSS projects. Individuals contributing to OSS projects may sometimes have conflicting interests and ego may prevent them to be agreeable with each other. The programmers' trust in the leadership is very important as that helps in resolving differences and avoiding creation of smaller communities or forking of the project (Lerner & Tirole, 2002).

2.6 Motivating Individuals

Motivating individuals to complete assigned tasks and improve their performance are some of the most important functions of the team leaders and project managers.

Commercial software is normally developed by paid employees of the company and project managers often use intrinsic and extrinsic rewards to motivate employees in achieving organisational goals. Many commercial organisations also link employee's recent performance with compensation and appraise the best performing employees.

Dr. Fowler (n.d. cited in Dwan, 2004) states that the real difference between the OSS and the proprietary software is in the human efforts. OSS projects rely on voluntary

contributions from people who share their expertise and contribute to the project in a community-based model (Raymond, 1998b; Shah, 2006; Rosén, 2008). Most programmers are not even paid for their contribution to the project (Cho, 2008). So, conventional methods of behaviour and output controls cannot be used effectively on such individuals. Instead they are more likely to be motivated by community norms and self-control (Cho, 2008).

According to Herzberg's (1959 cited in Vecchio, 2006:77) two factor theory, the performance of employees is affected by motivator and hygiene factors. Motivator factors such as career advancement and recognition are responsible for motivation, while hygiene factors such as job security and company policies are important but do not motivate individuals (Vecchio, 2006:77). The critics though argue that factors such as salary could also serve as ego and act as motivator factor (Vecchio, 2006: 78). With reference to OSS projects, recognition and reputation among community members can motivate programmers to contribute, while absence of fair administrative policies can adversely affect their contributions.

Roberts, Hann and Slaughter (2006) studied three Apache projects to understand the interrelation of motivation, participation and performance in OSS projects. They observed that extrinsic motivations do not lessen the effects of intrinsic motivations and both compensatory and status motivations generate above average contributions. But use-value motivations were found to generate below average contributions. Moreover, past performance rankings act as feedback system for developers and enhance their subsequent status motivations

Lin (2007) studied 50 Taiwanese firms to examine the impact of intrinsic and extrinsic rewards on employee attitudes and their intentions regarding knowledge sharing. This research showed that organisational rewards did not have any significant influence on the employee attitudes and intentions. However, reciprocal benefits, knowledge self-efficacy and enjoyment in helping others were found to be significantly associated to the knowledge sharing attitudes and intentions (Lin, 2007). These factors are equally applicable to the community contributions observed in OSS projects.

Various classical theories on motivation may be relevant in this regard. Maslow's (1968, 1987 cited in Vecchio, 2006:75-76) model of "hierarchy of needs" show that once physiological and safety needs are met, individuals are likely to be motivated by social, esteem and self-actualisation needs. Critics point that it is often difficult to prove that lower order needs were satisfied. Shah's (2006) research shows that many hobbyist developers are highly skilled, experienced and hold managerial positions. So, they are likely to be motivated by intrinsic rewards that satisfy their social, esteem and self-actualisations needs rather than extrinsic rewards that satisfy physiological and safety needs.

Subramanyam and Xia (2008) studied motivations of developers from developed and developing countries and found the presence of intrinsic motives such as sharing and learning in all regions. They also found that developers from developing countries preferred working on large, modular and universal projects. Such projects expose new developers to systematic and collaborative development and help them gain experience from career advancement perspective. Social learning theory states that certain

individuals show a strong desire to imitate superior performers or supervisors (Vecchio, 2006:83). Thus, junior programmers can learn and gain experience by imitating senior programmers who have earned higher reputation among hacker communities.

Another approach to motivate employees is through employee empowerment and setting expectations by designing job characteristics. Hackman and Oldham (1976, cited in Vecchio, 2006: 104-107) developed job characteristics theory which states that skill variety, task identity and task significance improve the meaningfulness of work and responsibility is enhanced by autonomy and feedback from the job. Programmers who contribute to OSS projects can experience these motivators because they not only enjoy autonomy of selecting their own tasks but can also decide how they complete their tasks (Cho, 2008). Various studies have shown that flexitime improves productivity (Cohen and Gadon, 1978 cited in Vecchio, 2006:107; Baltes et al., 1999 cited in Vecchio, 2006:107; Latack and Foster, 1985 cited in Vecchio, 2006:107).

Torvalds (1998, cited in Ghosh, 1998a) insists that programmers are like artists and their real motivation is the fun of programming while fame and reputation come later. Various studies have found that their participation is driven by variety of reasons such as satisfying own needs (Franke and von Hippel, 2003 cited in Shah, 2006), career concerns, learning and reputation (Hann et al., 2002 cited in Shah, 2006), enjoyment and creativity (Gelernter, 1998 cited in Shah, 2006).

Shah (2006) examined the motivation of voluntary developers and the impact of governance effect on the type and quality of their contributions and found that there are

two types of participants in OSS projects: need driven and hobbyist participants. Shah's (2006) research shows that participants initially join OSS project in order to satisfy their specific needs. Many participants had searched and compared other alternative products before choosing OSS and their decision was based on technical or legal reasons such as to be able to view and change the code. Shah (2006) found that participants share modified code with OSS communities due to their desire to conform to the norms of the community, desire to get feedback from others for improving their solution further and because of career concerns. Shah (2006) further observed that participants continued contributing to OSS projects because of fun and enjoyment, which is consistent with the observations of Torvalds (1998 cited in Ghosh, 1998a) and Raymond (1998b). Shah (2006) points out that hobbyist developers are critical for the functioning of Open Source communities.

2.7 Resource Allocation and Risks

Grand et al. (2004) developed a four-level management model for innovation based on the resource allocation of IT firms contributing to the OSS projects. The four levels at which OSS firms engage in resource allocation are summarised in [Appendix II](#). At level one, the companies primarily use OSS in order to reduce costs and employees are mainly trained on running, installing and maintaining the software and at level two, the firms develop OSS to complement their other products and services. At level three, OSS firms select OSS as a design choice and employ significant resources for the development of OSS projects. At level four, the firm's strategies and entire business model are aligned for OSS. Higher resource allocation allows firms to access new

technologies and innovations from external resources. Grand et al. (2004) state that although OSS firms release software publicly, the firm-specific individual knowledge and expertise remain with the developers. Grand et al. (2004) found that costs and the risks increase as the level of resource allocation increases. But, the firms with higher level of commitment to OSS benefit the most as they can build firm-specific knowledge and expertise.

Economides and Katsamakos (2006) examine the pricing models of the proprietary and OSS firms and show that a vertically integrated proprietary industry is more profitable than OSS industry and that OSS industry is more profitable than the vertically disintegrated proprietary platform industry when the demand of proprietary platform is weaker than the demand of applications. Using simulations, Economides and Katsamakos (2006) further show that when a proprietary system competes with an OSS system, the proprietary system is more likely to dominate in terms of both, the market share and the profitability. However, the dominance of OSS in the server markets (Dwan, 2004; Netcraft, 2010) and the growing popularity of few other OSS applications contradict with this claim at least in terms of market share.

Leach (2008) points out that firms which do not generate their main revenues from software royalty can reduce risks by adopting OSS model. This is because proprietary software requires more investment on resources for developing and testing the software. For instance, Apple and Nokia make most of their money from selling hardware devices, while Google's core business is to generate advertising revenues from its search engine. So, these companies do not directly sell software and hence the

risk is minimal for them to adopt OSS model. However, the risk is higher for pure software product companies that derive most of their revenues from software licensing (Leach, 2008).

2.8 Competitive Advantage and Strategies

Building sustainable competitive advantage is very important for the survival of any business. Thompson, Stickland and Gamble (2008:133) describe strategy as the management's game plan to gain competitive advantage over rivals. Porter (1996) differentiates between operational efficiency and strategic positioning and states that strategic positioning concerns with building competitive advantage over rivals that cannot be easily imitated. Porter (1996) reckons that existing tradeoffs in the market can be used for strategic positioning of the firm. Porter (1996; 2008) defines strategy as "building defences against the five competitive forces or finding a position where these forces are weakest". The five competitive forces are: rivalry among existing competitors, bargaining power of suppliers, bargaining power of buyers, threat of substitute products or services and threat of new entrants (Porter, 1996). So, firms need to identify relative strengths of competitive forces and find those areas where they have the best chance of outperforming their rivals.

Faldetta (2002) discusses the evolution of organizational models that evolved since fordism (a hierarchical and centralised model based on mass production) and the role of knowledge based organizational model in building competitive strategy. Barney (1991, cited in Faldetta, 2002) insists that firm's resources need to possess four attributes for

reaching competitive advantage; they have to be valuable, rare, imperfectly imitable and having no equivalent substitute.

Grand et al. (2004) recommend marshalling of sufficient knowledge resources in order to continuously support the discovery, knowledge creation and technical development. Faldetta (2002) insists that intangible resources such as organizational culture, entrepreneurial values and knowledge are not easily imitable. Faldetta (2002) further argues that freedom plays an important role in creativity, innovation and competence. This perspective suggests that it is possible to build sustainable competitive advantage based on the organizational culture and freedom (Faldetta, 2002).

Vujovic and Ulhøi (2008) point out that online OSS communities use the Internet for transferring and sharing implicit knowledge. This allows them to “create and sustain complex innovations with no manufacturer involvement” (Hemetsberger, 2003, cited in Vujovic & Ulhøi, 2008). Vujovic and Ulhøi (2008) discuss various implications of this for software firms and point out that innovation is not enough for software firms and they need to develop business strategies to tap opportunities upstream in the value chain (Vujovic & Ulhøi, 2008). Software firms also need to create closer relationships with their customers and open up innovation process to the external environment (Vujovic & Ulhøi, 2008). Vujovic and Ulhøi (2008) observe that “software firms extend their network not only as a reaction to the threat from OSS competitors but also to develop competencies and capabilities, to get closer to the customers and to make commercial use of the OSS components”.

2.9 Business Models

The concept of business model is not easily distinguishable from the strategy (Onetti & Verma, 2009) and many definitions are used in the literature. Fuller et al. (2010) describe business model as the “process by which the exchange of value is enacted”. Betz (2002) defines business model as an abstraction of business which describes how inputs to an organisation can be transformed to value-adding outputs. Betz (2002) constructs six generic business models based on four kinds of major inputs and outputs; that are, resources, sales, profits and capital. These models are summarised in the Table 1 given below.

Model	Input	Output	Description
Strategic Finance Model	Sales and Resources	Profits and Capital	The financial strategy dominates perspective. Useful when company wants to maximise both profits and long-term capital. For example, GM.
Strategic Enterprise Model	Resources and Capital	Sales and Profits	The production strategy dominates perspective. This is useful when company wants to optimise the production efficiency. For example, Mazda.

Strategic Response Model	Resources and Profits	Sales and Capital	The market strategy dominates perspective. This is useful when company wants to build sustainable competitive advantage based on quicker response time to the changes in the market. For example, Toyota.
Strategic Learning Model	Sales and Capital	Resources and Profits	The information strategy dominates perspective. This is useful when viewing the totality of single-business firm and building a new market of customers. In this case, access to the information and knowledge within organisation becomes the key asset for the company. For example, AOL.
Strategic Innovation Model	Profits and capital	Resources and Sales	The innovation strategy dominates perspective. The strategy is useful when viewing the totality of a single-business firm and innovation in technology becomes a dominant policy temporarily. For example, Amazon.

Strategic Firm Model	Sales and Profits	Resources and Capital	The diversification strategy dominates perspective. This is useful for a diversified firm where individual business units can have their own business models.
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Table 1 - Strategic Business Models (Source: Betz, 2002)

Mitchell and Coles (2003) describe business model as a plan of the business that needs changing over a period of time. They identify seven components of a business model, which provide answers to the following questions:

- “Who?” – defines all the stakeholders in the business
- “What?” – describes offerings and their effects on the stakeholders
- “When?” – specifies the timing of the offerings
- “Where?” – identifies the location for delivering benefits
- “Why?” – explains the rational for providing the stakeholder benefits
- “How?” – describes the method of providing offerings
- “How much” – states the costs and price that customers pay.

Onetti and Verma (2009) illustrate strategy as the central hub of the wheel and business model as the spokes connected to that hub. Onetti and Verma (2009) explain that strategy defines the firm’s goals while business model describes key policies such

as marketing, sales and product policies, with which the company aims to achieve those goals. These key policies need to be interconnected with each other and must reflect the strategy, which is represented by rim of the wheel (Onetti & Verma, 2009).

In practice, the consumers are unlikely to pay for an OSS; however, software companies can generate revenues from complementary products and related services (Haruvy, Sethi and Zhou, 2008). Raymond (2000) analysed economics of OSS development and presents various business models based on use-value funding and indirect sale-value. These models are summarised in the Table 2 below:

Business Model	Example Case	Description and Benefits
Use-Value Models		
Cost-sharing	Apache Server	Competing users find the product so useful that they are willing to share the cost.
Risk spreading	Cisco	The firms may face risks when original software developers leave the firm. OSS reduces this risk as the product gets supported by large of community members.
Indirect Sale-Value models		

<p>Loss-Leader/Market Positioner</p>	<p>Nescape Communications</p>	<p>The company uses OSS as a public relations campaign. This helps in creating or maintaining market position for company's other proprietary software which generates direct revenue for the firm.</p>
<p>Widget-frosting</p>	<p>Apple Computer's decision to open-source Darwin</p>	<p>This allows hardware firms to open-source drivers and configuration tools for free. This improves customer confidence. In this case, they lose nothing as there is no direct revenue stream from drivers</p>
<p>Give away recipe, open a restaurant</p>	<p>Cygnus Solutions, Red Hat, e-smith</p>	<p>Create a market position for services by giving away software products for free. Company retains core resources (head cooks) and thus uniquely placed to serve the market. As more users use the software, the potential market expands and company benefits.</p>

<p>Accessorising</p>	<p>O'Reilly & Associates Inc.</p>	<p>Support a very reputed OSS product and use that as a brand for selling accessories such as mugs and t-shirts.</p>
<p>Free the future, sell the present.</p>	<p>Aladdin Enterprises</p>	<p>In this case, proprietary software is released under a commercial license that includes closure provision with expiration date. Thus, the software is opened up in future lowering the future maintenance cost substantially. Customer also benefits from extended lifecycle of the product.</p>
<p>Free the software, sell the brand</p>	<p>Sun Microsystems (Star Office/ Open Office)</p>	<p>The software is released as open source while retaining a test suit or compatibility criteria. The company then sells the brand to the customers by certifying that their implementation of the technology is compatible with company's other products.</p>

Free the software, sell the content	Speculative business model that companies such as AOL can adopt	The client and server code is open source, but the value is in providing reliable content. The market for content expands as OSS community ports the software to more platforms.
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Table 2 - Open Source Business Models (Source: Raymond, 2000)

Bonaccorsi, Giannangeli and Rossi (2006) analysed the strategies of 146 Italian OSS companies and found that most firms adopted hybrid business model that combines offering proprietary software and OSS under different licensing schemes. Their research also found that hybrid model is not a transient state, but a permanent feature of the industry (Bonaccorsi, Giannangeli and Rossi, 2006). Raymond (2000) also hints at some forms of hybrid models that combine proprietary software and the OSS. The “Loss leader/market positioner” is a kind of hybrid model because the company still requires selling some proprietary software. But, some of these models are hypothetical and very hard to find in practice. For instance, “free the future, sale the present” business model involves making a closed source software more marketable by promising to open it in future. This model may only work for closed source companies facing declining market position; but it may not be suitable for a start-up firm that still requires establishing its position in the market. Similarly, “freeing the software and selling the brand” is only applicable to those companies, which already have an established brand and customers find some value in their certifications.

2.10 Open Source Licenses

Open Source Initiative (2010b) supports a number of Open Source licenses each with varying terms and conditions. Although the code released under Open Source license is open to everyone, the license may restrict users from integrating or using a proprietary component with OSS. Gomulkiewicz (2009) suggests that proliferation of FLOSS licenses is useful in some cases; but can cause confusion among hackers and end users. Bayersdorfer (2007) insists on the importance of tracing and examining the license of each OSS component used in a software project. Walsh and Tibbetts (2010) discuss various OSS license violation cases and warn that firms that use OSS need to assess their risks from IP right violations.

Jaokar and Gatti (2009) describe “copyleft” and “non-copyleft” OSS licenses based on the terms related to the derived work. Any modifications to the OSS released under “copyleft” license must be released back to the community under identical terms. In contrast, non-copyleft licenses such as Apache and BSD licenses do not impose such restrictions. Lerner and Tirole (2005) classify Open Source licenses into “restrictive”, “highly restrictive” and “not restrictive” categories. Lerner and Tirole (2005) explain that highly restrictive license do not allow modification that involve combining the software with any other software that does not employ such a license. Lerner and Turner (2005) observe that projects that targeted end-users tend to have restrictive licenses while those that targeted developers were likely to be less restrictive.

Onetti and Verma (2009) point out that license terms often put major constraints on the business model. However, their research also shows that organisations normally

revise their policies and select a different license or modify existing license if necessary. Thus, the business model and the Open Source license evolve in a two-step disjointed process over a period of time. (Onetti & Verma, 2009).

Onetti and Verma (2009) describe following three major business models based on the license type:

- **Reciprocal** – In this case, company offers OSS under copyleft license and earns revenues from professional services such as maintenance and training. The company needs to allocate resources for development of OSS and bear some of the engineering and R&D expenses. (Onetti & Verma, 2009).
- **Academic** – In this case, company offers core software under non-copyleft license and earns revenues from proprietary extensions of the software. This is also referred as “Open Core” because only the core product is Open Source. (Onetti & Verma, 2009).
- **Dual Licensing** – In this case, company develops and offers software under both Open Source and commercial licenses. The customers can either use the OSS available under copyleft license, which requires any derivative work to be released to the public using identical terms. Alternatively, customers can buy commercial license that frees them from the obligation of releasing any derivative work. (Onetti & Verma, 2009).

