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How the “Open Innovation” concept might be used to improve profitability in the service industry.

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Abstract

Innovation drives economic growth and profitability. History reveals that innovation leading to technological advances occurs when knowledge is shared. Research shows that some innovative companies that produce goods have successfully adopted open innovation processes. The research question is: How can the service industry implement successful open innovation processes that lead to improved profitability? Using a systematic review process we identified the most critical 42 articles in the field of open innovation and innovation specific to the open source software (OSS) industry. The OSS industry is early adopter of open innovation practices. Open innovation (OI) is being discussed and utilized in several goods-producing industries, including software, video gaming, telecommunications, sports equipment, and pharmaceuticals. Each company discussed in this paper is sharing internal knowledge and gaining outside input in different ways. There are two basic findings based on the research and the case studies: 1) There are six characteristics common to how the open innovation process has been implemented; and 2) There is no established, best practices process to implement open innovation. We use the identified characteristics to create a conceptual categorization (fundamentals, facilitators and actionables) that we then apply to the service industry for further analysis. Service firms, like goods-dominated firms adherent to service-dominant logic, are in the business of monetizing skills and knowledge. Open innovation is about involving internal and external stakeholders in this process. The two concepts, open innovation and services, are compatible. The key component of open innovation is the human element. Active involvement from board level executives (i.e., the lead user) is critical to driving the adoption of open innovation processes - in any industry category, and especially in services where knowledge is more tacit. More research should be done to better understand how the management of innovative companies shares knowledge.

Contents

1. Introduction

> *"Open innovation is the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively. (This paradigm) assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as they look to advance their technology" (Chesbrough, 2006).*

It is a widely accepted fact that innovation, specifically in a free-thinking and non-monopolistic environment, drives economic growth and profitability. In 1934, leading economist Joseph Schumpeter was among the first to describe capitalism as having a foundation of "continuous and constant innovation" (Schumpeter, 1934). He also said it was "the propelling force behind creative destruction." In other words, innovation results in the replacement of one product or process by a more technologically advanced one. Profit can then be obtained. This profit is subsequently eroded as competitors begin producing similar products or technologies. To avoid commoditization, the process of innovation must continue into perpetuity.

Innovation has not been a process in isolation. History reveals that innovation leading to technological advances occurs when knowledge is shared, i.e., in an "open" environment. Allen (1983) described collective invention in the 19th-century iron industry in England. Collective invention, in a time before formalized corporate R&D functions, according to Allen, was a byproduct of normal business operations and represented the "the accumulation of minor improvements" (Allen, 1983, p. 2). The example here is the incremental improvement of blast furnace technology that resulted in a gradual increase of furnace heights of new or rebuilt furnaces from 41-45 feet in 1851 to 96-100 feet by 1871 (Allen, 1983). The increased height enabled an increase in the temperature at which iron was fired, from 800 degree to 1400 degrees Fahrenheit (Allen, 1983). The net result of the gradual series of improvements resulted in a higher quality production of iron at a lower fuel consumption cost. This improving technology was shared through its development by contractors and consulting engineers as they moved from one furnace construction project to another. It also was shared formally through articles in engineering literature.

Allen cites five contributing reasons why knowledge was shared through this innovation process, despite what one would have expected to be a competitive environment : 1) The professional ambition of owners and managers to increase their reputation in the field; 2) The information would have been shared anyway due to the informal effects of labor mobility and the formal effects of publication; 3) Utilization of the design improvements were relegated to those already knowledgeable in the field so free riders would not benefit; 4) Owners of complementary assets, both downstream and upstream, actively propagated the technology sharing to make their business more profitable; and lastly, 5) Free revealing increased the size of the market in total resulting in higher profits to the inventors of the technology than what would have occurred had they hampered the sharing of the technology (Allen, 1983).

Today, the world's economic environment is more complex, with globalization, increased flexibility in the labor market, improved market institutions and standards, and the advancement of network technologies (Dahlander, 2010). The modern innovation process also is more complex, depending upon interactions between a firm's external stakeholders, including consumers, as well as internal stakeholders, such as management, employees and board members. Business models also have evolved, becoming more dynamic, interactive and non-linear (von Hippel, 1998). Thus, they are more permeable, or "open," to the influences of external stakeholders and ideas (Chesbrough, 2003; 2006).

In recent years, the term "open innovation" has come to represent the sharing of knowledge in the innovation process. Or, as Chesbrough has stated: "Open innovation is the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively" (Chesbrough et al, 2006, p.1).

This paper explores “open innovation” in academic literature, and how it has been applied in the modern business environment in relationship to services, processes and organizational structure. Research shows that some innovative companies that produce goods have successfully adopted open innovation processes. The research question is: How can the service industry implement successful open innovation processes that lead to improved profitability?

2. Methodology

A search was made for references to “open innovation” in academic literature using a systematic review process. The search was limited to the most widely cited articles on open innovation in the ISI Web of Science scholarly database. Keywords used were “Innovation” AND “open source software” OR “open innovation”. We included the term “open source software” in the query because much of the research done on open innovation lies in the open source software industry. This limiting search constraint also has the added benefit of limiting the number of result to 308 from 390.

The results were then filtered by whether the articles were written by or referenced at least two of the three main contributors to the field; Henry Chesbrough, Eric von Hippel and Linus Dahlander. This filtering took the number of articles down to 103. It is important to note that although Dahlander is a recent contributor to the field, his work to bridge Chesbrough and von Hippel, among others, in 2010 has enabled a more systematic treatment of this nascent academic field.

The articles were then filtered by whether they had been referenced at least three times per year in publication, resulting in 42 articles. Lastly, a check was run to ensure the quality of the articles by comparing the publications against the ABS Academic Quality Guide. All of the articles, with the exception of two, had a score of 3 or higher. The two articles that had a score of 2 were from the journal of ‘Industry and Innovation’. The two articles, however, were widely cited, and were written by authors who appear in peer reviewed journals. The remaining 42 articles are the top scholarly articles in the field of open innovation.

For a list of the 42 articles and the number of times each articles have been referenced see Appendix 6.1. For a breakdown of how many times each article referenced one of the three main authors see Appendix 6.2.

3. Results

3.1 Research

The two primary contributors to the field of open innovation are widely cited. Eric von Hippel of the Sloan School of Management at MIT is sited 32 times in the 42 selected journal articles. Henry Chesbrough of the Haas School of Business in Berkeley is cited 33 times in the selected journal articles. These numbers are increased to 103 and 193, respectively, if all 308 articles are included. Dahlander, a more recent contributor to the field, is cited 15 times within the selected 42 journal articles. The number of citations increases to 46 if all 308 articles are included.

Table 1: Breakdown of citations in 42 selected journal articles of primary authors

	von Hippel	Chesbrough	Dahlander
Cited	32	33	15
Authored	7	9	4

When looking closer at citation patterns, it became apparent that although other authors weighed the contributions of von Hippel and Chesbrough similarly, the two authors rarely cited each other (see Table 2). In fact, von Hippel only cited Chesbrough once in his seven papers. Chesbrough cited von Hippel twice in his nine papers. These citations came only when the authors co-authored the papers.