The main difference between “Open Core” and “Dual Licensing” business models is in the commercial extensions of the software. In the former case, the company sells

commercial extensions of the OSS, while in the later case; the company offers the same software under commercial license to some enterprises. However, very often companies such as SugarCRM use a copyleft license for core OSS and commercial editions includes extended functionality useful for enterprises (SugarCRM, 2010). Considering these subtle differences, the term “hybrid” business model is used in this paper to refer to both “Open Core” and “Dual licensing” business models.

2.11 Concluding Remarks

For an OSS company to succeed in business, it is important to identify critical success factors and risks from three perspectives: the economic viability of the business model, differentiation with competitors and ability to generate sustainable competitive advantage over rivals. So, literature on OSS was reviewed to cover various aspects of the business.

Previous studies have underlined several benefits of OSS from various perspectives. The users of OSS usually benefit from significantly lower costs, better quality and extended lifecycle of the product as the software is maintained by the community. The company that makes primary contributions and controls the OSS project benefits from significantly lower development and maintenance costs, quicker time to market, better quality and access to innovation from external resources (Morgan & Finnegan, 2007).

The literature supports the importance of community involvement for the success of an OSS project. Despite larger community involvement on complex projects such as Linux, most of the contributions still come from top few developers (Moon & Sproull,

2000; Krishnamurthy, 2002). The research also shows that motivation of such developers is primarily related to non-monitory rewards such as reputation and fun and enjoyment of programming (Shah, 2006). The case studies of Linux points out that an effective leadership is necessary for the success of OSS projects (Raymond, 1998b; Moon & Sproull, 2000).

Other studies have focussed on resource allocations, strategies and business models used by OSS companies. The risks in the business increase as the company's commitment for the resource allocation increases (Grand et al., 2004). The business models used by OSS firms can be grouped on the basis of their sources of revenues (Raymond, 2000) and the license types (Onetti & Verma, 2009) used. In general, there are three major types of business models: reciprocal, academic (or Open Core) and dual licensing (Onetti & Verma, 2009).

Chapter 3. Research Methodology

3.1 Introduction

This chapter discusses the research methodology and specific methods used for this research. The chapter also describes the theoretical model used for this research and data collection methods used for verifying the theoretical model and studying various strategies used by OSS companies.

3.2 Overview of Research Design

The research involved four phases as depicted in Figure 1. Initially, an explorative pilot study was conducted to gain more knowledge about OSS projects. This involved researching various OSS projects on Sourceforge.net, gathering relevant information from media reports and informal discussions with few OSS developers. Literature review was also conducted in order to study previous research on OSS firms.

Based on this, a theoretical model was developed in order to focus the research on specific research questions. The research was based on the analysis of two interviews, two case studies and surveys used for testing the hypotheses. The triangulation of various methods allowed deeper understanding of the business models and the strategies used by OSS companies.

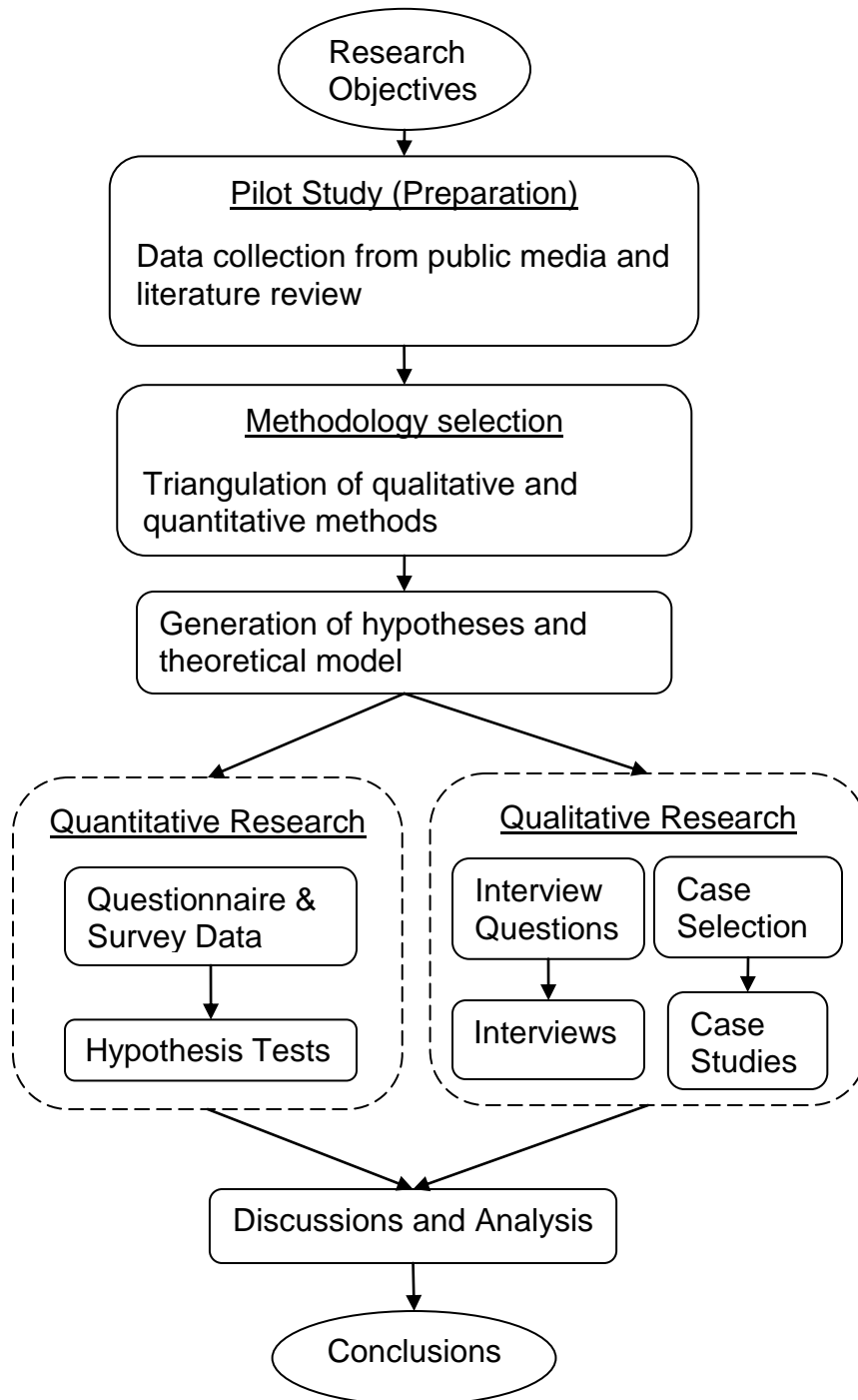


Figure 1 - Research Design (Adapted from White, 2000:27)

3.3 Theoretical Model

This was based on the initial exploratory study conducted during the pilot study. Exploratory study allows getting acquainted with the data (Andrienko and Andrienko, 2006:2). An exploratory data analysis allows “detection and identification of patterns, trends and relationships in the data” (Turkey, 1977 cited in Andrienko and Andrienko, 2006:3). Andrienko and Andrienko (2006:3) explain that exploratory data analysis is used for “hypothesis generation rather than hypothesis testing”.

Andrienko and Andrienko (2006: 461-462) describe ten principles of exploratory study: visualising overall view, simplifying and abstracting data, dividing and grouping, finding relations, finding visible patterns, zooming and focussing on subsets, detecting and analysing unusual characteristics, linking partial patterns, establishing structure and using the specific domain knowledge. These principles were used in generating the theoretical model as shown in Figure 2.

The theoretical model assumes that founding members and investors influence company’s business model and strategies. Further, it assumes that the risks and critical success factors are associated with the selection of business model and the execution of key strategies.

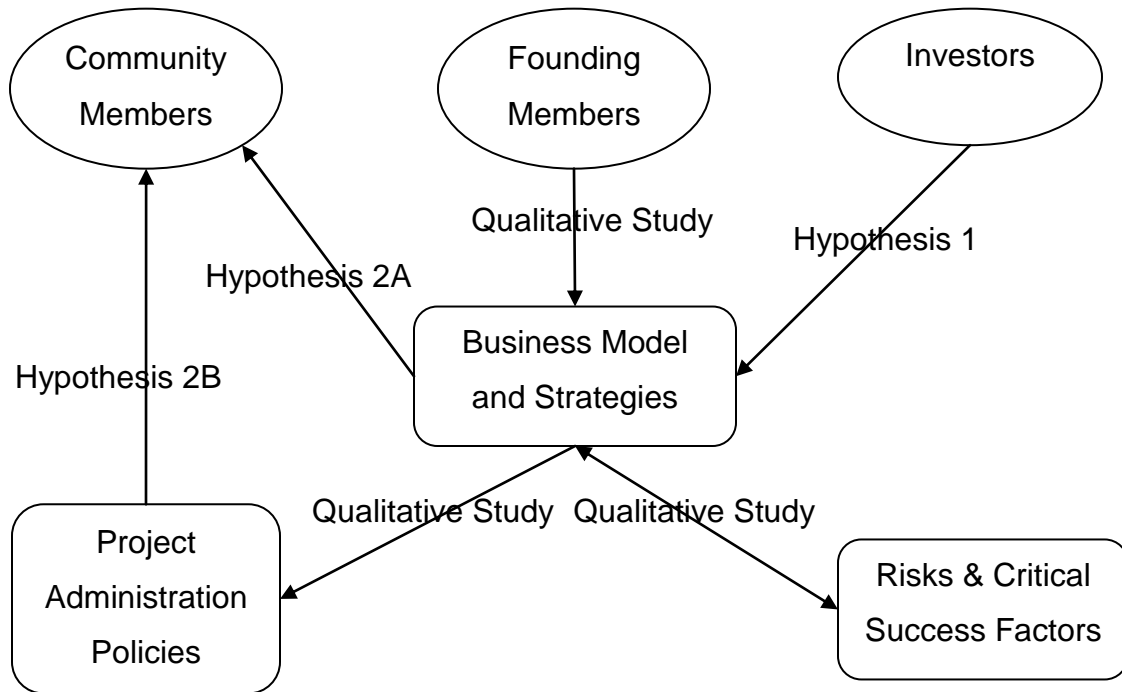


Figure 2 - Theoretical Model Used for Research

Hypothesis 1

Privately owned companies normally have limited resources and their initial focus is on meeting short-term cash flow of the company. So, such companies may not have enough resources for software development and marketing of the commercial edition of the software. Instead, they may want to reduce development costs and generate revenues by providing various services to the customers. On the contrary, a well funded, equity financed company requires a “hockey stick” like growth and generate higher returns for its investors (Janke, 2010a). So, such company may want to generate more profit by selling commercial edition of the software and use some aggressive

strategies that lock the customers. This will naturally lead them to adopt hybrid business model. So, the first hypothesis is:

“Well funded (venture financed or similarly funded) OSS companies are likely to adopt hybrid business model”.

The corollary of this hypothesis is:

“Privately owned companies with limited resources are likely to adopt reciprocal business model”.

Hypothesis 2A

When a company selects hybrid business model, it needs to include some value-added components to the commercial edition in order to justify license fees from the customers. Naturally, some important features are excluded from the core OSS product (Phipps, 2010). This is likely to annoy community members and they may stop making contributions to the OSS project and some unhappy members may fork the OSS project (Janke, 2010b). So, the hypothesis 2A is:

“Community contributions reduce when company adopts hybrid business model”.

Hypothesis 2B

When community members stop contributing to the OSS project, the company that controls the project requires more resources on developing, testing and fixing bugs in the software. As a result, the company will lose cost advantage and other benefits associated with OSS. So, the company may take a cautious and sensible approach and

try to avoid conflicts with community members by implementing fair administrative policies on the OSS project. Further, hypothesis 2B is proposed as follows:

“Fair and consistent administrative policies will have positive impact on the contributions from community members”.

3.4 Data Collection and Validation

3.4.1 Survey of OSS Business Models

A survey of 24 OSS companies was carried out to investigate their funding, business model and key strategies. The information was obtained from various reliable sources such as their websites, press reports and in some cases directly from the company sources. The survey data as summarised in [Appendix III](#) was used for testing the hypotheses and studying the respective company’s business strategies.

It was not possible to select OSS companies randomly as the availability of relevant information was the main constraint. The data might not be completely unbiased due to smaller sample size. Considering these limitations, the companies were carefully selected that met following criteria:

- The company’s objective is to generate profit for its owners. This filtered out OSS projects funded by charitable foundations or run by small number of individuals.
- The company contributed to one or more OSS projects. This filtered out those firms that merely use OSS, but do not contribute to the project. However, small companies that make minor contributions to OSS projects were considered.

The distribution of selected companies is as shown in the Table 3 and the charts given below:

Firm Level	Business Model		Funding	
	Reciprocal	Hybrid	Limited Private Fund	Venture/Stock
Level 1	7	0	7	0
Level 2	1	2	0	3
Level 3	4	5	3	6
Level 4	2	3	1	4
Total	24		24	

Table 3 - Surveyed OSS Companies

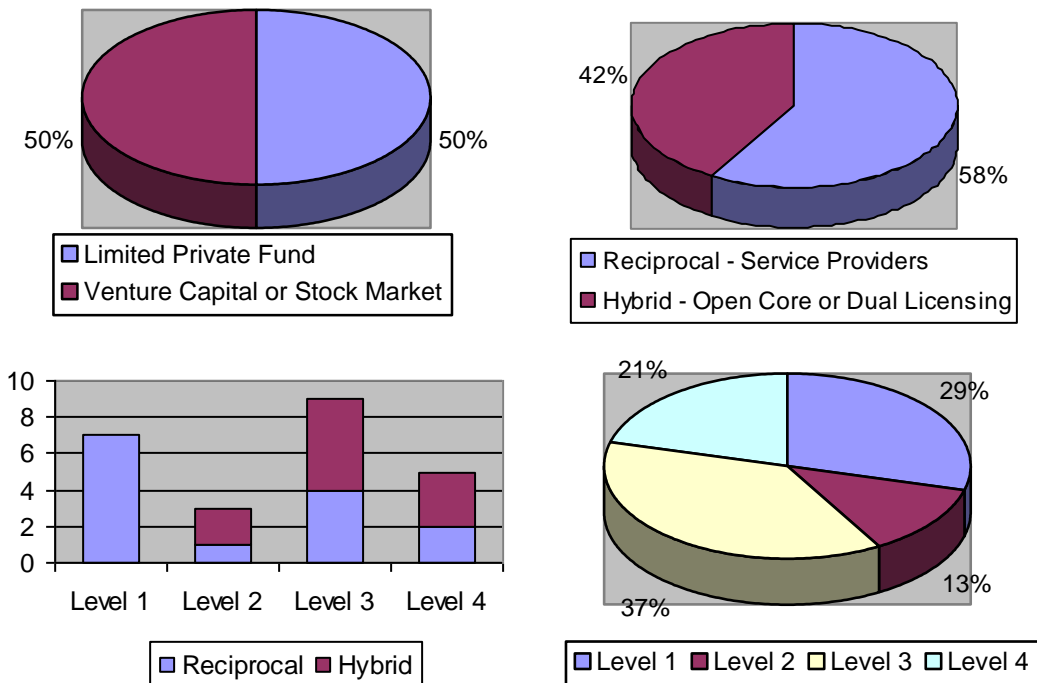


Chart 1 - Distribution of Surveyed OSS Firms

3.4.2 Survey of Forum Activities

Another survey of forum activities was carried out on two projects (Compiere ERP and Pentaho BI suite) in order to investigate the impact of hybrid business models and administrative policies on community contributions. The community contribution was measured in terms of number of forum messages before and after the selection of hybrid business model. A similar method was used in the literature for measuring community contributions (Ghosh & Prakash, 2000; Moon & Sproull, 2000; Krishnamurthy, 2002). The data surveyed from community forums is summarised in [Appendix IV](#).

3.4.3 Survey of Community Contributions and Governance Policies

The project governance policies and community contributions in few OSS projects were observed in order to test hypothesis 2B. The information was mainly obtained from public forums and is considered quite reliable due to detailed log of messages. The data is summarised in [Appendix VI](#).

3.4.4 Case Studies

The main purpose of case studies was to discuss critical factors and understand risks associated with OSS companies. The following two case studies were analysed:

- **Canonical** - This is an example of a company that uses reciprocal business model. The company develops Ubuntu operating system for desktops and servers, which is freely available as OSS.
- **Compiere** – The company develops an Open Source ERP software. This is the case of a company that originally used reciprocal business model; but later adopted hybrid business model after receiving funds from a venture capital firm. The company was recently acquired by Consona Corporation, which has its own proprietary ERP software.

3.4.5 Interviews

Telephonic interviews with two senior executives of OSS companies were conducted. The first interview was with the CTO of Saturn Systems, India. The company makes minor contributions to few OSS projects and provides related services

to its customers. The second interview was with the CEO of Foradian Technologies, India. The company develops Fedena, Open Source educational ERP software. The company has allocated dedicated resources for development of this project and uses reciprocal business model for generating revenues.

Both interviews focussed on understanding the respective company's strategies and their objectives in supporting OSS projects. The interview questions, responses and brief comments are summarised in [Appendix VII](#) and [Appendix VIII](#).

3.4.6 Survey of Market Position of OSS Products

A brief survey of market position of OSS products in few product categories was conducted to understand the effectiveness of OSS strategies. This is summarised in [Appendix V](#).

3.5 Research Methods

The aim of this research was to test and study various associations identified in the theoretical model.

3.5.1 Hypothesis 1

To test the first hypothesis, survey data from 24 OSS companies was used. The business models were broadly categorised into reciprocal or hybrid business model depending on whether the company offered a commercial version of the product for a premium. To test this hypothesis, Pearson Chi-Square and Fisher's exact test were used. The detailed calculations are included in [Appendix IX](#).

3.5.2 Hypothesis 2A and 2B

To test these hypotheses, the community contributions in the forum messages were statistically and analytically analysed for the two projects. Further, the administrative policies were examined for various companies from the survey. This involved both, qualitative and quantitative analysis to verify the impact of administrative policies on the community contributions.

3.5.3 Case Studies and Interviews

The main objective of the case studies was to study various critical factors and risks associated with the business models. For this, the two cases were carefully chosen so that various issues regarding commercial aspects of the business, leadership and the role of OSS communities could be discussed in detail. Similarly, the interview questions were designed to investigate various issues faced by the respective companies and their business strategies.

3.6 Concluding Remarks

This research was designed using triangulation of qualitative and quantitative methodologies in order to investigate various viewpoints and study critical success factors in running OSS companies. These results were then analysed to verify the theoretical model and to understand the bigger picture regarding business models and strategies used by OSS companies. The sample data was not purely random; but the use of several research methods helped in reducing errors to some extent.

Chapter 4. Research Findings

4.1 Introduction

This chapter presents the data used for the qualitative research and the results of the primary research. First, the hypotheses were tested using various statistical methods to understand the relationship between investors, the selection of business model and community members. Next, the case studies of Canonical and Compiere were discussed to highlight some major challenges faced by those companies and their business strategies. Finally, the two interviews were discussed to highlight specific issues faced by small, privately held OSS companies.

4.2 Quantitative Research

4.2.1 Results of Hypothesis 1

This involved statistically analysing mutually exclusive categorical data regarding the company's funding source and the business model adopted by the firm. The data collected from 24 companies is summarised in the Table 4 given below.

		Hybrid Business Model?		
		No (Reciprocal)	Yes (Hybrid)	Total
A well funded (Venture capital or Stock listed) company?	Yes	3	9	12
	No	11	1	12
	Total	14	10	24

Table 4 - Data Used for testing hypothesis 1

From visual inspection of this table, it is very clear that most of the data is concentrated along the diagonal (YES-YES and NO-NO). This suggests a possible relationship between the two variables. To verify the first hypothesis, Chi-Square Test and Fisher's Exact Test were used. This involved calculating the probability of null hypothesis. A brief description about these statistical tests and calculations are summarised in [Appendix IX](#).

A null hypothesis assumes that by default no such relationship exists and the observed data was obtained by pure chance. If no relationship exists, the probability of each cell is expected to have proportionally equal probability. So, the probability of obtaining the same observations by pure chance is calculated and if it is found to be smaller than the significance criteria then the null hypothesis is rejected and the original hypothesis is accepted. In this case, the significance criteria of 0.005 (0.5%) was selected. The calculated probabilities are summarised in the Table 5 given below:

Phi Coefficient	+0.676	This indicates a positive relationship between the two variables.
Pearson Chi-Square Probability	0.000926	Smaller than the significance criteria of 0.005. As the estimations of probability are relatively very small, the null hypothesis can be safely rejected.
Chi-Square Yates Probability	0.003752	
Fisher Exact Probability Test (one tail)	0.001380	
Fisher Exact Probability Test (two tail)	0.002760	

Table 5 - Statistical Test Results for Hypothesis 1

The statistical tests strongly suggest a positive relationship between the selection of hybrid business model and venture finance (or similar funding) available to the company. Thus, a firm having limited financial resources is more likely to adopt service-oriented reciprocal business model and most venture funded companies tend to use hybrid business model.

However, the statistical tests do not prove the existence of causal relationship between the two variables. It does not suggest that venture investors directly influence the management for adoption of hybrid business model. It is quite possible that most companies with reciprocal business model may not be actively seeking venture or equivalent funding due to smaller investment requirements.

4.2.2 Results of Hypothesis 2A

No clear evidence was found regarding the impact of hybrid business model on community contributions. In case of Compiere ERP project, the community contributions reduced significantly after the company chose hybrid business model. But, the community contributions continued to increase in case of Pentaho BI project.

Due to smaller sample size, it was not possible to draw any conclusions from this. But, these results suggest that the community contributions are affected by overall handling of the project rather than just change in the business model.

	Compiere ERP	Pentaho BI
Average Messages/Month (Overall)	131.72	101.72
Average Messages/Month prior to the selection of hybrid business model (12 month period)	180.5	44.27
Average Messages/Month after the adoption of hybrid business model (12 month period)	84.75	167.08

Table 6 - Average Community Contributions

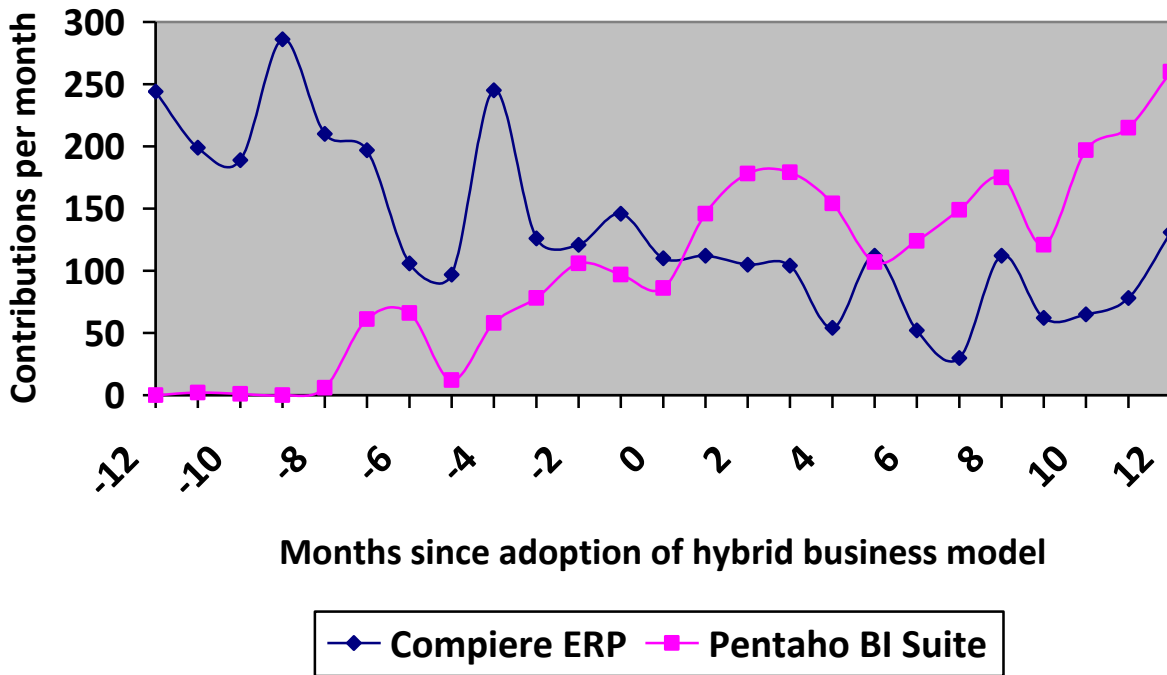
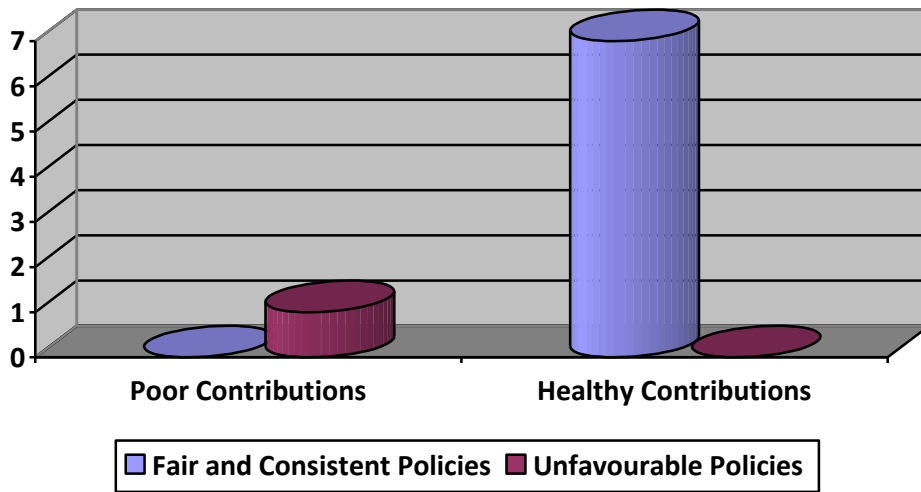


Chart 2 - Effect of hybrid business model on the community contributions

4.2.3 Results of Hypothesis 2B

To test this hypothesis, eight commercial OSS projects were examined regarding community contributions. Due to smaller sample size, statistical tests based on probability distribution were not possible. But, the results overwhelmingly suggest that OSS companies not only use fair and consistent administrative policies but also manage relationship with community members very holistically. Some firms go to the extent of providing free training and mentoring to the new community members. In the observed set of OSS projects, only Compiere ERP suffered negative publicity and received poor community contributions, while other projects received significant community contributions. Thus, a partial evidence to support this hypothesis was found.



4.2.4 Model Based on Statistical Tests

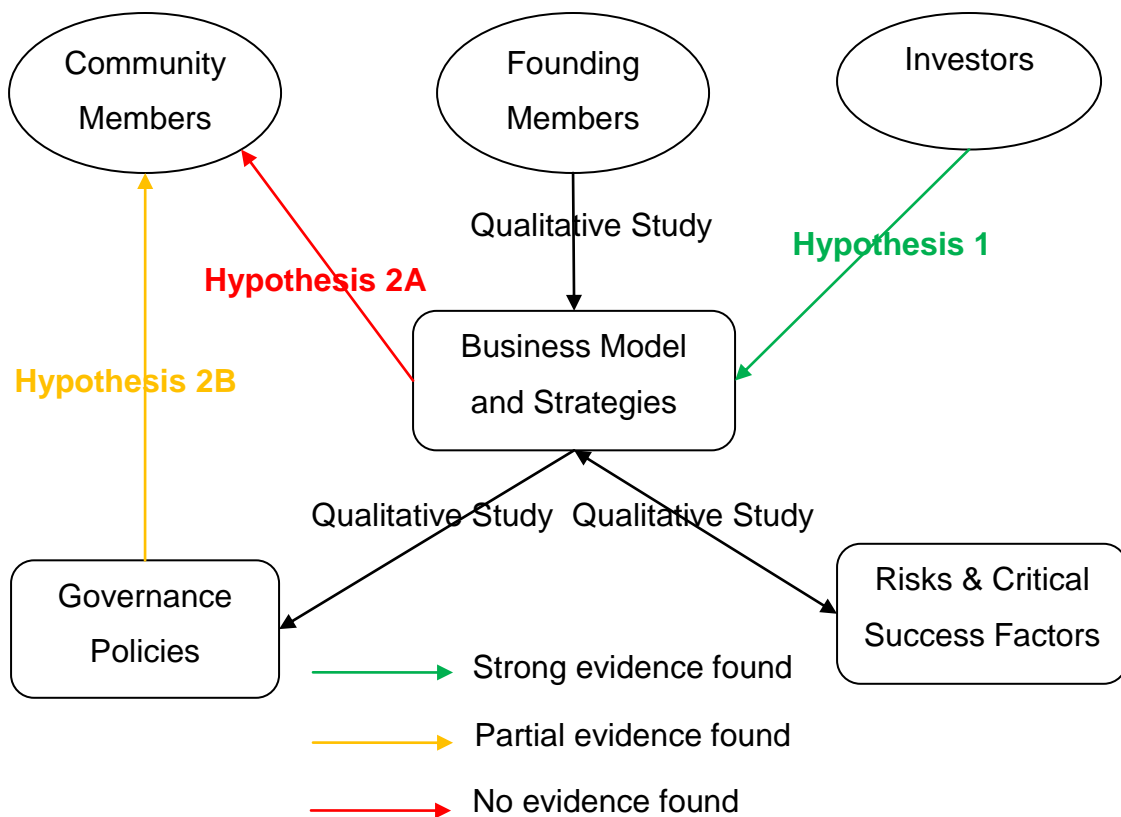


Figure 3 – Model Based on Statistical Tests

The results of the research are summarised in Figure 3. Various statistical tests showed stronger evidence for hypothesis 1; while there was no clear evidence found for hypothesis 2A. In case of hypothesis 2B, a smaller sample size was used. So, the statistical tests such as Perason’s Chi-Square test were not suitable. But, the sampled data partially confirms the hypothesis.

4.2.5 Observed Patterns from Survey

The researched data was further inspected for any observable patterns to understand the trends and some important observations were made. One in four venture funded OSS company continued reciprocal business model, while only one in twelve (only 8.33% in the observed set) privately funded OSS companies having limited financial resources adopted hybrid business model. Unsurprisingly, all level one firms were found to be privately funded.

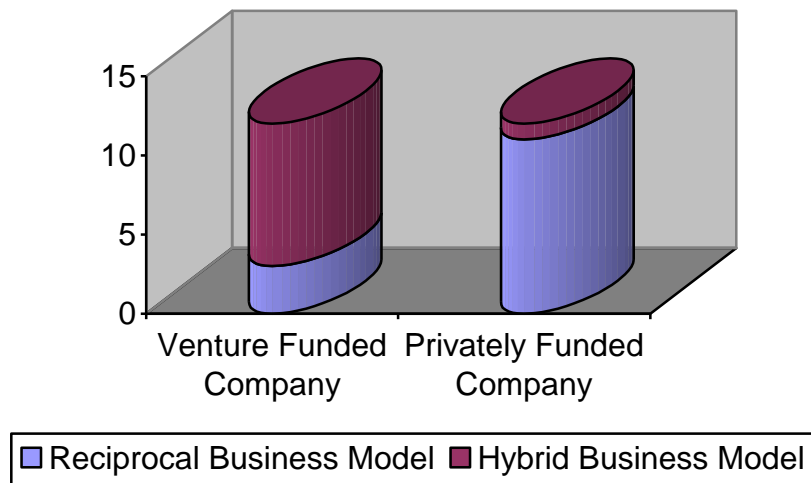


Chart 3 - Distribution of Open Source companies by funding options

The results suggests that some venture funded OSS companies continue with reciprocal business model despite having aggressive growth targets and most privately owned OSS companies having limited financial resources adopt reciprocal business model by default.

4.3 Canonical – Case Study of Reciprocal Business Model

4.3.1 Brief History and Background

Mark Shuttleworth, a South-African entrepreneur, started Ubuntu project and founded Canonical Limited in 2004 with an initial investment of \$10 million. Prior to this, he had successfully founded a security firm, Thwate Consulting and sold it to Verisign for \$575 million. (Shuttleworth, n.d.; Shankland, 2005).

Canonical sponsors and leads several OSS projects including Ubuntu project. Ubuntu is an interactive operating system based on the architecture of Debian operating system (Ubuntu, 2010b). The company also sponsors other OSS communities such as The Linux Foundation, GNOME foundation and KDE Community (Canonical, 2010b). Despite being privately funded, the company has enough financial resources for supporting and marketing its products and services. The company presently has over 350 employees in 30 countries (Canonical, 2010a) and allows them to work from their homes using Internet connections (Canonical, 2010c).

4.3.2 Vision

Mark Shttleworth's vision about the company is "to create software platforms that compete with the best, but are free to use, share and develop" (Canonical, 2010a). The

vision outlines the company's commitments for OSS principles. Unlike many other companies, it does not offer premium version based on OSS. To emphasise his message, Mark Shuttleworth announced, "Microsoft's dominance in the desktop market as the number one bug in the industry" (Shuttleworth, 2004).

4.3.3 Community Involvement and Governance

Keeping its promise and consistent with the company's vision, the software is completely open source and available for free. For this, the company seeks contributions from community members for software development, documentation, artwork, testing and reporting of bugs and supporting the software. It provides necessary platform for collaborative development of Ubuntu and other OSS projects sponsored by the company. The company also regularly arranges seminal developer summits to motivate community members and offers scholarships to the best OSS programmers. The company also promotes local community teams, called LoCo teams that work closely with Linux user groups, schools, municipalities and national governments for educating them about OSS.

The governance structures of the OSS project remain independent of the company and have its own community council, technical board and code of conduct. Being a major sponsor of the OSS project, Mark Shuttleworth is the "self-appointed benevolent dictator for life (SABDL)", which means he has been given the powers to make decisions on difficult issues when there are several right opinions (Ubuntu, 2010c). He also has the right to set priorities and ask company's employees to work on specific projects or issues (Ubuntu, 2010c).

4.3.4 Product/Service Offerings

Canonical offers Ubuntu and other OSS products for free, which can be easily downloaded from the company's website and earns revenues from various professional services. The company offers three types of services:

- **Enterprise services** – that include training, consultancy, system management and support, legal assurance and direct access to the experts.
- **Engineering Services** - that include OEM services for other hardware and software vendors. The company certifies their systems and provide customised development for their platforms.
- **Consumer Services** – that include training and desktop support for Ubuntu users. The company allows users to access its cloud network for synchronising personal digital contents such as contacts, documents and bookmarks.

The company has developed a partnership programme for technological collaboration with hardware and software vendors, solution providers and consultants. The partnership levels are categorised as bronze, silver and gold depending on their level of commitment. In addition, Ubuntu marketplace is available for small businesses.

4.3.5 Strengths and Weaknesses

The company's main strengths include:

- **Ubuntu project enjoys significant community contributions** – This helps in quickly fixing security holes and improving the overall quality of the software while saving significantly on the software development costs.
- **The technical competencies that it retains** – Being a major contributor and controller of the Ubuntu project, the company is best placed to offer professional services to customers according to their needs.
- **Well packaged and easy-to-use interface** – The operating system has captured attention and become popular among Linux users. Larger the user base, larger the potential market for the company to offer services.
- **The collaborative network** – The collaborative network extends to several global partners and community groups. This allows the software to run on various hardware platforms and support several languages.

The company's main weaknesses are

- **Reciprocal business model** – Although company is well placed to provide professional services, it does not generate profit by selling software licenses. This can limit the short-term profitability of the company. Ironically, this is also the strength of the company as it encourages community contributions.
- **Risk of a forked project** – This is a common risk for any OSS project. When some community members feel unsatisfied, they may fork the project and

cannibalise the market. For instance, Ubuntu project itself is a fork of another OSS project, the Debian operating system.

4.3.6 Market Position and Competition

The Ubuntu project gained significant popularity among Linux users since its first release in 2004. An estimate based on the visitor logs on Wikimedia site shows that Ubuntu Linux accounted for nearly 0.69% of the total requests and among Linux based computers, this accounted for over 36% of the requests (Wikimedia, 2010). Ubuntu's popularity among Linux based computers is partly due to its user friendly design.