Von Hippel and Chesbrough approach Open Innovation from fundamentally different points of view, causing an ambiguity in its definition. Chesbrough takes a market-based approach, which does not assume the complete forfeiture of intellectual property rights (IPR). Von

Hippel assumes that IPR rights are forfeited in a private-collective model, and that the resulting, co-produced offering is available for free to the public (Stuermer, et al, 2009).

Table 2: Breakdown of cross-citations between von Hippel and Chesbrough

	von Hippel	Chesbrough
von Hippel	na	2
Chesbrough	1	na

Von Hippel first looked at what he called the private-collective model of innovation in the open source software industry in 1998 (von Hippel, 1988; von Hippel and von Krogh, 2003).

IPR of source code developed in an open source software environment are forfeited under the intended terms of the General Public License (von Hippel and von Krogh, 2003). Chesbrough, credited with first using the term open innovation in 2003, viewed the paradigm from a market based perspective; "open innovation is a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as firms look in to advance their technology" (Chesbrough, 2003; 2006). Chesbrough uses the case based method to take a pragmatic view of how open innovation is being carried out by firms who, generally, retain IPR.

In addition to the seminal work done by von Hippel and Chesbrough, a number of other researchers have furthered contributed to the study of open innovation from various points of view. For example, several papers focus on the motivation behind users and user-based communities to contribute to open sourced projects (Lakhani and von Hippel, 2003; Lakhani and West, 2008; Fuller, 2010; Dahlander and Magnusson, 2005). Others have furthered the study by looking at open innovation through the prism of knowledge management as a dynamic capability of the firm (Lichtenthaler, 2011; Lichtenthaler and Lichtenthaler, 2009; Spithoven et al, 2009). Others have explored the connection between how technology can

facilitate user contributions to open innovation projects (Dodgson et al, 2006; Piller and Walcher, 2006; Kohler et al, 2009). Considerable attention in the literature has also been given to how firms manage the trade-off between revealing IPR and protecting core technology from competitors through hybrid forms of IPR management (Henkel, 2005; Bonaccorsi et all, 2006).

Teece, Allen and March provide an early analytical basis for the field (see Table 3). Teece's (1986) work on contractual alternatives to multi-national firms has provided an analytical foundation for openness in innovation as a complementary asset to the firm. Allen's (1983) work relies on an early example of how openness proliferated in the English metals industry during the industrial revolution. March's (1991) paper on exploitation and exploration provides a basis for how open innovation process can be used for organizational learning.

A number of secondary authors also have made contributions to the field (see Table 3). Henkel (2005) is widely cited for his work done with selective IPR. Lichtenthaler is cited 11 times in the selected group of 42 articles. He is cited in 64 times when all 308 articles are considered. Lichtenthaler's contribution to the field, in addition to providing an alternative point of view from our primary authors, is in how knowledge transfers are managed by the firm as a result of open innovation processes (Lichtenthaler, 2008; 2011). West and Lakhani have contributed with their work on the motivation of users, as well as the disproportionate contribution by women in open innovation communities (Jeppesen and Lakhani, 2010; Lakhani and West, 2008). Finally, Gassman, who is cited twice as a co-author with Chesbrough, has contributed to the field with his knowledge of corporate R&D management (Gassman et al, 2009; 2010).

Table 3: Breakdown of citations in 42 selected journal articles of secondary authors

	Teece	Allen	March	Henkel	Lichtenthaler	West	Lakhani	Gassman
Cited	15	15	8	13	11	17	19	10
Authored	0	0	0	1	3	3	4	2

3.2 Open Innovation Matrix

Dahlander, who has referred to open innovation as "shrouded in conceptual ambiguity" (Dahlander and Gunn, 2010), recognized the need for a systematic approach in his analysis. He produced a conceptual framework that "defines and classifies the different dimensions of openness" (Dahlander and Gunn, 2010). He also developed a two-by-two matrix to categorize research (see Table 4).

On the horizontal axis of Dahlander's matrix are 'inbound innovation' and 'outbound innovation'. On the vertical axis of Dahlander's matrix are 'pecuniary' (market based) and 'non-pecuniary' (non-market based). This matrix produces four dimensions; acquiring, sourcing, selling and revealing. Acquiring (inbound – pecuniary) is the process of licensing or acquiring outright expertise from outside the firm. Sourcing (inbound – non-pecuniary) is the process of leveraging the discovery of those outside the firm. Selling (outbound – pecuniary) is the process of licensing or selling technology developed inside the firm. This dimension requires the extra step of identifying an external firm capable of utilizing the technology. The last dimension (outbound – non-pecuniary), shares internally developed technology to the market without extracting immediate financial benefits, if any at all.

Table 4: Dahlander's structure of different forms of openness

	Inbound innovation	Outbound innovation
Pecuniary	Acquiring	Selling
Non-Pecuniary	Sourcing	Revealing

Source: Dahlander and Gann, 2010

Note: Dahlander's classification matrix of provides the researches with a starting point for separating out characteristics for successful open innovation projects in the literature for further review. This section is an exploratory exercise only and the concepts it reveals will be laid out in a more systematic approach later in the paper.

3.2.1 Acquiring

From our study of the literature we classified a number of articles that fit Dahlander's criteria of pecuniary, inbound innovation. Matrix 1 shows a select number of articles and comments related to how the authors addressed acquiring in open innovation. From the matrix we can see that Chesbrough (2003; Chesbrough and Crowther, 2006) goes into length about how firms can acquire technology from outside the firm. It is notable that Cisco outpaced Lucent in technology development by buying IP, rather than developing it in-house as Lucent did. It is also notable that Chesbrough (2003) and Lichenthaler (2011) make reference to innovation markets. These markets are concerned with buying IP, rather than developing it. It can be through the purchasing of companies in total or through the purchasing of specific IP that an acquiring firm is in better position to incorporate into its own business model than the firm selling the IP.

Matrix 1: Acquiring

				Inbound / Pecuniary
Author	Title	Citation	Year	Acquiring
Chesbrough, HW	The era of open innovation	176	2003	buy R&D (i.e, Cisco) rather than develop it in-house (i.e., Lucent) / Intuit bought TurboTax and QuickBooks
Chesbrough, H; Crowther, AK	Beyond high tech: early adopters of open innovation in other industries	78	2006	who work cross functionally to identify where and how external tech can be integrated into an existing
Christensen, JF; Olesen, MH; Kjaer, JS	The industrial dynamics of Open Innovation - Evidence from the transformation of consumer electronics	52	2005	outsourced component design and manufacturing
West, J; Gallagher, S	Challenges of open innovation: the paradox of firm investment in open-source software	43	2006	pooled R^D
Lichtenthaler, U; Lichtenthaler, E	A Capability-Based Framework for Open Innovation: Complementing Absorptive Capacity	23	2009	absorptive capacity
Jeppesen, LB; Lakhani, KR	Marginality and Problem-Solving Effectiveness in Broadcast Search	10	2010	virtual co creation of projects
Fuller, J	Refining Virtual Co-Creation from a Consumer Perspective	7	2010	virtual co creation of projects
Lichtenthaler, U	Open Innovation: Past Research, Current Debates, and Future Directions	3	2011	innovation markets

3.2.2 Sourcing

From our study of the literature we classified a number of articles that fit Dahlander's criteria of non-pecuniary, inbound innovation. From Matrix 2 we can see that the concept of open source software community involvement in open innovation is mentioned repeatedly. There are also a few references to facilitating factors of sourcing community involvement in a number of industries, such as; hybrid business models (Bonaccorsi, et al, 2006), complements (West and Gallagher, 2006), and user tool-kits (Franke and von Hippel, 2003). We will go into detail on these concepts later in the paper as we go into identifying the main characteristics of successful open innovation projects.