Overall Linux market share in desktop computers stands close to 1-2 % (Wikimedia, 2010; Netmarketshare, 2010). So, Ubuntu is still far away from gaining enough market share and Microsoft's Windows operating system still continues to dominate the desktop market (Wikimedia, 2010; Netmarketshare, 2010). Clearly, Microsoft is the company's biggest competitor. The company also competes against other Linux variants such as SUSE and Fedora and in fact, the rise of Ubuntu has not actually resulted in overall higher market share for Linux based systems.

Being a main contributor to the Ubuntu project, the company is well placed to offer consultancy and other services to the customers. The company's core engineering services and partnership programme allows it to offer custom solutions on wide range of hardware platforms.

4.3.7 Key Strategies

The company's main strategy is to make Ubuntu operating system more popular and gain from the increased market share. Mark Shuttleworth's personal fame may also have helped the company to build its brand image. The company seeks to build better public relations with community members and popularise its brand using following principles and associated actions.

- **Attacking the main competitor, Microsoft** – At the beginning of the Ubuntu project, Mark Shuttleworth announced Microsoft's dominance as the number one bug. The appeal has helped in getting wider publicity of company's projects among OSS communities. (Shuttleworth, 2004; Shuttleworth 2006).
- **Keeping its promise** – Canonical unambiguously promises to deliver completely free software based on Open Source (Ubuntu, 2010a). The promise has helped in creating confidence among community members and differentiating with other Linux vendors.
- **Promoting community activities** - It sponsors and arranges various community events such as developer summits where OSS developers can share their ideas. The company also sponsors scholarships to best programmers to motivate them.
- **Popularising brand** - The Canonical store sells accessories such as T-shirts and mugs in order to popularise and build brand loyalty.

The company realises that Microsoft's dominance in the desktop market is partly because most computers are sold with its Windows operating system pre-installed on them. To counter this, the company has partnered with Dell Corporation to sell a range of computers with Ubuntu preinstalled on them (Ubuntu, 2010d; Kerner, 2010a).

Ubuntu software is released twice a year and its LTS (Long Term Support) version is released every two years. The LTS version is supported for three years on desktops and five years on servers (Ubuntu Wiki, 2010). In a recent survey, the company found that commercial support and hardware certification were most important factors when buying servers and customers continued to use LTS releases even when newer versions were available (Kerner, 2010b; Carr & Barcet, 2010). Clearly, LTS releases are quite important for the company to be able to win support contracts.

The company also realises the importance of the server market as most support contracts are related to servers. Recently, it has stepped up efforts to increase its share in the server market by focussing on two major strategies – hardware certifications and cloud computing servers. Hardware certifications strategy involves working with hardware partners and certifying their hardware specific drivers and tools. This strategy ensures that Ubuntu server remains compatible with wider range of hardware platforms giving access to larger user base. Presently there are several official derivatives and localised versions of Ubuntu operating system.

The company has also collaborated with Eucalyptus Systems and integrated Eucalyptus's cloud software on Ubuntu server. In 2009, Ubuntu released version 9.04

that included Eucalyptus OSS for the first time (Foley, 2009). This allows customers to design their own cloud computing environment using Ubuntu server edition. The company also offers Ubuntu One, a public cloud service that allows users to share, store and synchronise their personal documents, music and databases. The service is aimed at supporting community activities and thereby popularising and increasing the user base.

Despite these efforts, company's success may be considered as mixed. Although it has gained popularity among Linux based computers, its overall market share remains below 1% (Wikimedia, 2010; Netmarketshare, 2010).

4.4 Case Study of Compiere – From Reciprocal to Hybrid Business Model

4.4.1 Brief History and Background

Jorg Janke began developing ERP and CRM applications in 1999 and founded Compiere in 2001 (Janke, 2010a). The source code was made available on Sourceforge, a large repository of several OSS projects. The project received excellent response from community members and in February 2004, Sourceforge (2004) selected it as the project of the month due to community activities and number of downloads each week. In March 2007, Compiere ERP surpassed 1.2 million downloads (Compiere, 2007b).

Initially, the company adopted reciprocal business model generating revenues from maintenance contracts and training. The training was considered as prepaid sales activity. The potential customers used to sign up for quarterly training and learn more

about the product. Once they became familiar with the product, it was easier to up-sell a subscription service to them. Company also built a partner network that provided customisation and localised maintenance. (Janke, 2010a).

Soon, Compiere was quite profitable generating good revenues (Janke, 2010a). This success attracted many venture capital firms and in 2006 the company raised \$6 million finance from New Enterprise Associates (Compiere, 2006). Under the new owners, management was under pressure to accelerate its growth and its previous approach was considered too slow. (Janke, 2010a).

In 2007, Don Klaiss was appointed as CEO of the company replacing Jorg Janke, who continued to serve as company's CTO for sometime (Compiere, 2007a). Klaiss followed aggressive sales driven strategies for accelerating the company's growth. In 2007, the company eventually adopted hybrid business model and started selling professional version of the product that provided better web interface to the customers. In 2009, the company reported aggressive growth in terms of revenues (Compiere, 2009a) and it had its biggest customer; La Poste a France based global postal organisation employing about 300,000 staff (Compiere, 2009b).

But, the company was widely criticised for its "open core" model as the company ignored OSS project and focussed on developing closed source versions of the software. The community members and partners who initially contributed to the project felt betrayed resulting in significant drop in the community activity (Janke, 2010a). Some community members also forked the project setting up Adempiere (Janke, 2010a).

Recently, Consona Corporation, which also has its own closed source ERP software, acquired the company for an undisclosed amount (Consona Corporation, 2010).

4.4.2 Vision

The company had different visions under the leaderships of two CEOs. Jorg Janke's vision was aligned with OSS community and he encouraged community members to make Compiere ERP a successful project. The approach helped company to grow steadily and become profitable using reciprocal business model.

Under Don Klaiss's leadership, the company adopted hybrid business model and followed aggressive sales strategy by targeting larger customers and generating revenues from license fees.

4.4.3 Community Involvement and Governance

The company initially built good relationship with community members. But, once company received venture funds, company's aggressive strategies irked partners and community members (Janke, 2010a; Janke, 2010b). In 2007, the company adopted hybrid model further aggravating their annoyance and community contributions nearly stopped in recent years. A careful analysis of forum messages suggests that the company continued to ignore messages posted by community members (phpbb, 2006; Sourceforge, n.d.). Klaiss (2007) pragmatically argued that the company cannot accept every feature request from community members and spread R&D investment all over and that the company only needed to focus on those areas where the highest potential

market existed. As a result, the community contributions dropped significantly as evident from the Table 7 given below.

Year	Forum Messages
From September 2001	84
2002	2,912
2003	5,606
2004	6,833
2005	6,517
2006	5,358
2007	2,032
2008	1,017
2009	752
2010 (until August)	144

Table 7 - Compiere Fourum Activity (Source: Sourceforge, 2010)

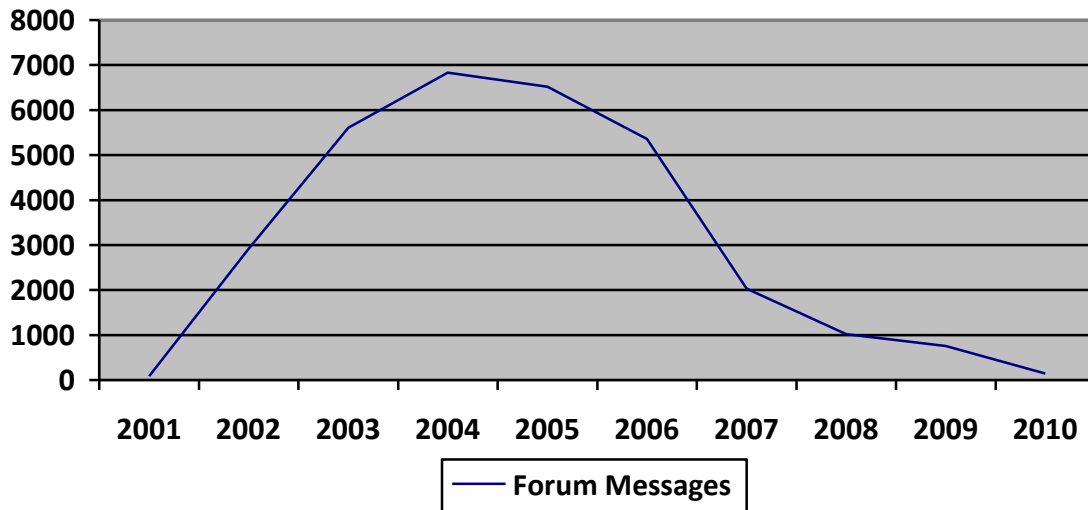


Chart 4 - Compiere Forum Activity (Source: Sourceforge, 2010)

4.4.4 Product/Service Offerings

The company initially provided a single version of OSS and offered training and maintenance contracts to the customers. However, once company adopted hybrid model, the company started offering other proprietary versions of the ERP product as given below.

- Community Edition –OSS project that provides core functionality.
- Standard Edition – The community edition with additional tools and support.
- Professional edition – Commercial license with web based user interface and additional features.
- Enterprise edition – Commercial license with enterprise class features such as management dashboard, multi-server support and cloud service.

- Cloud based solution - Compiere ERP is also available on Amazon's cloud network allowing small and medium businesses to lower their upfront costs by only paying subscription fees.

The company also offers various services such as functional and technical training, documentation and support for installation, implementation and migration.

4.4.5 Strengths and Weaknesses

The company's main strengths are as listed below:

- The product's architecture is based on platform-independent model making it easily deployable on cloud-based environments.
- The company partners with global partners who have relevant experience in the industry. The partners bring both industry specific and localised knowledge.

Despite these advantages, Compiere ERP is widely considered as a failed OSS project due to following weaknesses:

- Community contributions have dropped significantly in recent years and the company can no longer rely on community members to fix the bugs and further develop the product. So, the company has lost cost advantage and other benefits associated with OSS.
- The company has received negative publicity due to its "Open Core" business model. With nearly no OSS activity in recent years, the company is now widely considered as just another proprietary software company.

4.4.6 Market Position and Competition

The company has reported an aggressive growth in recent years. Recently Compiere won its biggest customer, La Poste, a global postal processing organisation based in France, which helped the company to enhance its profile. But, reports suggest that the company may have lost some customers in the pursuit of larger deals (Scavo, 2010) and its share in the overall ERP market still remains very low. Panorama Consulting (2010) report places Compiere ERP under Tier III vendors list, while Tier I (such as SAP and Oracle) and Tier II (such as Epicor and Sage) vendors still dominate the market share. Even among OSS vendors, the company has several competitors like Adempiere, OpenBravo and Opentaps.

Compiere and other Tier III organisations primarily serve small and medium businesses that are price sensitive. Compiere is one of few organisations that provide ERP application on cloud. This suits smaller businesses as they only need to pay subscription charges instead of expensive license fees.

4.4.7 Key Strategies

Jorg Janke initially decided to make Compiere ERP available as OSS because it was tough to market the product due to fierce competition among already established players (Janke, 2010a). This was a disruptive strategy that allowed small businesses to use ERP software at significantly lower cost. The community members responded positively and helped in popularising the product. The company benefited from low cost

and free publicity of the product. Janke (2010a) refers to inbound marketing technique used by Compiere in order to build relationships with partners and customers.

The company's product strategy was based on model driven design, an approach of defining system functionality using platform independent model. This allows greater adaptability of the product across multiple platforms and making it easily deployable in the cloud environment. Consona Corporation (2010) acknowledged Compiere ERP's superior architecture as a key determinant when acquiring the company.

The company's marketing strategy primarily focuses on its partner network. The authorised partners market the company's products and services while adding further value to the customers with services such as localised support, system integration and customisation (Compiere, 2010). Under Don Klaiss' leadership company replaced some partners and focussed on experienced ERP resellers in order to get bigger deals from corporate customers (Janke, 2010a).

Janke (2010a) reports that the company had conflicts with some partners. They used to fix bugs on their own without contributing to the main project and sell their custom versions of the software to the customers. Some partners even avoided paying fees to Compiere as per their partnership contracts. As a result, Compiere was losing revenues. When Don Klaiss took over, he fired non-performing partners and stressed on creating partnership with more experienced ERP resellers. (Janke, 2010a).

4.5 Interview with CTO of Saturn Systems

4.5.1 Brief company background

Saturn Systems is a privately owned small organisation that provides custom solutions and services such as consultancy and support services for OSS products such as Linux and MySQL. The company also develops some proprietary products such as vehicle management solution, reservation system, portal solution and online artwork approval system, which are based on OSS components. The company has made some useful contributions to OSS projects such as MySQL InnoDB and phpMyIB. The company also provides documentation for various OSS projects, which customers find very useful.

4.5.2 Interview Analysis

The company benefits from using OSS in two ways. Firstly, the company can lower its development costs and offer economic solutions to price sensitive customers. Secondly, the company benefits by building reputation with OSS communities. The company makes contributions to OSS projects considering it as social responsibility of giving it back to the Open Source communities. In return, the company benefits as community members help in resolving customer related issues through forums.

The company is not overly dependent on its OSS strategy. But, the management thinks it is quite important for the company as it benefits from lower development costs and the revenues from supporting OSS products. The company serves price sensitive customers and considering the competition, it is important for the company to provide

economic solutions. Thompson, Strickland and Gamble (2008: 143) point out that low cost provider strategy works best when the price competition among rivals is vigorous and when identical supplies are readily available from several eager sellers. But, the low cost provider strategy can only be profitable when the company achieves enough cost advantage over rivals (Thompson, Strickland & Gamble, 2008:134).

Kotler and Keller (2008:399) state that customer satisfaction relates to the difference in the expected service and the perceived service. When perceived service is below the expected level then customers feel dissatisfied. Reliability, responsiveness and assurance in terms of ability of employees are some of the most important determinants of service quality (Kotler and Keller, 2008:400). Thus, for a service oriented company, competence of employees is very important to be able to meet or exceed customer expectations. By contributing and engaging with OSS communities, the employees gain knowledge from experts, learn new technologies and build technical competencies. This enables company to provide timely support and offer better solutions to its customers.

4.6 Interview with CEO of Foradian Technologies

4.6.1 Brief company background

Foradian Technologies is a privately owned small company that develops Internet based solutions. It was founded by some freelancers who had earlier helped each other on other projects. The company develops web based solutions for its customers and has recently opened the source code of Fedena, an ERP system designed for schools

and university campuses for managing their administrative tasks. The OSS product is offered with full functionality under Apache license, which is a non-copyleft license.

The Fedena project has received a good response from community members and some members have started translating and customising the software for their local markets. Recently, one of the contributors has applied a patch to the software for Turnkey Linux, a virtual appliance library. This allows it to be easily deployable on cloud networks.

As with many other OSS projects, most of the contributions come from small number of individuals and the company has allocated dedicated resources for the development and maintenance of the software. But, the company has received publicity and reputation due to Fedena project. The company primarily earns revenues from training, consultancy and customisation and support services offered to customers. The company also has plans to publish a user manual on using and implementing Fedena software for users and partner companies. This is expected to popularise the software and generate some revenues for the company. The company claims to be making profit from the Fedena project.

4.6.2 Interview Analysis

Although Foradian Technologies is a small firm, it has created global footprints by developing and sharing OSS project, Fedena with Open Source communities. The company has aligned its marketing strategies and internal policies to create necessary buzz about Fedena project and to make it commercially successful. The management is

fully aware of the challenges and risks ahead and have taken certain steps for avoiding possible mistakes.

This case is similar to the early days of Compiere ERP when Jorg Janke decided to open the source code for publicising the product (Janke, 2010a). Small firms are often under-resourced to market their products to the potential users. It is difficult to sell a closed source software product to potential customers when the company or brand name is relatively unknown to them. In such circumstances, opening the source code helps in marketing of the product. Janke (2010a) explains that traditionally the cost of marketing is covered by software license fees while the cost of software development is recovered from maintenance contracts. Janke (2010a) further argues that although software is given away at no cost to customers, the company gets free publicity.

Although community members may make fewer contributions, they add great value to the project. For instance, some members helped writing Fedena installation steps in Spanish and another developer added a patch for Turnkey Linux making it possible to run it in a cloud environment. The utility value of such contributions is not easily quantifiable; but, the company clearly makes substantial savings on software development costs. The company does not consider the possibility of forked project as a risk. The real risk is when community members stop supporting the software.

During the interview, it was revealed that the management had studied other OSS projects and had developed a definitive plan for resource allocation on the Fedena project. The companies that use reciprocal business model must ensure that they

provide quality services to the customers in a timely manner. Klaiss(2007) notes that software development is a very expensive process. So, optimisation of internal resources is very important to ensure a balance between OSS project and revenue generating activities.

4.7 Other Observations

4.7.1 Market Position Scenarios

The cases studies and survey revealed following three scenarios of market positions:

- **Closed Source Software dominating the market** – In this scenario, OSS companies seem to focus on features and open standards and have only managed marginal success. For instance, Microsoft's Windows operating system continues to dominate the desktop operating systems and SAP and Oracle continue to dominate the ERP market. Although, Ubuntu operating system from Canonical has gained popularity among techno-savvy Linux users, it enjoys a very small market share compared to Microsoft. So, OSS companies seem to be mainly targeting niche price sensitive customers such as government and educational institutes. The closed source companies have taken a defensive approach to protect and lock their customers.
- **OSS competing with Closed Source Software** – In this scenario, OSS such as Firefox browser enjoys wider acceptance and have gained significant market share limiting the dominance of closed source companies.

- **OSS dominating the market** –For example, Apache is clearly dominating the web server market (Netcraft, 2010). OSS companies such as Redhat are quite successful and profitable. This success is because the server technology is normally chosen by technical managers based on various considerations such as performance, scalability, security and reliability whereOSS enjoys an edge over closed source software.