Matrix 2: Sourcing

Author	Title	Citation	Year	Inbound / Non Pecuniary Sourcing
von Hippel, E; von Krogh, G	Open source software and the "private-collective" innovation model: Issues for organization science	231	2003	highlights lead user contribution to OSS
Lakhani, KR; von Hippel, E	How open source software works: "free" user-to-user assistance	218	2003	highlights lead user contribution to OSS
Franke, N; von Hippel, E	Satisfying heterogeneous user needs via innovation toolkits: the case of Apache security software	97	2003	"user toolkits" as a solution to heterogeneous demand
von Hippel, E	Innovation by user communities: Learning from open-source software	73	2001	highlights lead user contribution to OSS
Henkel, J	Selective revealing in open innovation processes: The case of embedded Linux	60	2006	benefits from oss community provided development support
von Krogh, G; von Hippel, E	The promise of research on open source software	57	2006	motivations for contribution
Dahlander, L; Magnusson, MG	Relationships between open source software companies and communities: Observations from Nordic firms	52	2005	symbiotic, commensalistic, and parasitic approaches to OI
West, J; Gallagher, S	Challenges of open innovation: the paradox of firm investment in open-source software	43	2006	attracting donated complements
Dahlander, L; Wallin, MW	A man on the inside: Unlocking communities as complementary assets	39	2006	sourcing from individuals
Bonaccorsi, A; Giannangeli, S; Rossi, C	Entry strategies under competing standards: Hybrid business models in the open source software industry	38	2006	hybrid models in OSS communities
von Hippel, E	Horizontal innovation networks - by and for users	25	2007	sea kayaking members formed an innovation community
West, J; Lakhani, KR	Getting Clear About Communities in Open Innovation	17	2008	communities
West, J; O'Mahony, S	The Role of Participation Architecture in Growing Sponsored Open Source Communities	14	2008	sponsored vs autonomous OI communities
Dahlander, L; Magnusson, M	How do Firms Make Use of Open Source Communities?	14	2008	how firms make use of communities (accessing, aligning and assimilating)
Spithoven, A; Clarysse, B; Knockaert, M	Building absorptive capacity to organise inbound open innovation in traditional industries	14	2010	ability of a firm to recognise the value of new, external information, assimilation
Bianchi, M; Cavaliere, A; Chiaroni, D; Frattini, F; Chiesa, V	Organisational modes for Open Innovation in the bio-pharmaceutical industry: An exploratory analysis	4	2011	during the first three phases of the drug discovery and development process

3.2.3 Selling

From our study of the literature we classified a number of articles that fit Dahlander's criteria of pecuniary, outbound innovation. From Matrix 3 we can see that the selling and acquiring categories are similar. That said, however, the authors get into a number of interesting topics, such as "false negatives" (Chesbrough, 2003; 2004). These topics will be explored further when we discuss the characteristics of successful open innovation projects.

Matrix 3: Selling

				Outbound / Pecuniary
Author	Title	Citation	Year	Selling
Chesbrough, HW	The era of open innovation	176	2003	Sell or license R&D (n/a) oi enables development of "false negatives"
Chesbrough, H; Crowther, AK	Beyond high tech: early adopters of open innovation in other industries	78	2006	gear BM to finding suitable companies to sell tech to
Dahlander, L; Magnusson, MG	Relationships between open source software companies and communities: Observations from Nordic firms	52	2005	licencing
West, J; Gallagher, S	Challenges of open innovation: the paradox of firm investment in open-source software	43	2006	complements / patent pooling (i.e., GSM patent pool assembled by European telephone
Chesbrough, H; Schwartz, K	Innovating business models with co-development partnerships	30	2007	external tech partnerships via equity investments in promising relationships
Chesbrough, H	Managing open innovation	29	2004	how to bring "false negatives" to market
Lichtenthaler, U; Lichtenthaler, E	A Capability-Based Framework for Open Innovation: Complementing Absorptive Capacity	23	2009	desorptive capacity
von Hippel, E; von Krogh, G	Free revealing and the private-collective model for innovation incentives	20	2006	not practical
Gassmann, O; Enkel, E; Chesbrough, H	The future of open innovation	13	2010	begun, but in the near future, a whole industry will arise around intellectual property's
Bianchi, M; Cavaliere, A; Chiaroni, D; Frattini, F; Chiesa, V	Organisational modes for Open Innovation in the bio-pharmaceutical industry: An exploratory analysis	4	2011	clinical tests and post-approval activities
Lichtenthaler, U	Open Innovation: Past Research, Current Debates, and Future Directions	3	2011	innovation markets

3.2.4 Revealing

From our study of the literature we classified a number of articles that fit Dahlander's criteria of non-pecuniary, outbound innovation. From Matrix 4 we can see the inherent conflict between Chesbrough and von Hippel. Chesbrough (2003) refers to firms who engage in non-pecuniary outbound innovation as "innovation missionaries" who develop and freely reveal technology for the greater good. Von Hippel (2007), on the other hand, frames free revealing as a benefit for those who do so and does not see free-riders as a problem, as they do not benefit to the same extend as contributing users due to the knowledge gains accrued during the collaboration process. Again, this is a starting point and we will get into more detail on the various characteristics of successful open innovation projects later in the paper.

Matrix 4: Revealing

				Outbound / Non Pecuniary
Author	Title	Citation	Year	Revealing
Chesbrough, HW	The era of open innovation	176	2003	"innovation missionaries" develop tech to serve a cause
Franke, N; von Hippel, E	Satisfying heterogeneous user needs via innovation toolkits: the case of Apache security software	97	2003	"user toolkits" / democritization of innovation
Henkel, J	Selective revealing in open innovation processes: The case of embedded Linux	60	2006	revealing is strongly heterogenious amoung firms
West, J; Gallagher, S	Challenges of open innovation: the paradox of firm investment in open-source software	43	2006	giving away tech to stimulate demand for complementary products
von Hippel, E	Horizontal innovation networks - by and for users	25	2007	free revealing of proprietary information; "When benefits from free revealing exceed the benefits that are
von Hippel, E; von Krogh, G	Free revealing and the private-collective model for innovation incentives	20	2006	revealing, best practical option - increase profit and benefit innovators more than free riders
Dahlander, L; Magnusson, M	How do Firms Make Use of Open Source Communities?	14	2008	giving away tech to create larger user base

3.3 The Six Characteristics

The literature reveals six characteristics that comprise the basis of open innovation. Open source software provides us with an excellent example for how these characteristics work in concert.

The characteristics are: 1) The motivation behind open innovation contributions from individual users and user-based communities; 2) The importance of lead users in the facilitation and guidance of open innovation projects; 3) The use of open innovation as the means to facilitate the adoption of complementary products or services; 4) The role that technology plays to facilitate user-based contributions; 5) The role open innovation plays in regards to a firm's knowledge management capacity and organizational structure; 6) The concept of IPR and the related managerial decision to determine how best to manage the trade-off between how much IPR to be revealed.

3.3.1 Characteristic 1: Motivation

A key characteristic behind any open innovation project is the individual motivation behind the contribution of individual users and user-based communities. There are two conceptual forms of motivation inherent to any human endeavor: intrinsic and extrinsic. Intrinsic motivations occur when a user values an activity for its own sake. Extrinsic motivation occurs when there is an expectation of an outcome of some sort. It may be a financial reward, peer recognition or as a signaling tool to potential employers of a user's competence or creativity. The benefits that influence motivation are defined as either pecuniary (monetary) or non-pecuniary (non-monetary). Both intrinsic and extrinsic motivation for open source software projects are primarily influenced by non-pecuniary benefits.

Fuller (2010) further defines the motivational characteristics at work in the context of an open innovation project (see Table 5). In Table 5, we can discern that intrinsic motivation enables contribution to a wider range of product categories than would occur through extrinsic motivations alone. This is an important distinction as firms look to harness ideas from outside its value chain.

Table 5: Proposed Impact of Motives on Expectations

	Extrinsically Motivated	Intrinsically Motivated
Preferred Behavior	Goal-Orientated Looking for Valued Outcomes	Experimental-Orientated Looking for Enjoyable Experiences
Interest in Co-Creation Projects	Situational/Selective Depending on offered outcome	Enduring/Non-Selective Depending on Process
Product Category	Directed Certain Product Categories Only	Non-Directed Wide Range of Product Categories
Task	Specific Certain Co-Creation Tasks Only	Broad Various Co-Creation Activities
Incentives / Rewards	Monetary Benefits Financial Compensation Participation in Product Success	Rewarding Experience Feedback Recognition
Context / Support	Supporting Task Completion Facilitates/Reduces Work	Experience Enriching Provide Recreation
Interaction Partner	Instrumental/Pragmatic Serving Needs Offering Solution/Compensation	Ritualized Well-Known/Prestigious

Source: Fuller, 2006, p. 106

Table 6 provides a range of motivational categories progressing from extrinsic to internalized extrinsic, then on to intrinsic, from experiential-oriented behavior to goal-oriented behavior (Fuller, 2006).

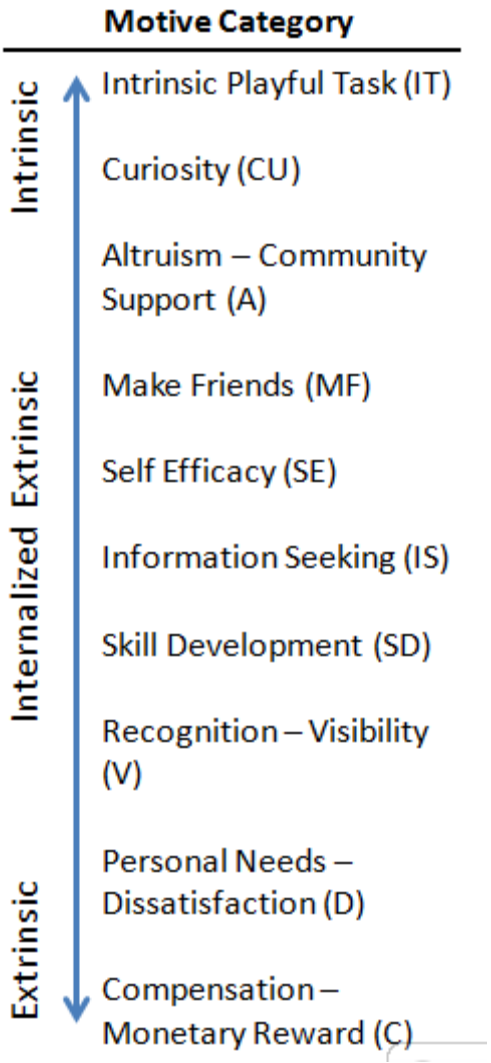
By understanding user motivation, management can either direct users toward a preconceived goal via extrinsic motivation, or enable users to push the boundary of management's understanding of the topic via a more intrinsic-structured way of stating a

problem. This concept is expanded upon by Lakhani and Jeppesen (2010) in their paper on broadcast search.

"Although managers may play a central role in choosing problems and the institutional mechanism for having them solved, the inclusion of broad external and marginal perspectives on the problem design and definition phase may also be valuable, and perhaps make problems more 'solvable'" (Jeppesen and Lakhani, 2010). The authors identify various groups of users, highlighting women as a group that is historically ignored or discounted. Yet, they found that women contributed disproportionately to the open innovation project in their study. It is inconclusive whether this finding is statistically significant given that this was the only paper that made note of it.

Jeppesen and Lakhani also highlight the benefit that can be brought by people from an industry that are outside of the particular industry looking for new ideas. For example, in 1714, the British Parliament established a prize to be awarded to anyone who could find a solution to determining the longitude while at sea. Sir Isaac Newton was one of the judges on the prize committee and thought the answer lay in the field of astronomy. Instead, clockmaker and carpenter John Harrison came up with the winning idea, "evidencing a novel understanding of materials science and mechanics" (Randall, 1996). Carpenter used his knowledge of precise instrumentation and applied it to navigation. It took forty years for the committee to award Harrison with the award, as parallel advancements in manufacturing enabled the construction of a usable version of his invention.

Table 6: Motive Categories for Engaging in Virtual Co-Creation Projects



Source: Adapted from Fuller, 2006, p. 105

Open source software (OSS) projects encompass the open innovation process in the design, distribution, and after sales support of software as they include input from outside sources (von Hippel and von Krogh, 2003). Open source software projects also provide an understanding of how communities function. An excellent example is what happened with the software company Apache, whose products are used in servers that constitute the backbone of the World Wide Web. As the software was initially being implemented and used, but still very much in need of refinement (or, 'field support" Lakhani and von Hippel, 2002) question-and-answer forums were established for developers and early users. Free

flow discussions were taking place. Both the company and the customers had an extrinsic motivation to get the technology in working order.

The information seekers were extrinsically motivated because they were interested in both solving a specific problem (information seeking (IS) from Table 6) and in gaining skills (skills development (SD) from Table 6), which also can be considered internalized intrinsic goal seeking. The information providers were similarly motivated, with the added category of gaining reputational benefits (recognition / visibility (V) from Table 6). According to Fuller's (2006) intrinsic-extrinsic motivation scale, gaining recognition for participation is a more extrinsically motivating force. This is an important distinction in that it may dispel the notion that open source software projects are dominated by intrinsically motivated individuals.