4.7.2 Closed Source Competitors

It was found that closed source companies often take defensive position in response to the challenges from OSS. Some of the common strategies adopted by Closed Source companies are:

- **Counterattack** – Market leaders often use counterattacks by invading attacker’s main territory in order to defend their own position (Kotler and Keller, 2008: 347). For instance, Microsoft funded IDC report claims that total cost of ownership (TCO) of Windows servers is cheaper than Linux servers (Microsoft, 2002; IDC, 2007). However most other analysts criticised the findings for the bias and misleading calculations involved (Gross, 2003; Scavo, 2002). Later, Microsoft was reprimanded by UK watchdog, Advertising Standards Authority (ASA), for the misleading advertisement (BBC, 2004).
- **Joining the OSS Club** – For example, Nokia opened the source code of Symbian operating system as it was facing challenge from Android, another

Open Source mobile operating system (Ganapati, 2010). The strategy allows extended lifecycle of the software and retaining market position.

- **Acquiring OSS Competitor** – The strategy helps in consolidating the market position. For instance, Oracle Corporation recently acquired Sun Microsystems, which had previously acquired Oracle's competitor, MySQL (Oracle, 2009a; Oracle, 2009b). Similarly, Consona Corporation (2010), which has its own closed source ERP system, acquired Compiere recently.

4.8 Concluding Remarks

The results of the hypothesis tests indicate that investors have some influence on the business model and community contributions are affected by administrative policies and general handling of the OSS project. But, there was no evidence to suggest any link between the selection of hybrid model and community contributions. The case studies and the interviews focussed on understanding various challenges faced by OSS companies and their main strategies for competing against closed source competitors. Some additional observations regarding market positions were made in order to understand the effectiveness of those strategies.

Chapter 5. Analysis of the Results

5.1 Introduction

This chapter further discusses the observations and analyses the results of the primary research in order to visualise the larger picture regarding risks, critical success factors and strategies of OSS firms. The chapter combines the results of statistical tests

5.2 Open Source Business Model Framework

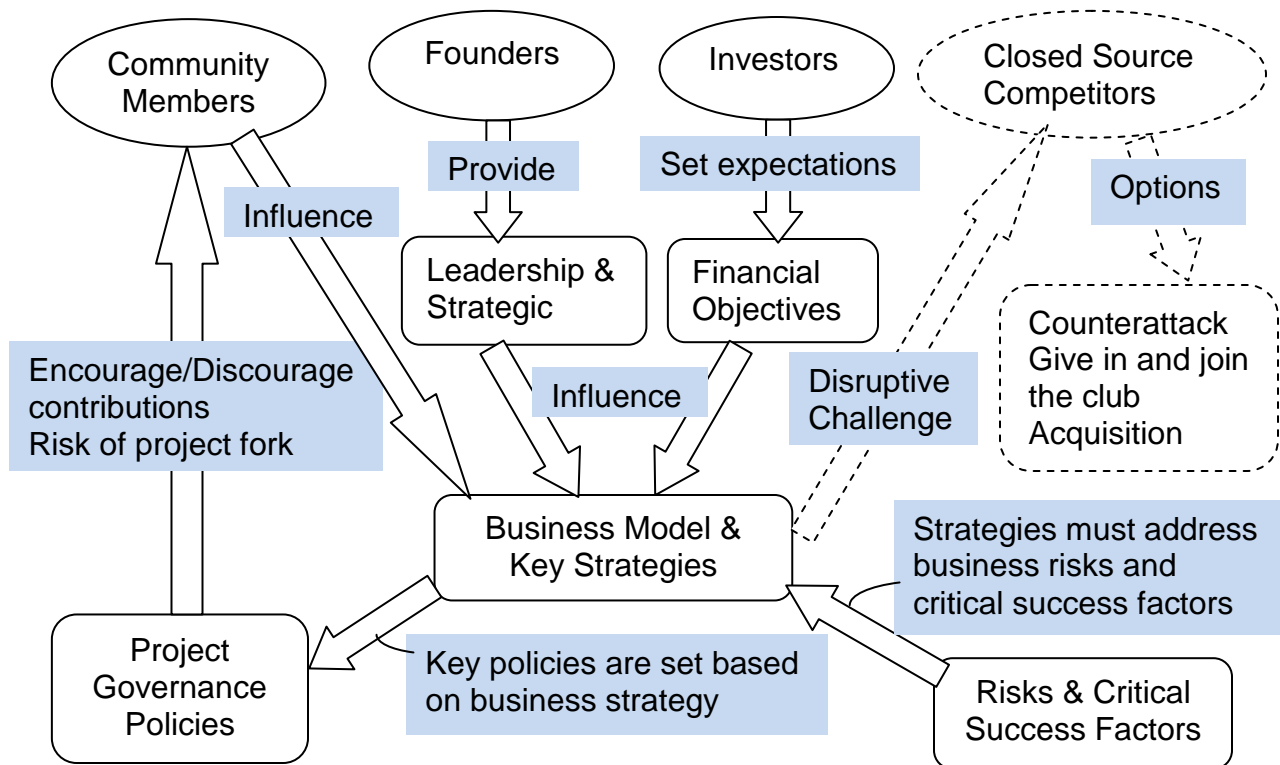


Figure 4 - Framework of OSS Business Models

The research highlighted various challenges and risks faced by OSS businesses and their strategies to counter those challenges. The framework diagram shown in Figure 4 summarises the key findings.

Business model of a company normally evolves from various factors. The research identifies three factors that influence the business model - strategic visions of the founders, financial objectives set by the investors and the community members. The strategic vision helps in making strategic choices and setting key policies. It is important to note that business model evolves over a period of time depending on company's internal situation and external pressures. For instance, Compiere changed its business model to accelerate its growth. When founding members strongly support Open Source principles (Open Source Initiative, 2010a), the company is likely to adopt reciprocal business model as in the case of Canonical. Leadership can help in establishing better relationship with community members and using innovative business model that suits the company to meet financial objectives. It is suggested that their influence and leadership can possibly cushion the company from investors' pressures.

The community members have a two-way relationship with the business model. Their activities can particularly influence the product and marketing strategies. For instance, their feature requests can shape the OSS product and when a contributor adds a new language support or a new feature to the OSS project, it creates new marketing opportunities for the company. Similarly the research shows that fair policies and honest commitments from management encourage community contributions, while aggressive strategies may adversely affect contributions from community members.

Statistical tests show that OSS firms having limited financial resources mostly follow reciprocal business model and they are likely to adopt hybrid business model on receiving venture funding. However, some companies like Canonical have continued to use reciprocal business model despite having significant investments. The case suggests that Shuttleworth's original vision of creating free software platform has clearly influenced company's business model.

Hybrid model, particularly "Open Core" model is controversial and many consider it to be against the principles of OSS communities as it inhibits software freedom for users (Phipps, 2010). The case study of Compiere shows that community members may feel betrayed when company adopts aggressive growth strategies. This involves higher risk for the business as some unhappy community members can fork the project anytime. So, OSS companies may avoid hybrid business model due to core values set by their founders and to avoid the risk of isolation.

When an OSS company adopts hybrid business model, it requires allocating more resources for development and marketing of the product. Such company also requires resources for carrying out legal work and controlling the copyright of the OSS in order to sell proprietary version of the software. On the other hand, reciprocal business model allows company to significantly reduce development costs and gain from the experience of hacker communities. So, privately funded companies having limited financial resources are likely to adopt reciprocal business model.

The case study of Compiere underlines that community members must not be ignored by OSS companies. A broken relationship may result in project forks and poor contributions from community members. In such cases, the company loses cost advantage as it requires allocating more internal resources for testing and fixing bugs found in the OSS project and for developing closed source features. However, poor contributions cannot just be attributed to business model. Evidences suggest that OSS firms can successfully build trusted relationship with community members using fair governance policies and by actively encouraging community contributions.

The community edition of the software needs to include enough basic features to make it useful for community users. For instance, SugarCRM's community edition includes necessary features such as dashboard application, web services API and cloud connectivity (SugarCRM, 2010). Capobianco (2006) explains the dilemma of a product manager in deciding which features need to go with community edition because adding an important feature in proprietary edition often annoys community members. On the other hand, if there are only minor enhancements in the commercial edition then customers may not have enough incentives for paying the license fees. Capobianco (2006) suggests that product segmentation should occur on the basis of user types rather than product features. For example, Funambol provides fully functional community edition with all features needed for community users and earns revenue from carrier edition with features only useful for mobile operators and device manufacturers (Capobianco, 2006; Funambol, 2010). Capobianco (2006) points out

that, in this case, conflict is avoided because OSS edition users do not care about the features sold to mobile operators.

The governance policies also affect the relationship with community members. The company that holds copyright of the OSS and controls the project needs to administer the community website and define an agreeable code of conduct to ensure that forum messages are used for constructive discussions. Fairer and consistent policies can create confidence among community members and encourage them to contribute to the project. Particular attention is required on prioritisation of tasks and for resolving conflicts between individual interests of community members and commercial interests of the company.

The Compiere case study reveals that companies that adopt hybrid business model may find it challenging to position its commercial products in the market. This is because potential customers are usually cautious about accepting commercial license terms that may potentially lock them to a particular supplier. Moreover, less community activity means customers become heavily reliant on the company for future services and hence they may treat such company as just another closed source company. So, it becomes critically important to balance both sides and calibrate appropriate level of features in the community edition of the software.

Janke (2010b) argues that people only contribute when they cannot monetise their work. He explains that it is difficult to sell cool features; but one can earn fame by sharing those with others. Based on his experience with Compiere, Janke (2010b)

argues that the motivation of commercial partners such as value added resellers (VAR) is limited. Janke (2010b) found that most VARs wanted to sell their own value added solutions to the market. So, they fixed bugs and modified the code without directly contributing to the main OSS project.

On the other hand, Janke (2010b) found that end users showed more interest and provided valuable contributions to the OSS project as they were interested in making sure that the features they wanted are supported in the mainstream OSS project. Similarly, small OSS firms may want to build competencies by contributing to OSS projects. Watson et al. (2008) point out that some employers actively encourage their employees to work on OSS projects. Thus, some firms use cost sharing and risk spreading models suggested by Raymond (2000).

5.3 Key Strategies

The study also highlighted various commonly used strategies used for revenue generation, marketing, creating product/service mix and encouraging community contributions. This is summarised in Figure 5.

A business model is viewed as a collection of various strategies and policies interrelated to each other (Onetti and Verma, 2009). Revenue generation is generally the main commercial driver, which can be broadly categorised as reciprocal, academic, or open core and dual licensing (Onetti & Verma, 2009). Reciprocal model is a service based approach; whereas the other two models are hybrid models which that involve selling closed source license for generating profits.

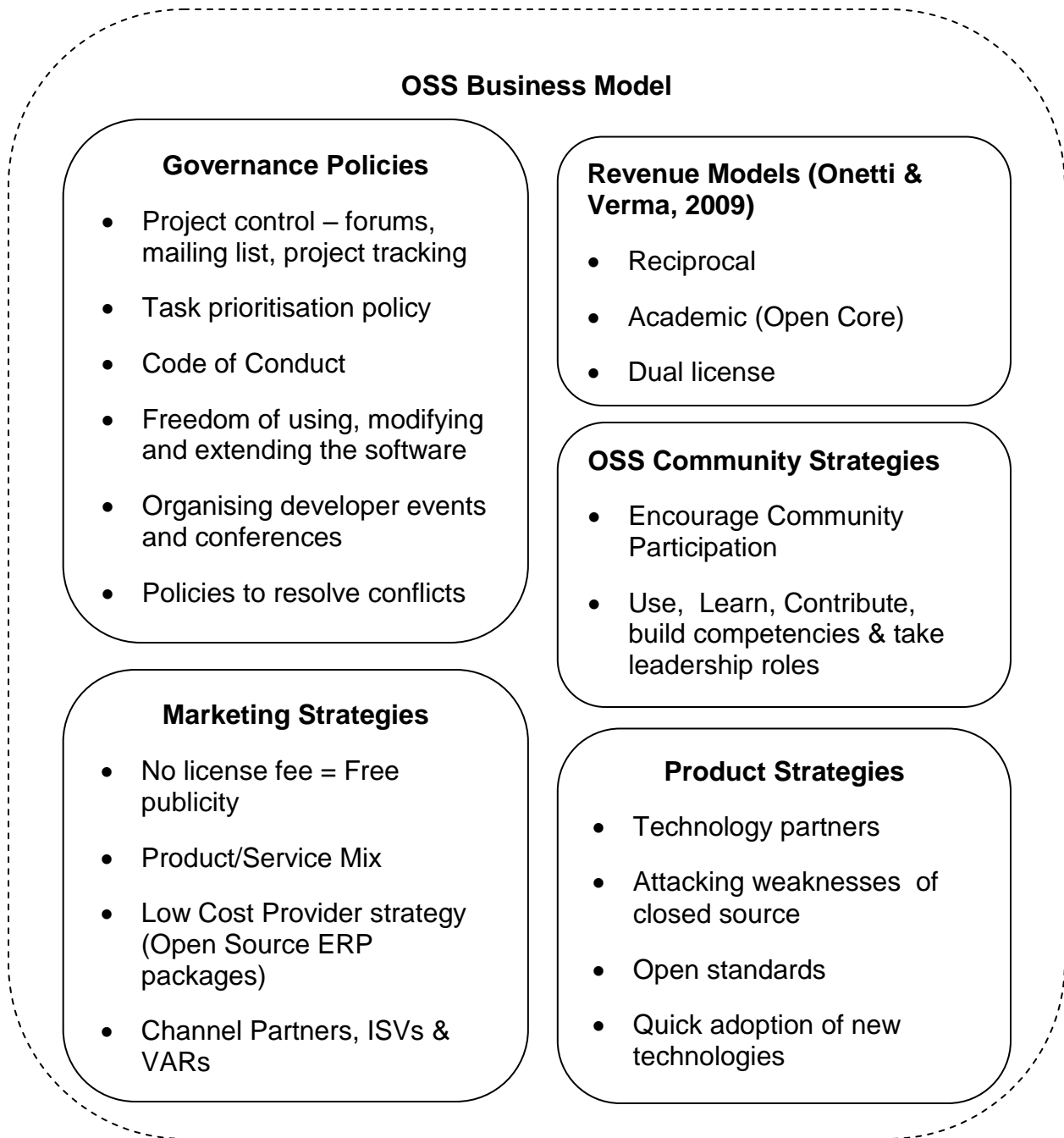


Figure 5 - OSS Key Strategies

5.3.1 OSS Community Strategies

To control the costs, OSS companies encourage community members to contribute to the community edition of the project. More community contributions means lesser internal resources required for developing, documenting, testing and maintaining the software. The reciprocal model is friendlier with community members and it involves least risk of conflicts with hacker community and requires lower cost of development. On the other hand, adoption of hybrid model need to be handled cautiously and company requires more allocation of internal resources for the development and marketing of the product.

Small OSS firms often build specific competencies by asking their employees to contribute to OSS projects. Such firms can gradually acquire new skills and build competencies through the learning process. Some firms also take leadership roles in OSS projects in order to influence the product development and gain from reputation. Such companies are better placed to offer professional services and custom solutions to corporate customers.

5.3.2 Marketing Strategies

The survey and case studies showed various marketing strategies of OSS companies as described below:

- **No License Fee = Free Publicity** – When a company offers fully functional OSS project, it gets free publicity of the product and the company's brand. More the product's usefulness and reliability, larger the potential customer base for the

company. However, customers still need to be pursued for selling support contracts, relevant services and premium editions. For instance, Compiere used this strategy initially and Foradian Technologies is using this strategy for popularising its brand.

- **Creating Appropriate Product/Service Mix** – The strategy involves carefully selecting product features according to the user types in order to serve commercial interests while keeping community members relatively happy. For instance SugarCRM (2010) and Funambol (2010) have found a balance between community and commercial editions by appropriately calibrating features in each edition.
- **Channel Partners** - Value-added resellers (VARs) and independent software vendors (ISVs) are often used as channels to reach potential customers. They provide local support and customisation services to customers. Janke (2010b) found that channel partners had very limited contributions to the Compiere ERP project and some partners even refused to share revenue as per their contract with Compiere. However, generalisation cannot be made from this case alone and channel partners are generally quite important for marketing of the product.
- **Low Cost Provider** – Many OSS firms use this strategy to serve price sensitive customers such as educational institutes and government organisations. These companies gain cost advantage over rivals by building economic solutions using OSS components such as Linux and MySQL and complementing that with

internal efficiencies achieved through various other activities such as technological partnerships and collaborations. For instance, many level one OSS firms such as Saturn Systems use this strategy.

5.3.3 Product Strategies

The study revealed following product related strategies:

- **Technology Partners** - OSS companies often partner with system integrators and hardware and software vendors. This allows the software to be run on various platforms and expand the customer base. System integrators build custom solutions specific to particular industry or specific customers using OSS components. Closer collaborations allow sharing of knowledge and reduce overall cost and time to the market.
- **Attacking Weaknesses of Rivals** – OSS companies often point out to the security vulnerabilities and unreliability of closed source software. They argue that the source code of OSS gets inspected by many peer programmers allowing quicker discovery and fixing of critical software bugs.
- **Adoption of Open Standards** - OSS companies normally adopt open standards for document formats and interfaces enabling others to quickly build useful additions that extend the functionality.
- **Release Early, Release Often** – This strategy was successfully used by Linus Torvalds in the Linux project (Raymond, 1998b). It is particularly very useful in

rapid development environment where each release may potentially have several bugs; but they are exposed to thousands of testers around the world. This helps in early detection and fixing of critical bugs and the product features are adjusted according to customer feedbacks. This significantly improves the quality of the software while saving significantly on overall product development costs.

- **Early Adoption of New and Superior Technology** – OSS companies can take advantage of innovations by quickly embracing new technologies and taking the market lead. For example, Open Source ERP vendors adopted web technologies and have started offering cloud services SAP was slower to react (Ashford, 2010). Closed source companies often require substantial investments for adoption of new technologies.

5.4 Market Position of OSS companies

Open Source strategies seem to succeed in two areas: Price sensitive markets and where technical qualities such as reliability, scalability and security are more important to the customers. For instance, London Stock Exchange replaced its expensive Microsoft's .NET based solution with Linux based solution (Vaughan-Nicholas, 2009; King, 2010) after the .NET server crashed bringing the market to standstill for several hours (Ku and Lau, 2008). On the other hand, closed source companies seem to dominate in product categories where the switching costs are significantly higher and the familiarity with the system matters to the users.