Von Hippel further solidifies this point; "In the Apache project, paid participation and status motivation predict above-average developer participation, and interestingly, the use-value motivations predict below-average contribution levels" (von Krogh and von Hippel, 2006).

It is understandable that in the context of a technical support forum users are motivated by extrinsic factors. The work in itself is mundane and does not allow a great deal of creativity on the part of those asking or answering questions. Communities, however, are capable of producing intrinsically motivated forces given the right environmental factors. Interestingly, the majority of time spent on the help website by information providers; 98%, is used to read questions, while 2% is used to provide answers (Lakhani and von Hippel, 2002).

Nordic OSS firms, in particular, have found other ways to use open innovation processes. Rather than fixing software glitches that may seem mundane, users developed source code, which demonstrates technical expertise and earns them respect, status, or, what is referred to 'social motivational factors" (Dahlander and Magnusson, 2005; 2008). The added status also increases the users' self-esteem and the knowledge that he or she helped others, which

translates to “altruism - community support (A)” from Table 6. This motivational category, although technically still in the internalized extrinsic grouping, is at the border of pure intrinsic motivation. The implication is that contributors are “beneficiaries of the public good because they care about the system as such” (Dahlander and Magnusson, 2005).

MySQL, another software company, built an open source community to develop database software. It engaged in a symbiotic open source relationship with its contributors. “A symbiotic approach implies that the firm is focusing on the realization of mutual benefits for both the firm and its community” of users and developers (Dahlander and Magnusson, 2005). The community engagement at MySQL organized social events, including fairs and workshops, for users and developers. O’Mahony and Ferraro (2004) found that face-to-face interaction among community members helps shape social norms and create acceptance for the commercialization of user generated input. The implicit take-away is that the more contributors are made to feel they are an important part of the community as a whole, the more their motivations shift toward the intrinsic end of the motivational factors scale (see Table 6).

In summary, the motivation to participate in open source projects is mainly extrinsic at the individual level. Once open source projects take on a community element, motivations become more intrinsic. The effort of establishing a symbiotic, intrinsically inclined community is worthwhile for a firm because intrinsically motivated individuals are more likely to develop creative solutions and participate in a wider range of tasks in a wider range of industries (Fuller, 2006).

3.3.2 Characteristic 2: Lead Users

The second characteristic of successful open innovation-based projects is the involvement of lead users. Lead users are individuals, or a group of individuals, that display a high degree of competency and creativity. They tend to contribute disproportionately to projects and as

such enable lesser users to contribute to or learn from open innovation communities. Lead users can be found both inside and outside of a firm. If they are not employed directly by a firm, the importance of the open innovation community fostering more intrinsic motivational factors becomes more important.

Fuller (2006) does not address the issue of lead users directly, but he does state that those individuals who make the most meaningful contributions to open innovation projects are those that show the highest ability in 'web-exploration related' skills and 'innovation related' characteristics. Web-exploration related skills refer to a user's technical skill set. The nature of open innovation projects is that they occur online. Thus, it's important that an individual is well versed in online-related tools. These can range from programming languages in the open source software environment to graphic design tools in a product-design environment. Innovation-related personal characteristics refer to an individual's inherent creativity. So, while their technical skills are a precondition to contribution, a contributor's ability to think in a creative manner further enables a lead user to make a meaningful contribution.

Case studies in the literature illustrate that lead users contribute disproportionately to open innovation projects. In the case of the firm Apache, the most active 1% of the users in the open source software environment originated 20% of the posts, and the top 20% of contributors originated 61% of the posts (Franke and von Hippel, 2003). Stated another way, the Apache open source environment relies on roughly 100 contributors who in aggregate provide 50% of the posts (Lakhani and von Hippel, 2003). From the 'motivational characteristics' section of this paper we know, that 98% of users find value in their efforts to take part in an open innovation community. As such, we can infer that not only do lead users contribute disproportionately to the open innovation community at large, but that they facilitate the involvement of users with lesser skills or creativity.

It is also notable to point out that lead users spend a considerable amount of time on their contributions. From the Apache case, we know that lead users answer hundreds of postings. When we look at open innovation from the perspective of a competition, much like the

navigation at sea case from the motivational characteristics section, we see a direct correlation between the hours of effort spent and the winning solution (Jeppesen and Lakhani, 2010).

Who are these highly competent, creative and hard working contributors?

The sports equipment industry provides a clear case of a handful of individuals who provided a disproportionate contribution on an industry. In the mid-1970s, a few creative individuals with a passion for windsurfing started using ocean waves in Hawaii as a ramp to jump off of. By the late-1970s, with the addition of a few more key contributors that had advanced technical skills, the concept of adding straps to a windsurfing board as a means of keeping the board from flying off of the participant's feet mid-air allowed the sport to flourish. Larry Stanley, one of the founders of the sport, said, "As soon as we did it (adding straps to the board), there were about ten of us who sailed all the time together, and within one or two days there were various boards out there that had foot straps of various kinds on them and we were all going fast and jumping waves" (von Hippel, 2001, p. 83). In addition to the contribution by the lead users, a sense of community, spurred by face-to-face interaction, created an intrinsically motivated group of individuals who together transformed the traditionally tranquil sport of windsurfing, normally done on placid lakes, into an extreme sport, competing with surfers for waves in Hawaii.

The examples provided by the transformative effect of a few individuals in the windsurfing and server software industries shows the power of intrinsically motivated, non-compensated, contributors to manage an internally generated flow of information to evolve an industry category. The other category of lead users come from firm employed, extrinsically motivated, individuals who use externally generated flows of information to evolve a product offering. For example, manufacturers of windsurfing boards or rival server software firms, like Sun Microsystems, likely used the advancements from its respective open innovation communities to update its product offerings, or to launch new lines altogether.

This alternate approach is taken up by Chesbrough and Crowther (2006) as they discuss how firms can leverage knowledge generated outside of the firm.

Chesbrough takes the concept of the lead user in the private-collective construct and pivots toward a market based approach where firms employ 'internal champions' challenged with internalizing technology developed elsewhere in order to keep up with the technology curve. It is the job of the internal champion to work cross functionally to disseminate technology developed elsewhere into a firm's "existing product development phase-gate process" (Chesbrough and Crowther, 2006). The authors view this as a top-down process, heavily involving the R&D function (Chesbrough and Crowther, 2006). We can infer that the ideal champion would be the CIO, or even the CEO, given the breadth of knowledge that a top down approach would require. Unfortunately, the literature does not shed additional light on this topic.

A caveat of lead user contributions is the recognition that lesser users can free-ride on the work done by lead users. The dilemma facing contributors comes in the form of how much and whether to contribute private goods – their skills, creativity and time – to the creation of a public good – an open innovation project. Von Hippel and von Krogh (2003) argue that the private benefits that accrue during the process of contributing to an open source software project outweigh the private costs associated with revealing such information. This means that the act of contributing private goods "becomes a benefit in itself, over and above the public good it is intended to produce" (von Hippel and von Krogh, 2003). Free-riders would not share in the more intrinsically motivated benefits, such as learning through creative problem solving.

West and Gallagher (2006) call this free-rider imposed dilemma the "paradox of firm investment in open source software". The answer to this dilemma will be picked up in the complementary assets section of this paper. Suffice to say that if either the size of the industry grows, or the market adoption of the technology increases as a result of technology leakage, it benefits all parties involved.

In summary, lead users and industry champions are critical success factors in open innovation projects. These leaders benefit above their marginal costs of doing so. They also facilitate lesser users to contribute to their own understanding and the project as a whole by posing non-rhetorical questions and pointing out bugs or errors of logic. The transformational impact of industry leaders are vividly illustrated by extreme windsurfing. The work done in open source software is just as tangential when we realize that the software powering the backbone of the internet, its servers, and many of its services, like Wikipedia, were developed through the collective action of relatively few people.

3.3.3 Characteristics 3: Complementary Assets

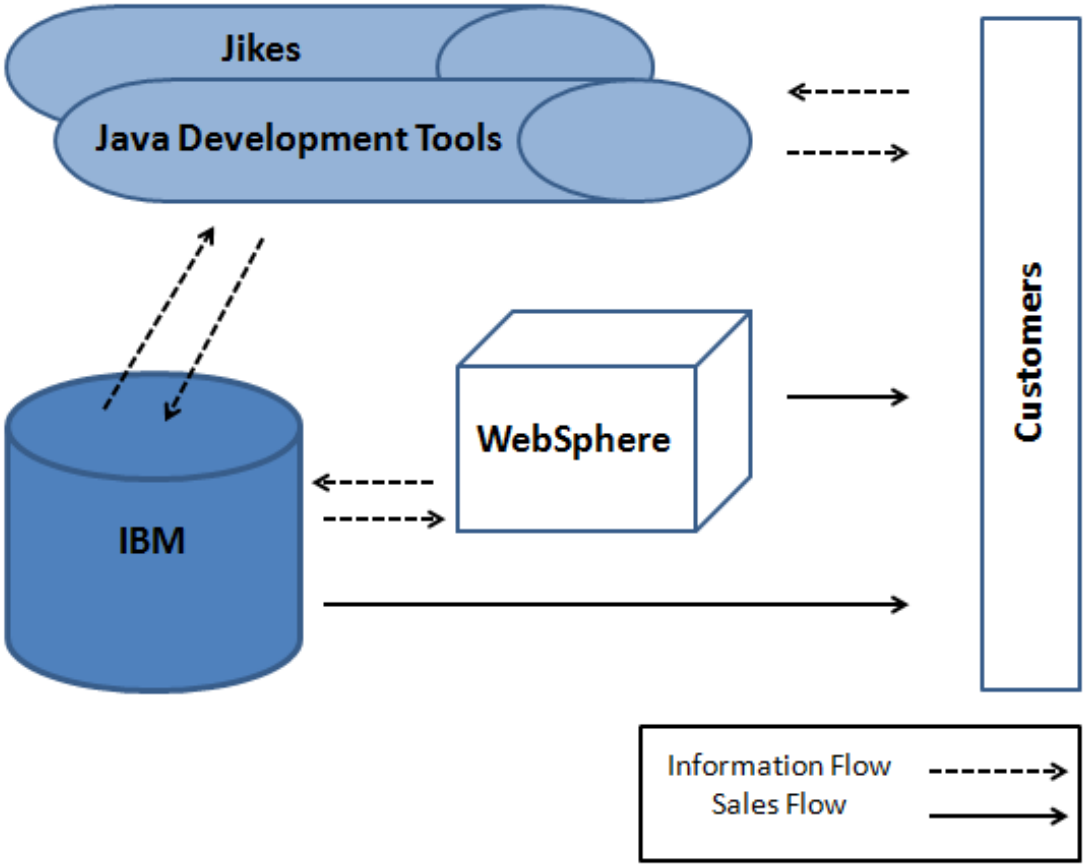
The third characteristic of successful open innovation projects is the concept of complementary assets. A complementary asset is any asset that compliments a firm's core business such as a chain of gas stations for an oil company. We are interested, specifically, in those complementary assets that play a role in the facilitation of a firm's innovation process. Complementary assets can occur inadvertently, as in the case of technology leakage discussed in the lead user section, or by design. Since it is not a core part of the business, a complementary asset may reside outside of the formal boundaries of a firm. It may, in fact, be beneficial to a firm if a complementary asset does reside outside its boundaries. We have seen that in open innovation projects, a more intrinsically motivated user base will contribute more creative ideas. The mechanics of creating an intrinsically motivated user base are more theoretical than the process of facilitating user contribution. As such a review of how firms use complementary assets, on the other hand, is best done by reviewing cases presented in the literature.

IBM is held up as a model of an innovative company. The company, which is historically associated with hardware and infrastructure, has successfully transformed itself into a service provider. The decision by IBM management to exit from the PC market was an implicit admission that it could not maintain its leadership position in an industry that had quickly

become one dominated by low-cost manufacturers. The exit also demonstrates the higher margins associated with knowledge intensive service processes. By 2009, over half of IBM's profits came from services – a business segment that the company originated only 15 years prior (Chesbrough and Rosenbloom, 2002). In addition to exiting lower margin industries, IBM successfully developed complementary assets, such as Java development tools, to spur adoption of its core business and thwart rivals from cornering the market.

The Java programming language, created by Sun Microsystems, provides an example of how IBM employed a complementary assets strategy to challenge Microsoft and establish an open source community it could benefit from. IBM developers rolled out a Java compiler tool, Jikes, and Java development tools, for use in its WebSphere application server product, and then released the technology for further development in an open source environment (von Krogh et al, 2009). The ensuing non-profit corporation resulted in the further development of the Java development tools by users outside of IBM (see Figure 1). An IBM executive explains the company's thinking; "It is not that we are looking to make more money off the platform. It is just that we are looking to accelerate the adoption of Java and the building up of it for all of us" (West and Gallagher, 2006, p. 325). The IBM example shows how it obtained and developed a complementary asset and released it to the open source environment to help spur the market adoption of its WebSphere product, en route to facilitating the company's transition to an innovative service based company.

Figure 1: IBM usage of complimentary assets



Source: Authors own figure

IBM employed a similar strategy with the Linux operating system (OS). Although IBM did not create Linux, IBM understood that with enough investment it could be a counterweight to the Windows OS. Investment would be needed to ensure that the product worked effectively enough to bundle the OS with its existing products, in a complementary manner, rather than having to pay royalty or development fees to Microsoft. Other technology companies similarly realized the potential of the OS, leading to the institutionalization of further development work on the OS through the creation of the Open Source Development Labs (OSDL) (Chesbrough and Appleyard, 2007). Board seats on the OSDL cost $500,000, effectively giving Linux corporate sponsorship. Given that it maintained its OSS status the trade-off seems to be worth it as the integrity of the private-collective project remains intact. The OS would now have the necessary infrastructure in which to compete effectively against the incumbent Windows. An IBM executive, in order to illustrate the thinking behind the

company's involvement in open source projects said; "I have long observed that it takes $500 million to create and sustain a commercially viable OS. Today, we spend about $100 million on Linux development each year. About $50 million of that is spent on basic improvements to Linux to make it more reliable. The other $50 million is spent on things that IBM needs, like special drivers for particular hardware or software to connect with it. We asked the OSDL to estimate how much other commercial development spending was being done on Linux. This didn't count any university or individual work, just other companies like us. They told us the number was $800-900 million a year, and that the mix of basic vs. specific needs was close to 50/50. So that $500 million investment (required for an operating system) is also there now for Linux as well (counting only the basic portion, not the specific portion). And we only pay $100 million towards that. So, you can see even from a very narrow accounting view that this is a good business investment for us" (Chesbrough and Appleyard, 2007, p. 72).