The case of Firefox is worth noting as it is a unique example of a successful client-side OSS application. Many users started using Firefox due to perceived security concerns regarding the security of their data over the Internet. For instance, the German government recently warned against using Microsoft's Internet Explorer (Emery, 2010). Slomka, Przechlewski and Wrycza (2007) studied the success of Firefox software and found perceived usefulness as the principal determinant of people's intention of using it. They found that ease of use was less significant in determining people's intention of using Firefox.

These observations are based on explorative study of few companies under certain product categories only. So, these results need to be cautiously considered. Nevertheless, the results provide an important insight about the effectiveness of OSS strategies. This explorative study reveals the pattern shown in Figure 6.

Security and reliability is important	<p>Open Source software competes with closed source software for market share.</p> <p>Example: Communication and Networking software – Vyatta Inc.</p>	<p>Open Source Software dominates the market</p> <p>Example: Linux and Apache Servers</p>
Familiarity and user friendliness is important	<p>Closed source software dominates the market</p> <p>Example: ERP packages</p>	<p>Community edition and freeware software, if available</p> <p>Example: Firefox, Open Office.</p>
	Higher switching cost, less sensitive to software price	Price Sensitive Customers

Figure 6 - Market positions of OSS products

5.5 Sustaining Competitive Advantage

To sustain the cost advantage, it is necessary that OSS project attracts substantial contributions from community members. For sustaining these advantages, following approaches were observed:

- Using Successful OSS Projects** - Many small companies such as Saturn Systems build technical competencies related to successful OSS such as Linux and MySQL. They provide custom solutions and relevant services such as maintenance and consultancy. For this, the supporting staffs need to have up-to-date knowledge about OSS. So, such companies make occasional contributions to the OSS projects in order to develop relationship with community members.

- **Encouraging Community Members** - The companies that develop and control OSS projects need to encourage community members for making contributions. This helps in improving the quality of software and reducing the overall development costs substantially. The research suggests that fair and consistent project governance policies help in sustaining community contributions. The OSS companies also need to find a balance between community activities and the commercial interests of their investors.
- **Supporting Channel Partners** – Many OSS companies rely on channel partners to market the product. They normally provide custom solutions and localised services to the customers. The OSS company provides high level of support and access to the internal resources of the company to the channel partners. The collaborative efforts help in reducing the overall cost of the solution offered to the customers.

5.6 Concluding Remarks

The research found evidences that founders, investors and community members have influence on the business model and strategies of OSS firms. The surveys, the cases studies and the interviews further revealed various risks and key strategies used by OSS firms. The results of the research were summarised in the business model framework as shown in Figure 4. Further, commonly used strategies are summarised in Figure 5. The competitive edge of OSS companies was discussed on the basis of a brief market survey to gain additional insight about the effectiveness of OSS product

strategies. The research provided partial answers to the original research questions, which are discussed in the following chapter.

Chapter 6. Conclusions and Recommendations

6.1 Introduction

This chapter discusses the implications of the research findings and suggest some recommendations for OSS companies. The chapter also highlights limitations of this research and suggests the scope of further research.

6.2 Answers to Research Questions

The research provided some partial answers to the original research questions as discussed below.

6.2.1 What are the revenue sources and the business models available to OSS companies and whether company's financial resources have an influence on its business model?

The OSS companies primarily earn revenues from various professional services such as training, consultancy, customisation and support contracts or by selling premium edition of the software or both. Evidences show that privately owned companies mostly adopt service-based reciprocal business model, while well funded OSS firms tend to adopt hybrid business model. However, there are some exceptions to this and the research shows that business model is influenced by the strategic visions of the founders, the financial objectives set by the investors and the relationship with community members.

6.2.2 What are the critical success factors and risks for OSS companies?

The contributions from hacker communities is critical during early stages of OSS projects because they improve the quality of software and more community involvement triggers greater visibility and marketing of the product. OSS companies face major challenges in encouraging community members to contribute to their project.

Community members include hackers, users and commercial partners who may have their own interests in the project. The research shows that consistent and fair policies help in sustaining community contributions. But, it is not always possible to listen to every single request (Klaiss, 2007) and Compiere case study shows that unsatisfied member may create a fork of the project (Janke, 2010a; Janke, 2010b). So, leadership is important for resolving any conflicts arising from individual interests. Some companies hire experienced hackers; so that they can guide the project and provide leadership on various matters.

To encourage community contributions, it is critically important to balance the commercial interests and the expectations of the community members using appropriate product and marketing strategies as depicted in the Figure 7 shown below.

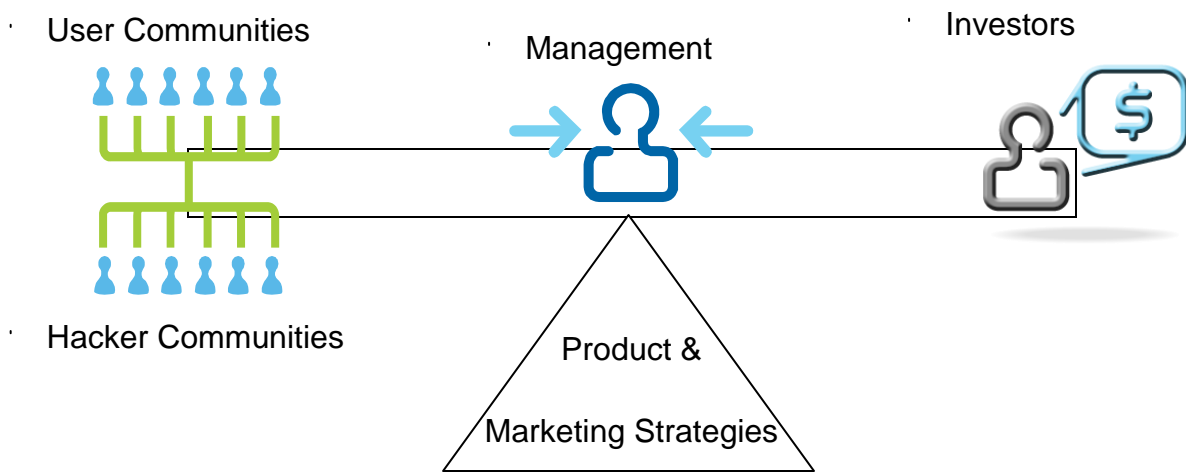


Figure 7 - Balancing Interests of Community Members and Investors

Hybrid business model involves higher risk because it requires making community edition less attractive while annoying community members. The community members primarily demand freedom for users and programmers for extending the product and any attempt to lock the customers or restrict the usage of the software creates tension between the management and the community members. The company loses cost advantage and other benefits associated with OSS when community members stop supporting the OSS project. So such companies require more internal resources for the development and maintenance of the software.

Some companies such as SugarCRM have managed to find the right balance by adding enough important features in the community edition (SugarCRM, 2010). Funambol avoids this conflict by segmenting its products across two types of users - carrier edition for mobile operators and device makers and community edition for other

enterprise users who do not need carrier edition features (Capobianco, 2006). Thus, selection of appropriate product/service mix is very important for OSS companies that use hybrid model.

On the other hand, reciprocal business model involves less risk because of lower marketing and overall development costs for OSS firms. Such companies need to build internal competencies for delivering quality services in timely manner. At the same time, it is important to ensure that OSS product gets updated regularly with bug fixes and additional features. So, the challenge is in optimisation of resources among direct revenue generating tasks and non-revenue generating, but strategically important tasks. The top management need to ensure that strategically important tasks are not ignored and allocate enough resources for the OSS project.

6.2.3 What are the common strategies used by OSS companies and can they help in building sustainable competitive advantage over their rivals?

A competitive advantage can be sustainable only when competitors cannot imitate it easily. Olson (2006) points out that a company cannot sustain competitive edge by technology alone and insists on developing integrated operations around product and service life cycles. In case of Open Source businesses, the software product is openly available and everyone has access to the source code. Thus, it is not difficult for competitors to imitate similar technological capabilities in their software. But, it is possible to create a sustainable advantage by combining various strategies discussed below:

- OSS companies can achieve genuine cost advantage by creating better relationships with community members to reduce overall development costs.
- Collaborative development in partnership with hardware and software vendors can help in building unique product advantages.
- Many small OSS companies build expertise in certain domains, industries or local markets and offer custom solutions to the customers.
- Some companies use best practices during system design and use very flexible architecture from very early stages of the OSS project. This allows the company to take leadership position by quickly adopting newer technologies and offering flexible solutions to customers.

Partially available evidences suggest that OSS companies enjoy competitive edge over closed source companies in price sensitive markets and in mission-critical applications where the security and reliability are of utmost importance and closed source companies enjoy significant market share where familiarity and switching costs are important determinants. In some cases, customers possibly develop brand loyalty due to familiarity with particular software.

6.3 Recommendations

6.3.1 General Recommendations

Without community contributions, OSS companies cannot achieve sustainable advantage over competitors. Competition exists among OSS companies as well. For

instance, Compiere, Adempiere, OpenBravo, OpenERP, Opentaps are some of the Open Source ERP projects. Thus generating enough enthusiasm from hacker groups becomes paramount to the success of OSS business. For this, the following recommendations are suggested for project managers:

- It is important to implement consistent and fair project governance policies for setting project priorities and finalising community edition features. It is necessary to create an organisational culture where community members feel comfortable about various product related decisions. Experienced leadership can help resolve conflicts arising from differences of opinions.
- Inhibiting or restricting freedom on usage, modifications and redistribution of software discourages community contributions. So, managers need to avoid this by using appropriate Open Source license.
- Ensure that the product architecture meets technical expectations of hacker groups and is designed using open standards. Community activities also depend on general usability and viability of the software (Sagers, 2007). During early stages of the project, hackers may provide useful suggestions that allow greater flexibility and scalability of the software. Ignoring their suggestions can adversely affect community involvement.

Although OSS companies normally enjoy cost advantage, this may not be significant enough in some cases. For instance, IDC (2007) paper points out that software

amounts to only about 7% of the total cost of ownership. So, OSS companies also need to use suitable marketing and product strategies for positioning the software product.

OSS companies generally seem to enjoy competitive edge in product categories where security and reliability are most important for the customers. So, it is suggested that OSS companies may be more successful in serving those markets where customers give higher priority to security, performance and reliability.

6.3.2 Recommendations for OSS firms that use reciprocal business model

The reciprocal business model is adopted by two kinds of OSS firms – the firms that control and make significant contributions to OSS projects and the firms that primarily provide solutions and professional services based on OSS projects. Both kinds of OSS companies rely on the revenues from professional services and there can be several competitors who can provide equally good services. The recommendations for such firms are:

- To be able to provide competitive services, the employees must build relevant technical competencies by actively contributing and possibly undertaking higher responsibilities on OSS projects.
- The employees need to develop networking skills for building relationships with local businesses and OSS community members.
- The company enjoys unique advantage when it is the prime contributor and controls the OSS project. Such companies allocate dedicated resources for the

development and maintenance of OSS project. To sustain the low cost advantage, the company requires encouraging contributions from community members and optimising internal resources.

6.3.3 Recommendations for OSS firms that use hybrid business model

The firms that adopt hybrid business model need particular attention to the product strategies and ensure a balance between commercial and community editions. This may be achieved using following recommendations:

- Product managers should include commonly used important functionality in the community edition. Community members get annoyed when community edition merely serves as a trial version with several limitations.
- Segmenting product based on user types rather than product features can be particularly beneficial (Capobianco, 2006).
- Mixing various levels of support with commercial editions can be beneficial. This when combined with appropriate product strategies gives an impression that commercial editions are designed for certain type of customers.
- It is also beneficial to establish partnerships with other technology firms in order to reduce the overall development cost and enhance the product's usability.

6.4 Limitations

The research was based on various sources of information and both qualitative and quantitative methods were used to understand various aspects of OSS business models

and answer the research questions. However, there are following limitations applicable to this research.

6.4.1 Possible Errors in the Researched Data

The survey information was mostly obtained from publicly available sources such as company websites and media reports as many companies did not directly respond to the questionnaires sent to them. It was particularly more difficult to obtain information about private and smaller OSS companies. This may have caused following types of errors and may have influenced the research findings

- **Selection Bias** - This may have introduced some errors or noise in the statistical tests on the hypothesis. So, statistical results were also confirmed using qualitative research.
- **Accuracy of Information** - Although most data was collected from reliable sources, it is possible that the authors or publishers may have some bias in providing information. In some cases, it is also possible that information was presented in a misleading way. To avoid this problem, information about each company was collected from multiple sources wherever possible and the interview questions were targeted considering company's contextual information.
- **Missing Information** - Missing or unavailable information is another source of possible errors in the interpretation of data. It is difficult to avoid this type of error as companies will always hold some critical information about their businesses.

To avoid this type of error, various media reports and reputed blog sites of known experts were used to discuss their opinions and establish certain facts.

6.4.2 Limitations in the Interpretation of Results

A careful analysis was necessary considering the possibility of bias and other type of errors in the selected data. Some of the major limitations of the research are discussed below:

- Due to smaller sample size, it was not possible to use statistical tests on hypothesis 2A & 2B. So, the qualitative analysis was used to confirm the findings. Particularly, no evidence was found to support hypothesis 2A. But, qualitative analysis revealed a stronger relationship between project governance policies and community contributions.
- The research identified some major strategies used by OSS companies based on the available information. However, the exact impact of these strategies was difficult to assess due to the lack of critical inputs. Moreover, some strategies are also often used by closed source companies. The research though highlights some critical factors for succeeding in OSS businesses.
- It was difficult to directly assess whether sustainable competitive advantage can be achieved using OSS strategies. The interviews confirmed that OSS companies can achieve competencies by contributing to OSS projects and previous research shows that competencies based on intangible resources such as organisational culture and knowledge are not easily imitable (Faldetta, 2002).

- The market position and competitive edge of OSS firms are based on observation of few OSS projects during explorative study. So, the market positions of OSS products shown in Figure 6 merely suggest a possible link between the variables and should be used cautiously.

6.5 Further Scope of Research

Considering the limitations discussed above, further research in following areas is suggested

- This research was inconclusive regarding the impact of business model on the community contributions due to smaller sample size. The available data suggests that community members are not necessarily averse to hybrid business model and may continue to make significant contributions depending on overall handling of the project. More extensive research is necessary to identify specific factors that have positive and negative impact on the community contributions.
- Investigation is needed to establish whether OSS companies can achieve real cost advantage by analysing their expenses on various marketing and development activities.
- It is important to identify factors that influence customers to adopt OSS. The study only suggests that customers' acceptance is possibly influenced by factors such as user familiarity, price sensitivity, switching costs and concerns over security and performance. Further research is needed to confirm this

observation and identify any other factors that influence customer acceptance of OSS.

- Some OSS companies are quite successful while others seem to enjoy smaller market share. A more extensive research is needed to study factors such as strategic partnerships, financial resources and technical competence and marketing skills of employees that could help in building successful businesses.

6.6 Summary of Contributions of this Research

The research found partial answers to all the research questions and was successful in highlighting important strategies and critical success factors. It was necessary to use triangulation of several methods for investigating various strategies and factors that affect the success of OSS companies.

The framework model depicted in Figure 4 summarises the key findings of this research. Most of these findings are consistent with previous research. This research particularly aimed to produce a larger picture of OSS businesses that shows the role of community members, leadership of founders and investor pressures on the formulation of key strategies and business models. The study also identified major risks and critical success factors for OSS companies. These results have significant implications for OSS firms. Based on this some important recommendations are suggested.

The research has several limitations and further research is needed for confirming certain patterns that emerged during this research. Particularly, OSS projects need to

be studied further to confirm whether they are more likely to succeed in certain markets, but not in others..

In conclusion, both hybrid and reciprocal business models are viable provided that the OSS project attracts and sustains enough community contributions. For this, OSS companies need to implement fair and consistent governance policies and employ appropriate product strategies to balance the expectations of community members and investors. The strategies identified in this research and the recommendations are useful for OSS companies to make strategic decisions.

APPENDICES

APPENDIX I - Glossary of Abbreviations and Technical Terms

Term	Meaning
Closed Source Software	The proprietary software whose source code is not available with the software and has restrictions on its usage, modification and distribution.
Community Members	This term is often used to refer to individuals and groups that follow Open Source principles. This includes hackers (see meaning below), users and other organisations that use and contribute to Open Source Software.
ERP	Software used for Enterprise Resource Planning
FLOSS or FOSS	Free/Libre Open Source Software. The term refers to both Free software and/or Open Source Software.
Free Software	Free software refers to the freedom for its users. Free software essentially provides four freedoms to its users: freedom to run the program for any purpose, freedom to learn about the program and modify it, freedom to redistribute copies and freedom to distribute modified versions. (Free Software Foundation, 2010).

Freeware	The software that is available to use at no cost. But the source code is often Closed Source.
Hackers	Webopedia (2010) defines hacker as a slang term for computer enthusiast; a person who enjoys learning programming languages and computer systems. The term is also used to describe programmers associated with the FLOSS community and this meaning is used throughout this paper. The term should not be confused with the derogatory meaning of the term often used in media to describe criminals who break into a computer system by circumventing its security.
Open Source Software (OSS)	The software whose source code is freely available for inspecting, modifying and distributing as defined by Open Source Initiative (2010a).