The pharmaceutical industry has also used the concept of open source complementary asset generation to capture value. Merck realized that the mapping of the human genome would create opportunities to develop drugs based on genetic markers. In a preemptive move to keep biotech firms from patenting the various genetic markets, Merck established the Merck Gene Index as an open source intellectual commons (Chesbrough and Appleyard, 2007). Merck also contributed its own resources to ensure that the project fulfilled its complementary role of providing a repository of information that Merck could then use to develop drugs.

Nokia, a wireless telecommunication company, provides an example of how a company's intellectual property can be used as a complementary asset. Nokia established the global system for mobile communication (GSM) technology as a standard for wireless communication. Nokia did so not just by developing the technology, but by willingly licensing it to partners and competitors so as to facilitate the development of the necessary chipsets for implementing the standard (Chesbrough, 2003). Europe today is a direct beneficiary of this strategy. America, on the other hand, never agreed to a standard

communications system. As such, telephone calls in America are constantly dropped as the cell phone switches between competing wireless systems.

The selected examples of the work done by IBM, Merck and Nokia illustrate how firms can create complementary assets in an open-source environment to capture value and facilitate market adoption of their core businesses. These examples also show the societal benefits of an open business model, which both extracts from and contributes to technological progress.

3.3.4 Characteristics 4: Technology

Using technology to facilitate user-based contributions is the fourth characteristic of successful open innovation projects. Technology in this case refers to design, development and communications. It can be used to either facilitate development work or communication through open innovation. Consumers display heterogeneous demand in consumption of products and service processes (Vargo and Lusch, 2009). This characteristic of consumer behavior makes it difficult for a firm to predict consumption patterns. It also makes it difficult for a firm to build products or offer service processes to all consumers. As such, the use of technology enables firms to transfer heterogeneous value creation to the consumer. If we extend this concept to its logical conclusion, a firm could simply offer a minimally viable product or service process, based on its core competence, and then enable consumers to tailor it to fit their needs and demands, using the technology.

Technology can be used to facilitate communication amongst the OSS community members. Dahlander and Magnusson (2005) propose that ‘interaction tools’ (such as online forms, mailing lists, etc.) can facilitate communication at the intersection between a firm and its community. This form of technology is rather standard at this point and has been in use since the beginning of the OSS movement. Other, more novel, communication technologies are the usage of virtual worlds where a user can create an avatar to interact with other community members. An avatar is a virtual representation of a person and enables that

person to represent himself or herself in a chosen manner. In fact, an avatar can better represent a person's "true self" than in face-to-face settings (Kohler et al, 2009). This could be due to the fact that social barriers are relaxed through anonymity. That is, a person is not prejudged by race, age or gender in an environment that lacks inherent biases. In the OSS environment, users are judged on the quality of their contribution.

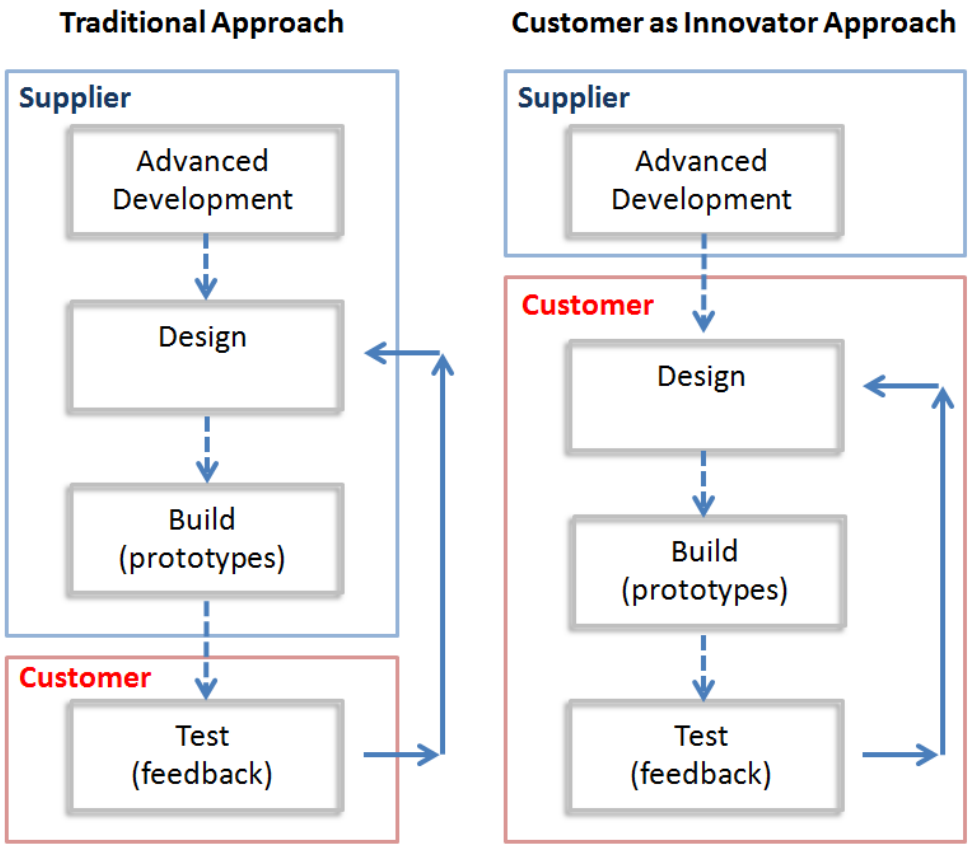
IBM uses virtual world technology to enable its geographically diverse workforce to attend meetings together. The results of these unique meetings show that they create a sense of camaraderie which would have otherwise not been possible without extensive traveling (Kohler et al, 2009).

Technology being used to facilitate the development work of open innovation projects is referred to in the literature as user "tool kits" (von Hippel and von Krogh, 2003). Tool kits provide a means of transferring value creating tools and processes to enable consumers to adjust homogeneous products or services to their heterogeneous needs. In the idealized form, tool kits constitute the democratization of the innovation process (Franke and von Hippel, 2003). According to the literature, tool kits provide for important capabilities: 1) They allow users to run through an iterative design process of trial and error without having to manufacture; 2) They are user friendly, and decrease the learning curve involved with acquiring design skills or other technical competencies; 3) They contain properly vetted knowledge libraries users can reference, and 4) tool kits must impart knowledge about the capabilities and limitations of the manufacturing process (Thomke and von Hippel, 2003). Tool kits enable a feedback loop earlier than that provided by the traditional product design cycle. The implication of a well structured user tool kit is a complete reanalysis of the role of the customer in the innovation process.