APPENDIX II – Resource Allocation Levels in OSS firms (Source: Grand et al., 2004)

Level	Resource Allocation	Strategic Benefits
Level 1 – Users of OSS	Expertise to install, run and	Cost reduction, greater transparency of software, No

For example, several websites are hosted on Linux as operating system and Apache server as web server	maintain the software	lock-in into commercial software, support available from user forums.
Level 2 – OSS complements other products and services For example, Sun Microsystems	Investment for developing OSS projects, building organisational knowledge base and adaptation of internal processes to maintain and support the OSS.	Other companies including competitors may cooperate in the OSS project considering mutual benefits.
Level 3 – Open Source as design choice	Significant contributions to OSS projects with substantial investment of resources.	Develop own software using OSS building blocks. Lower development cost as external resources contribute to the project.
Level 4 – Fully compatible business model for OSS	The entire business model is compatible with OSS. The organisation needs to handle the relationship with	Same as 3. Main advantage is the access to new technologies and innovations from external resources. Very

For example, Red Hat.	users and hacker communities while serving commercial interests.	low cost of development.
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APPENDIX III – The Survey of Open Source Businesses

Company	Funding Source	Brief Description of the Business Model
Acquia Inc. Woburn, MA, USA.	Venture Capital	<p>Develops social publishing software, Drupal.</p> <p>Advantages – OSS, lower cost, flexibility, functionality</p> <p>Revenue: Support services, training</p> <p>Strategies –Partners, resellers, publicity from OSS</p> <p>Business Model: Reciprocal</p> <p>Resource Allocation (Grand et al., 2004) – Level 4</p> <p>Source: www.acquia.com</p>
Axiom Tech Limited. Stockport, UK.	Private	<p>Provides IT support and Payment card industry data security standards (PCIDSS) compliance services based on OSS.</p> <p>Advantages – lower cost solutions, security, specific</p>

		<p>expertise in security requirements of card payments</p> <p>Revenue: Support, consultancy and web content management solutions</p> <p>Strategies –partners, lower cost provider,</p> <p>Business Model: Reciprocal</p> <p>Resource Allocation (Grand et al., 2004) –Level 1</p> <p>Source: www.axiomtech.co.uk</p>
<p>Canonical Limited. London, UK.</p>	<p>Private. But well funded company having significant investment from Mark Shuttleworth.</p>	<p>Develops Open Source operating system used on desktops and servers</p> <p>Advantages – Fully OSS, Easy to use, Security, Cloud ready</p> <p>Revenue: consulting, training and maintenance contracts, certification, engineering services</p> <p>Strategies –publicity from OSS, technology partners, resellers, SaaS</p> <p>Business Model: Reciprocal</p> <p>Resource Allocation (Grand et al., 2004) –Level 4</p>

		Source: www.canonical.com and www.ubuntu.com
CFEngine Limited. Oslo, Norway.	Privately Held	<p>Develops software for data centres and configuration management.</p> <p>Advantages – OSS, security, expertise in configuration management</p> <p>Revenue: Enterprise edition, services and cloud subscription</p> <p>Strategies – technology partners</p> <p>Business Model: Dual license, Hybrid</p> <p>Resource Allocation (Grand et al., 2004) –Level3</p> <p>Source: www.cfengine.com</p>
Clicks and Links Limited. Cheshire, UK.	Privately Held	<p>Provides ICT consultancy and solutions based on OSS products. Provides solutions for virtual presences for clients based on OpenSIM and Second Life platforms</p> <p>Advantages – low cost solutions</p> <p>Revenue: Support, consultancy and web content management solutions</p> <p>Strategies –Technology and consultancy partners.</p>

		<p>Specific expertise in virtual worlds based on OpenSIM project</p> <p>Business Model: Reciprocal</p> <p>Resource Allocation (Grand et al., 2004) –Level 3</p> <p>Source: www.clicksandlinks.com</p>
<p>Compiere Inc. Indianapolis, IN, USA. (Now part of Consona Corporation).</p>	<p>Venture capital</p>	<p>Develops Open source ERP package.</p> <p>Advantages – Cloud ready, Easy to use web interface</p> <p>Revenue: Premiums editions and related services</p> <p>Strategies –partners and resellers</p> <p>Business Model: Open Core, Hybrid.</p> <p>Resource Allocation (Grand et al., 2004) – Level 3</p> <p>Source: www.compiere.com</p>
<p>Credativ Ltd. Rugby, UK.</p>	<p>Private</p>	<p>Provides services such as training, support, consultancy and various solutions based on OSS products. Significant contributions to various OSS projects.</p> <p>Advantages –lower cost provider, 24x7 support</p> <p>Revenue: Support, consultancy and training</p>

		<p>Strategies –partners, low cost provider.</p> <p>Business Model: Reciprocal</p> <p>Resource Allocation (Grand et al., 2004) –Level 1</p> <p>Source: www.credativ.co.uk</p>
Enterprise management consulting. London, UK.	Private	<p>Provides custom solutions based on OSS. Certified Linux partner.</p> <p>Advantages – Low cost solutions</p> <p>Revenue: Support, consultancy, custom solutions</p> <p>Strategies –Low cost solution provider, technology partners</p> <p>Business Model: Reciprocal</p> <p>Resource Allocation (Grand et al., 2004) –Level1</p> <p>Source: www.emcuk.com</p>
Eucalyptus Systems, Inc. Goleta, CA, USA.	Venture Capital	<p>Develops software used in private and public clouds.</p> <p>Advantages – OSS, Cloud ready, Web interface</p> <p>Revenue: Enterprise edition, consulting, training and support services</p>

		<p>Strategies –technology partners, SaaS</p> <p>Business Model: Dual license, Hybrid and SaaS</p> <p>Resource Allocation (Grand et al., 2004) –Level 3</p> <p>Source: www.eucalyptus.com</p>
Foradian Technologies Private Limited, India	Private	<p>Develops Open Source ERP for educational institutes.</p> <p>Advantages – OSS, low cost, cloud ready</p> <p>Revenue: Customisation, support contracts, training and consultancy</p> <p>Strategies – Publicity from OSS, technology partners, resellers,</p> <p>Business Model: Reciprocal</p> <p>Resource Allocation (Grand et al., 2004) –Level4</p> <p>Source: http://www.fedena.com and http://www.foradian.com</p>
Funambol, Inc. Redwood City, CA, USA.	Venture Capital	<p>Develops OSS that enables synchronisation of data between mobile devices and backend data servers and provides push email capability.</p> <p>Revenue: Carrier edition developed for large scale</p>

		<p>deployments. Training, consultancy and maintenance services.</p> <p>Strategies – Partnerships with ISV and System integrators, Appropriate product/service mix to avoid conflicts with community members.</p> <p>Business Model: Dual license, Hybrid.</p> <p>Resource Allocation (Grand et al., 2004) – Level 3</p> <p>Source: http://www.funambol.com/</p>
<p>Marketcetera Inc. Palo Alto, CA, USA.</p>	<p>Venture Capital</p>	<p>Develops and supports an automated trading platform based on OSS. Value added components are not feature based. They allow connectivity to the real time market data from various data vendors.</p> <p>Advantages – OSS, flexible and secure</p> <p>Business Model: Reciprocal.</p> <p>Revenue: Support Subscriptions, training and consultancy, customisation of data adapters.</p> <p>Strategies – Technology and channel partners</p> <p>Source: www.marketcetera.com</p>

<p>MuleSoft Inc. San Francisco, CA, USA.</p>	<p>Venture Capital</p>	<p>Develops web applications based on OSS components such as Mule ESB , RESTx and Tcat server. Also develops enterprise versions.</p> <p>Advantages – OSS, secure, reliability, performance.</p> <p>Market Dominance – Yes.</p> <p>Business Model: Hybrid and SaaS.</p> <p>Revenue: Subscriptions, product support, training and consultancy. Also offers cloud computing</p> <p>Strategies – Partnerships with ISV, OEM and System integrators</p> <p>Resource Allocation (Grand et al., 2004) – Level 4</p> <p>Source - http://www.mulesoft.com/</p>
<p>Netways Gmbh. Nürnberg, Germany</p>	<p>Private</p>	<p>Provides managed services, training and consultancy for Open source systems. Contributes and makes useful enhancements to various OSS products</p> <p>Advantages –lower cost solutions</p> <p>Revenue: Custom solutions, managed services, consultancy</p>

		<p>Strategies –Technology partners.</p> <p>Business Model: Reciprocal business model</p> <p>Resource Allocation (Grand et al., 2004) –Level 1</p> <p>Source: http://www.netways.de/en/de/home</p>
OpenBravo, S. L. Pamplona, Spain	Venture Capital	<p>Develops Open source ERP package</p> <p>Advantages – OSS, Web based</p> <p>Revenue: Enterprise edition and services. Custom solutions.</p> <p>Strategies –partners and resellers</p> <p>Business Model: Dual license, Hybrid.</p> <p>Resource Allocation (Grand et al., 2004) –Level 3</p> <p>Source: www.openbravo.com</p>
openQRM Enterprise. Köln, Germany	Privately Held	<p>Develops data centre management software</p> <p>Advantages – OSS, lower cost, flexibility, security</p> <p>Revenue: Support, training and consultancy services</p> <p>Strategies –Cloud based solution, technology partners</p>

		<p>Business Model: Reciprocal</p> <p>Resource Allocation (Grand et al., 2004) –Level 3</p> <p>Source: http://www.opengrm-enterprise.com/</p>
Open Source Strategies, Inc.	Private	<p>Develops and sponsors various OSS projects such as opentaps ERP+CRM, Apache OFBiz, ToolEast and Asterisk.</p> <p>Advantages – OSS, lower costs.</p> <p>Revenue: Services such as training, evaluation, certification, customisation and technical support</p> <p>Strategies – Publicity and reputation from OSS.</p> <p>Business Model: Reciprocal</p> <p>Resource Allocation (Grand et al., 2004) – Level 3</p> <p>Source: http://www.opensourcestrategies.com/</p>
Opus Vision Limited. Rugby, UK.	Private	<p>Provides communication and enterprise solutions based on OSS</p> <p>Advantages –lower cost solutions</p> <p>Revenue: Support, consultancy, custom solutions</p>

		<p>Strategies –Low cost solutions using OSS.</p> <p>Business Model: Reciprocal</p> <p>Resource Allocation (Grand et al., 2004) –Level1</p> <p>Source: http://www.opusvl.com</p>
<p>Penguin Factory Limited. Glasgow, Scotland, UK.</p>	<p>Private</p>	<p>Provides IT consultancy and support based on OSS</p> <p>Advantages –lower cost solutions</p> <p>Revenue: Support, consultancy, firewall/VPN solutions</p> <p>Strategies –Low cost solution provider.</p> <p>Business Model: Reciprocal</p> <p>Resource Allocation (Grand et al., 2004) –Level1</p> <p>Source: http://www.penguinfactory.co.uk</p>
<p>Saturn System wares Private Limited. Trivendrum, India</p>	<p>Privately held</p>	<p>Contributes to various OSS projects and provides documentation. Also develops other closed source products using OSS such as Linux and MySQL.</p> <p>Advantages – OSS, low cost solution provider</p> <p>Revenue: Maintenance services, closed source products</p>

		<p>Strategies – Low cost provider strategy, partners</p> <p>Business Model: Reciprocal model.</p> <p>Resource Allocation (Grand et al., 2004) – Level 1</p> <p>Source: www.saturn.in</p>
<p>Sendmail, Inc. Emeryville, CA, USA.</p>	<p>Venture partners</p>	<p>Develops OSS for message filtering and builds message processing appliances. Also sell proprietary software bundled with OSS. But, there is a clear separation between OSS and Closed Source products</p> <p>Advantages – OSS, security, filtering features</p> <p>Revenue: hardware and virtual appliances for message processing, product support</p> <p>Strategies –technology and compliance partners</p> <p>Business Model: Reciprocal.</p> <p>Resource Allocation (Grand et al., 2004) –Level 2</p> <p>Source: www.sendmail.com</p>
<p>SugarCRM Inc. Cupertino, CA, USA.</p>	<p>Venture capital</p>	<p>Develops Open source CRM package.</p> <p>Advantages – Open Source, Web interface, flexible</p>

		<p>reporting and other product features</p> <p>Revenue: Professional edition, support and training services</p> <p>Strategies –partners and resellers</p> <p>Business Model: Dual license, hybrid</p> <p>Resource Allocation (Grand et al., 2004) –Level 4</p> <p>Source: www.sugarcrm.com</p>
<p>Untangle Inc. San Mateo, CA, USA.</p>	<p>Venture Capital</p>	<p>Develops open source firewall software and provides solutions for educational, non-profit organisations and government</p> <p>Advantages – OSS, lower cost, security</p> <p>Revenue: Hardware appliances, premium applications such as web filters, support services, various levels of closed source product bundles</p> <p>Strategies – Low cost provider strategy, partners and resellers</p> <p>Business Model: Dual license, hybrid.</p> <p>Resource Allocation (Grand et al., 2004) – Level 2</p>

		Source: http://www.untangle.com/
Vyattta Inc. Belmont, CA, USA.	Venture Capital	<p>The company develops network operating system having scalability and network security. Also sales hardware appliances with software subscription.</p> <p>Advantages – OSS, lower cost, security, performance</p> <p>Revenue: Hardware appliances, subscription for premium features, support services</p> <p>Strategies – Low cost provider strategy, partners and resellers</p> <p>Business Model: Open Core, hybrid.</p> <p>Resource Allocation (Grand et al., 2004) – Level 2</p> <p>Source: www.vyatta.com</p>

APPENDIX IV - Survey of Community Contributions

Months since adoption of hybrid business model	Community Contributions			
	Compiere ERP	Mean Difference	Pentaho BI	

-12	244	112.28	-	-107.42
-11	199	67.28	2	-105.42
-10	189	57.28	1	-106.42
-9	286	154.28	0	-107.42
-8	210	78.28	6	-101.42
-7	197	65.28	61	-46.42
-6	106	-25.72	66	-41.42
-5	97	-34.72	12	-95.42
-4	245	113.28	58	-49.42
-3	126	-5.72	78	-29.42
-2	121	-10.72	106	-1.42
-1	146	14.28	97	-10.42
Hybrid Model Adopted	110	-21.72	86	-21.42
+1	112	-19.72	146	38.58
+2	105	-26.72	178	70.58
+3	104	-27.72	179	71.58

+4	54	-77.72	154	46.58
+5	112	-19.72	107	-0.42
+6	52	-79.72	124	16.58
+7	30	-101.72	149	41.58
+8	112	-19.72	175	67.58
+9	62	-69.72	121	13.58
+10	65	-66.72	197	89.58
+11	78	-53.72	215	107.58
+12	131	-0.72	260	152.58
Average Messages/Month	131.72		107.42	

APPENDIX V- Survey of Market Position of OSS Products

Product Category	Market Leader	OSS Position	Important Considerations
Web Server Operating System	Linux	Dominating	Security, Performance, Scalability
Web Server	Apache	Dominating	Security, Performance,

Applications			Scalability
Database Server	Oracle	MySQL has about 25% market share. OSS is competing against other proprietary databases	Features related to performance, scalability, backup, reporting, administrative tools
Desktop operating system	Microsoft Windows	Very low market share.	Familiarity, User interface, Range of available applications
Office Suit	Microsoft Office	Very low market share.	Familiarity, functionality, ease of use, existing documents
ERP	SAP, Oracle	Very low	Familiarity, functionality, customisation, switching cost
Networking products	Cisco	Vyatta Competing	Security, performance, reliability, switching cost,

		against Cisco	price
Browsers	Internet Explorer	Firefox gained significant market share in recent years	Free software, security concerns,

APPENDIX VI - Survey of Community Contributions and Governance Policies

Governance Policy - 0 = Unfavourable 1= Fair and consistent

Community Contributions - 0= Poor (< 50 messages each month on an average), 1 = Good or Excellent Contributions (Over 50 messages each month on an average).

OSS Project	Administrative Policy	Community Contribution	Comments
Compiere ERP	0	0	Company ignored community concerns. Project was forked due to discontent among community members.
Pentaho BI	1	1	Pentaho provides key features in the community edition and encourages community

			contributions. Appointed one of the lead developers as architect on the project.
CFEngine	1	1	Key features are available in community edition and enterprise edition allows some productivity enhancements useful for enterprises. CTO is the original author of the software.
Eucalyptus	1	1	Provides community wiki and community cloud sandbox. Most important features are OSS.
Funambol	1	1	Supports several OSS projects and a platform for communication. User level segmentation for carrier edition.
SugarCRM	1	1	Handles community

			<p>relationship holistically.</p> <p>Provides SugarForge for community activity, Wiki for project documentation, arranges events, publishes contributors, provides free training. Interacts with other partner communities such as MySQL and redhat.</p>
Untangle	1	1	<p>Most functionality is available as OSS. Support for wiki and developer network.</p>
Vyatta	1	1	<p>Most functionality available as OSS. Provides website for community contributions and Wiki.</p>

APPENDIX VII - Interview I

Brief Information	Company: Saturn Systems
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<p>About Interviewee</p>	<p>Position in the company: CTO and one of the directors</p> <p>Employees: 40</p> <p>Date and Time of Interview: 15 June 2010</p>
<p>Question</p>	<p>What are your company's main objectives?</p>
<p>CTO Reply</p>	<p>Help customers succeed by aligning and optimising products and services according to customer needs while significantly reducing time and costs</p>
<p>Notes</p>	<p>Objectives are quite common with companies that provide IT Services. Specifically, cost reduction is primary objective of many OSS companies.</p>
<p>Question</p>	<p>What are company's products and services? Are they based on Open Source?</p>
<p>CTO Reply</p>	<p>Carego – Workflow management software</p> <p>Portales – Portal solutions</p> <p>Reserway – Online travel solutions</p> <p>Xeproof – Online artwork approval system</p> <p>These are proprietary products based on OSS components. The company also provides Linux and MySQL support to its customers.</p>

Notes	The company's business is not primarily based on OSS products alone. However, there is a clear separation of proprietary software and OSS based services. The OSS is mainly used for cost reductions.
Question	What are company's activities specifically with reference to OSS?
CTO Reply	Company maintains technical documentation for OSS and also makes some donations. Company provides customer services for OSS products such as MySQL. The company has also made several active contributions to OSS projects such as MySQL Innodb , zapatec widgets, YUI and Gecko applications.
Notes	The company can be categorised as level 1 company (Grand et al., 2004). The company has built its business around OSS and related services. The company also provides customisation and occasionally makes some modifications to the core OSS products. The company has contributed to the OSS communities by making donations as well.
Question	What are the main objectives in making contribution to OS community?
CTO Reply	As a social responsibility, company believes in contributing back to the community. Also, company's customers benefit significantly because of OSS.

Notes	The main objective is driven by social responsibility strategy, which indirectly benefits the company. By contributing, the company earns reputation among FLOSS communities and the use of OSS also helps company to reduce its overall costs.
Question	OSS is available to everyone, including your competitors. So, do you think this is a disadvantage when releasing OSS software?
CTO Reply	You have caught me there. No. I do not think this is a disadvantage because everyone benefits from it.
Notes	There is admission of the fact that differentiation with competitors cannot come from OSS alone. The company needs to build internal competencies to achieve sustainable advantage.
Question	So are there other advantages that are more important to you?
CTO Reply	Yes. The main benefit is the freedom for everyone. There are great amount of resources available from communities external to the company. This helps in reducing overall costs.
Notes	These are general benefits of using OSS. A company can provide low cost solutions to its customers when it uses OSS components. This is very important for price sensitive customers in India.
Question	How important is OSS strategy for you? Not important, less

	important, quite important, critically important.
CTO Reply	Yes. It is quite important for company's success.
Notes	The company's revenue is not based on OSS. It is not critically relying on OSS. However, the company has built competencies based on OSS products and hence it is quite important for the company.
Question	How much of the company's revenues can be linked to your OS related strategies?
CTO Reply	This is difficult to say. But company earns significant revenues from the maintenance of OSS.
Notes	The support contracts are quite important for the company.
Question	Does your company have competitive advantages over rivals and are they sustainable?
CTO Reply	Yes. The company has developed unique products based on OSS to provide reliable solutions to its customers. The company also provides customisation and support services on OSS products. These are sustainable as we have developed good relations with our customers.
Notes	Typically, the company's customers are price sensitive users and the use of OSS allows company to keep their costs to minimum. Providing OSS product support is part of the relationship marketing strategy to

	win customer confidence. Although these benefits are complementary, it is difficult to say whether contributions made to OSS make them sustainable.
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APPENDIX VIII - Interview II

Brief Information About Interviewee	Company: Foradian Technology Position in the company: CEO Date and Time of Interview: 15 July 2010
Question	What are the company's main objectives?
CEO Reply	Initially, the company was primarily developing websites and web applications for customers and accepted any relevant job on offer. Sensing new opportunities in educational management software the company is now focussing on Fedena, an OSS project. The objective (of the project) is to help educational institutes in simplifying their processes by using the power of Internet.
Notes	This is a privately owned small company that initially started like any other web design firm. But, company identified opportunities in educational management software and has opened the source code in order to receive contributions from OSS communities under Apache

	license.
Question	What are company's products and services? Are they based on OSS?
CEO Reply	We sponsor and develop Fedena, which is an OSS project for educational management software. Users can download software from the company website at no cost. The company offers various services such as support contracts and training to its customers.
Notes	The company has allocated dedicated resources for development and maintenance of Fedena project. The company is currently using reciprocal business model and offers a fully functional product at no cost.
Question	What are the company's main objectives in developing OSS?
CEO Reply	We found that many individuals in India usually start with small projects such as educational or library management software to gain some experience. Most of this software is custom designed and there is no single standard used in those projects. So our objective was to differentiate with such closed source projects. The OSS strategy has helped the company to reach out to a larger audience. The schools and universities in other parts of the world have different educational systems. So, it was not possible to study all necessary features and

	<p>provide customisation. Being an OSS project, it is possible for anyone to provide suggestions and make changes to the original code. Some OSS developers from China and other countries have already started translating and customising Fedena for their local market. There are no direct financial benefits at the moment. But, this has helped company to build its brand name.</p>
Notes	<p>The company's primary objective is to market the OSS at no cost and build the company's brand name from publicity. This was the same strategy that Jorg Janke used for Compiere ERP during its early days (Janke, 2010a).</p>
Question	<p>OSS is freely available to everyone, including your competitors. So, do you think this is a disadvantage?</p>
CEO Reply	<p>No. The company decided OSS strategy after studying other cases (particularly, SugarCRM) and this was the option that suited the company most. Initially, company developed the software as closed source and later even considered selling additional components such as human resource management. But, soon we (the company) discovered the power of OSS and decided to make the fully functional software available (as Open Source). Even though competitors can modify OSS, they are still required to attribute to Project Fedena. Of course, it is not possible to trace every user and some may be</p>

	<p>rebranding the software without publishing the original contributor.</p> <p>The Apache license is business friendly and the main advantage is the publicity of the company. The Apache License requires preservation of the copyright notice and disclaimer, but it is not a copyleft license — it allows use of the source code for the development of proprietary software as well as free and open source software.</p>
Notes	<p>The OSS strategy adopted by the company is a well thought and researched move. This has allowed company to prepare and execute a definitive action plan for development of Fedena project.</p>
Question	Are there other advantages that are more important to you?
CEO Reply	<p>Yes. The users and community members contribute to the project by reporting software bugs and submitting feature requests. Fedena ERP is now available on Turnkey Linux and can be installed on cloud. The company is now getting noticed globally, which was not possible otherwise.</p>
Notes	<p>The company's main objective is to popularise the software and make it available on number of platforms. The community contributions are enhancing the product's usability and this is helping the company to build its brand and get more customers.</p>

Question	How do you control the project?
CEO Reply	We have a community website where anyone can contribute to the project. But, most of the contribution (nearly 95%) comes from the company's own resources. We have a well defined roadmap for the future development of the product.
Notes	As with most other OSS projects, the primary contributions are made by few individuals. The company is required to allocate internal resources for the project. But, even smaller contributions from community members are quite important and help reduce costs.
Question	How do you motivate Open Source community members to contribute to this project?
CEO Reply	The company doesn't do anything specific to motivate community members. It is interesting to find out individual interests. For example, one of the contributors recently added Fedena project to Turnkey Linux. This will allow Fedena to be installed on cloud or any hardware.
Notes	Open Source community members are usually self-motivated individuals. This is consistent with previous studies on this subject.
Question	How important is Open source strategy for your business?
CEO Reply	It is quite important for the success of the company. Company has

	allocated dedicated resources for the development and the maintenance of Fedena project.
Notes	This reconfirms company's commitment for the OSS project.
Question	What are company's revenue sources? Do you generate revenue from Open Source project?
CEO Reply	The company earns revenue from training, consultancy, maintenance contracts and customisation of the software. But, schools in India are relatively new to using computers and it is not easy to sell software to them. It requires building rapport with the school management. The company also uses distributors and resellers for marketing the product. They get commission on maintenance contracts. The company is also planning to publish an official manual about using and customising Fedona project. This is expected to generate good revenue for the company.
Notes	The company primarily uses reciprocal business model. The company has developed its marketing plan based on this.
Question	Does your the company have competitive advantages over rivals and are they sustainable?
CEO Reply	Yes. As an OSS project, Fedena has significant advantage over other closed source competitors. The company also controls and makes

	<p>most contribution to the Fedena project. So, company has significant advantage for providing services related to Fedena project. Moreover, we are continuously making updates and including new functionality to make the project very useful and scalable. The company will soon make the project available on cloud network.</p>
Notes	<p>As a service oriented company, the company's main focus is on building necessary technical competencies. The company enjoys competitive advantage over those companies that merely resell the software because most contributions for the project come from internal resources.</p>
Question	<p>Fedena project is available under Apache license. So, other community members may fork the project. How do you manage this risk?</p>
CEO Reply	<p>Yes. There is always a possibility that someone may fork the project. For this, the company is providing continued support for Fedena project. The company listens to the suggestions from community members and keep the project up-to-date.</p> <p>Unlike GPL license, Apache license is business friendly. It allows programmers to integrate closed source components as well. This makes it really useful in business environment.</p>

Notes	OSS projects may be forked at any time. But, this is not a risk from open-source perspective. The actual risk is when community members stop contributing to the project. To avoid this problem, the company is making sure that community members are listened and the project remains up-to-date.
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APPENDIX IX - Statistical Analysis

Correlation

Correlation is a measure of relationship between the two variables. Pearson product moment correlation coefficient is the most widely used correlation coefficient and assumes that both variables are normally distributed. Its value can range from -1 to +1; where negative values indicate negative relationship while positive values indicate positive relationship and zero indicates no relationship or independence of variables. (Statsoft, 2010).

Lowry (2010a) explains that Pearson Product Moment Correlation Coefficient (r) is the ratio of observed covariance with the maximum possible covariance as shown below:

$$r = \frac{\text{Observed Covariance}}{\text{Maximum possible positive covariance}} \quad \dots \text{ (Lowry, 2010a)}$$

The maximum possible positive covariance is the geometric mean of two individual variances. So, this can be given as:

$$r = \frac{\text{Covariance}(X, Y)}{\sqrt{\text{Variance}_X \text{Variance}_Y}} \dots \text{(Lowry, 2010a)}$$

For a sample size of n, this can be calculated as:

$$r = \frac{\sum_{i=1}^n (X_i - \bar{X})(Y_i - \bar{Y})}{\sqrt{\sum_{i=1}^n (X_i - \bar{X})^2} \sqrt{\sum_{i=1}^n (Y_i - \bar{Y})^2}} \text{ (Wikipedia, 2010b)}$$

Where, \bar{X} and \bar{Y} are the mean values of X and Y variables respectively.

Chi-Square Distribution

Chi-Square distribution with k degrees of freedom is the distribution of sum of the squares of k independent variables (Wikipedia, 2010c).

Pearson's Chi-Square (χ^2) Test

This is a test for significance of relationship between categorical variables based on Chi-Square distribution. For this, a null hypothesis is used that takes a default position that there exists no relationship between the two variables. In this test, the theoretical distribution is compared against the observed distribution to accept or reject the null hypothesis. (Lowry, 2010b; Wikipedia, 2010d).

The Chi-Square (χ^2) is calculated using the formula:

$$\chi^2 = \sum_{i=1}^r \sum_{j=1}^c \frac{(O_{i,j} - E_{i,j})^2}{E_{i,j}} \dots \text{(Wikipedia, 2010d)}$$

Where, χ^2 is the Pearson Chi-Square test statistics and $O_{i,j}$ and $E_{i,j}$ are the observed and expected frequencies respectively. The expected frequency of each cell can be calculated using the following formula:

$$E_{i,j} = \frac{\text{Row Total} \times \text{Column Total}}{\text{Total Sample Size}} = \frac{\sum_{k=1}^c O_{i,k} \sum_{k=1}^r O_{k,j}}{N} \text{ (Lowry, 2010b; Wikipedia, 2010d)}$$

Where,

$\sum_{k=1}^c O_{i,k}$ is the sum of observed frequencies in i^{th} row and

$\sum_{k=1}^r O_{k,j}$ is the sum of observed frequencies in j^{th} column.

The probability of the Chi-Square value is then obtained from the Chi-Square distribution curve and if the probability is found to be smaller than the statistical significance criteria then the null hypothesis is rejected.

Yate's Correction Factor

Yate's correction factor is used to use more conservative when the expected frequencies are less than 10. This is calculated using following formula:

$$\chi^2_{\text{Yates}} = \sum_{i=1}^n \frac{(|O_i - E_i| - 0.5)^2}{E_i} \dots \text{(Wikipedia, 2010e)}$$

Chi-Square (χ^2) Test For Two Dimensions of Categorisation

	0 = Reciprocal Model	1 = Hybrid Model	
1 = Well funded, Venture/Publicly Listed	a = 3	b = 9	a+b = 12
0 = Limited Resource, Private	c = 11	d = 1	c+d = 12
Total	a+c = 14	b+d = 10	N= a+b+c+d =24

Lowry (2010b) explains that the degree of freedom is the “amount of arbitrariness”. In this case, there is only one degree of freedom as the other value can be determined from the first. The sample data collected from 24 companies included 12 private companies having limited resources and 12 well funded companies having venture funding or similar equity financing.

The following chart shows, the chi-square distribution with one degree of freedom.

Chi-Square Distribution with Degree of Freedom=1

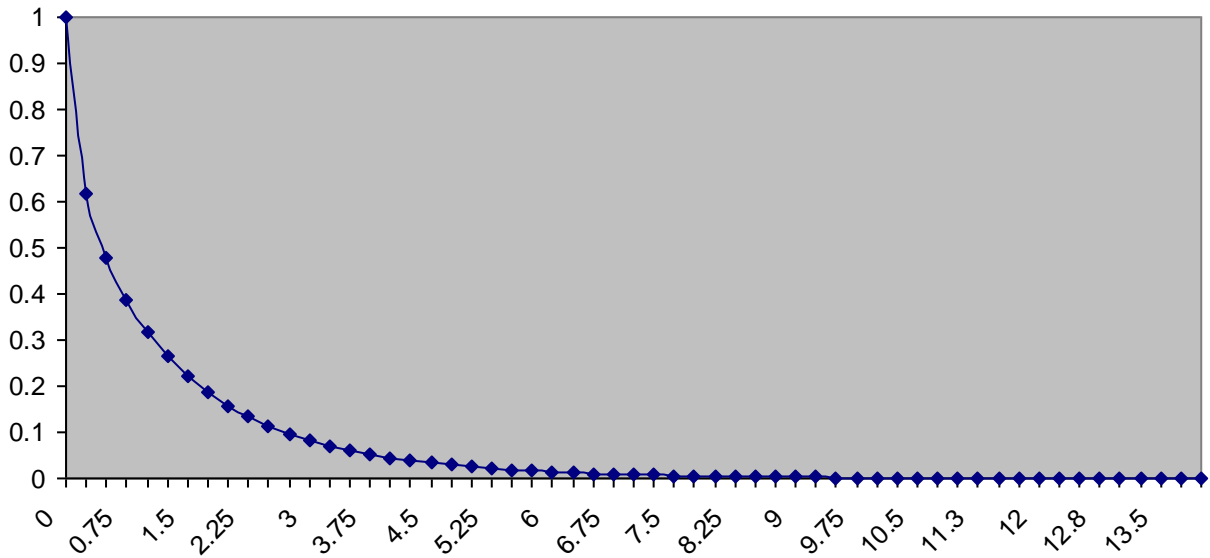


Chart 5 - Chi-Square Distribution for One Degree of Freedom (Source: Lowry, 2010e)

The corresponding value of Chi-Square for the critical significance of 0.005 is approximately 7.88.

To calculate Chi-Square value for given sample, it is necessary to first calculate expected frequencies for each cell. This is obtained by following formula:

$$E_a = \frac{12 \times 14}{24} = 7 \quad E_b = \frac{12 \times 10}{24} = 5 \quad E_c = \frac{12 \times 14}{24} = 7 \quad E_d = \frac{12 \times 10}{24} = 5$$

Comparing observed values we get following Chi-Square values for each row

	0 = Reciprocal Model	1 = Hybrid Model	
1 = Well funded,	O _a = 3	O _b = 9	

Venture/Publicly Listed	$(3-7)^2/7 = 2.286$	$(9-5)^2/5 = 3.2$	
0 = Limited Resource, Private	$O_c = 11$ $(11-7)^2/7 = 2.286$	$O_d = 1$ $(1-5)^2/5 = 3.2$	Sum
			$\chi^2=10.972$

The value of $\chi^2=10.972$ corresponds to the probability of **0.000926** on the probability distribution curve. This is smaller than the statistical significance criteria of 0.005. So, the null hypothesis can be rejected using the Pearson's Chi-Square test. But, as the expected frequencies are smaller than 10 in this case, it is important to consider Yate's correction factor (Brown, 2010). Using the formula for Yate's correction factor, we obtain following values

	0 = Reciprocal Model	1 = Hybrid Model	
1 = Well funded, Venture/Publicly Listed	$O_a = 3$ $(3-7 - 0.5)^2/7 = 1.75$	$O_b = 9$ $(9-5 - 0.5)^2/5 = 2.45$	
0 = Limited Resource, Private	$O_c = 11$ $(11-7 - 0.5)^2/7 = 1.75$	$O_d = 1$ $(1-5 - 0.5)^2/5 = 2.45$	Sum
			$\chi^2_{Yates} = 8.4$

The value of $\chi^2_{\text{Yates}} = 8.4$ corresponds to the probability of **0.003752** on the Chi-Square distribution curve. As this probability is smaller than the significance criteria of 0.005, the null hypothesis can be rejected. Thus, the Chi-Square statistical test confirms the relationship between the business model and the financial resources available to the company.

Phi Coefficient

The Phi Coefficient is another measure for the association of variable, which ranges from -1 to +1 and can be calculated for a 2x2 contingency table as shown below:

$$\phi^2 = \frac{\chi^2}{N} \dots \text{(Wikipedia, 2010f)}$$

$$\phi^2 = \frac{\chi^2}{N} = \frac{10.972}{24} = 0.4572. \text{ So, } \phi = +0.676$$

The positive value confirms the hypothesis.

Fisher's Exact Test

One of the limitations of the Chi-Square test is that it is based on approximations and the logical validity of the observations decreases with smaller expected frequencies (Lowry, 2010c). In such cases, Fisher's exact test is recommended. This is calculated by finding exact probability of observing a particular set of values as described below:

$$\begin{array}{ccc} a & b & a+b \\ c & d & c+d \end{array} \text{ is given by}$$

$$a+c \quad b+d \quad n = a+b+c+d$$

$$P = \frac{(a+b)!(c+d)!(a+c)!(b+d)!}{n!a!b!c!d!} \dots \text{ (Lowry, 2010d).}$$

Using this formula, we get following probabilities.

Observation Set	Probability
3 9 12 11 1 12 14 10 24	$P = \frac{12 \times 12 \times 14 \times 10!}{24 \times 3! \times 9! \times 11!} = 0.001346$
2 10 12 12 0 12 14 10 24	$P = \frac{12 \times 12 \times 14 \times 10!}{24 \times 2! \times 10! \times 12! \times 0!} = 0.000034$
One tailed probability =	0.001380

Similarly, the probability of the other end of the observation set can be calculated as

Observation Set	Probability
9 3 12 1 11 12 10 14 24	$P = \frac{12 \times 12 \times 14 \times 10!}{24 \times 3! \times 9! \times 11!} = 0.001346$
10 2 12 0 12 12 10 14 24	$P = \frac{12 \times 12 \times 14 \times 10!}{24 \times 2! \times 10! \times 12! \times 0!} = 0.000034$
Sum	0.001380

$$\text{Two tailed probability} = \text{One tailed probability} + 0.001380 = 0.002760$$

This is smaller than the significance criteria of 0.005. So, it is safe to reject the null hypothesis.

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