Figure 2 shows the traditional approach of new product development versus the customer-as-innovator approach (adopted from Thomke and von Hippel, 2003). In the traditional approach, new product or service design is done within the boundaries of the firm. Finished products are then tested by the customer. The customer then provides feedback to the

company's design personnel and the iterative process begins. The customer as an innovator approach, on the other hand, leaves the entire design and iterative approach to the customer. The firm conducts the advanced development in both models. The advanced development process can be thought of as the firm's core business or IP. This diagram proposes an answer as to how to deal with the fact that consumer tastes are heterogeneous. By recognizing this fact, a firm can act accordingly to empower the consumers with a user tool kit and allowing them to modify the product to service to their individual specifications. This process will continue until a finite number of market segments emerge. The communication interface between the firm and its community takes place at the boundary separating the two. That said, however, a firm will most likely also be involved in the design, build and test process. To what extent is depended on the firm's resources and business model.

Figure 2: The customer-as-innovator approach to new product / service design



Source: Thomke and von Hipple, 2003

The second capability of user tool kits can be expanded upon with the concept of adding modularity to the design architecture. Design "architectures that are modular allow developers to focus their talents on specific modules without having to learn the whole system" (West and O'Mahony, 2008). By breaking the design work into specialized pieces, users that lack the competence required at all stages of value creation can still contribute to a predefined subset of value creation.

The video games industry has benefited from the user as an innovator approach. The Turkish company TaleWorlds followed the approach exactly. The company was founded by a husband and wife team. The two of them produced a minimally viable product, with the help of outsourced programmers, and then released a beta version (or minimally viable version) to the market (http://forums.taleworlds.com/). Because the game concept was novel

and fun to play, it attracted a large following of enthusiasts who were motivated to develop the game further. TaleWorlds supplied its fans with tool kits, enabling them to create user-generated modifications ("mods"), which contributed to a more refined version of the game. The development of mods had the second benefit of keeping the title in front of the consumer for a longer period of time than normal product cycles would dictate. This gives publishers time to develop follow-on products without tying up core internal development and design resources (West and Gallagher, 2006). The virtuous cycle of releasing a minimally viable version, involving the consumer in the value creation process through the development of mods, feeding back those refinements to the company's core development team and then developing follow-up products has resulted in success for TaleWorlds specifically, and many other gaming companies in general. Given the high cost of developing today's advanced games, this model gives upstarts a viable way of overcoming barriers of entry due to monetary constraints.

In summary, the use of technology to facilitate the contribution of and communication between members of the OI/OSS communities and the firm shows a great deal of promise of helping a firm to segment its market and create value. The concept of the consumer as a value creator is an important contribution to the field. By empowering these consumers through the employment of tool kits, real value can be created. Innovative companies without large scale development-and-design resources can focus on delivering a core product or service process, use their customers as innovators, and have a much higher success rate when launching new products. Companies with large scale resources and capabilities also can follow this model. However, there is bound to be cultural and organizational inertia hindering their efforts, given that this approach requires firms to hand over control of all but the most crucial parts of its value chain to its consumers.

3.3.5 Characteristics 5: Knowledge Management

The fifth characteristic relates to a firm's capacity to successfully capture, retain and employ knowledge gained through open innovation projects. Several authors make an explicit

connection between open innovation and knowledge management (Lichtenthaler, 2011; Lichtenthaler and Lichtenthaler, 2009; Spithoven et al, 2010). The basis of this connection comes through the concept of dynamic firm capacities (Teece, 1986; Teece, et al, 2007). Internal expertise at knowledge management is a dynamic capability for any firm.

The importance of making an explicit connection between open innovation and knowledge management (KM) is to determine whether a firm has the absorptive capacity to benefit from inbound open innovation (Spithoven et al, 2010; Cohen and Levinthal, 1990). Open innovation increases both the volume and complexity of information a firm has to absorb. Consequently, the demands on management are increased. Ulrich Lichtenthaler, Chair of Organization at the University of Mannheim, Germany, also emphasizes that open innovation puts pressure on management to take a closer look at how products and service processes are developed in regards to the needs and demands of the marketplace, and to increase the emphasis on consumer input in strategic business development.

"Open innovation is defined as systematically performing knowledge exploration, retention, and exploitation inside and outside an organization's boundaries throughout the innovation process" (Lichtenthaler, 2011, p. 77).

The user-as-innovator approach assumes that absorptive capacity is implicit in open innovation projects. But if making absorptive capacity an explicit concern, we can then begin the process of refining our understanding of how a firm may benefit from open innovation. The exploration, or capturing of knowledge, process is done through the iterative process of soliciting feedback from consumers, thus acquiring knowledge. The retention process refers to maintaining knowledge outside of a firm's boundaries by using inter-organizational relationships as an extension of the internal knowledge base (Lichtenthaler and Lichtenthaler, 2009). This is done by companies that do not have an internal R&D-reliant approach to innovation. The exploitation process is simply how a firm benefits commercially from the knowledge gained through the open innovation process. This can be done through licensing technology to collaborative, complementary companies

(Chesbrough and Crowther, 2006) or through producing company owned products or service processes.

In summary, knowledge management is a consideration in business model design in that it is important to capturing new ideas. A firm's capacity to absorb and commercialize ideas is an important consideration when designing its value chain. It is not enough to go through the iterative process of the user-as-innovator approach if the mechanisms are not in place to benefit from the process.

3.3.6 Characteristic 6: IPR, selective revealing and managerial complexities

The sixth characteristic of successful open innovation projects is concerned with the trade-off between the degree to which innovation is revealed. The purpose of intellectual property rights (IPR) is to ensure that an innovator can appropriate profits from his innovations, thus motivating him to reveal his innovations to the public in the first place. In traditional business models, where community involvement is not central to business operating procedures, ensuring the exclusivity of innovations is common practice. In open innovation, where community involvement is central to the business model, there is a strategic decision as to what information is shared, and what information remains confidential and proprietary.

The open source software industry uses a form of IPR, called the general public license (GPL), which stipulates that collaboratively developed source code is freely available to the public, and is responsible for much of the industry's ability to attract developers residing outside the firm (Von Hippel and von Krogh, 2003). The GPL gives assurance to these developers that a firm will not appropriate profits based on their work. In theory, this concept holds and firms find other ways to profit from open innovation, as discussed in the complementary assets section. In practice, the extent to which code developed under the GPL is revealed can be manipulated by firm management to achieve strategic firm goals.

Henkel (2006, p. 966) states; “Commercial OSS development, even if based on GPL’ed software, perfectly well accommodates a combination of free revealing and various means of protecting one’s code. Firms thus have the chance to practice selective revealing.” The specific accommodating mechanisms that Henkel is referring to consists of three parts: 1) Code only has to be revealed to paying customers; 2) The delay between development and revealing due to the time lag between development and product launch; and 3) The practice of making drivers only available as loadable binary modules rather than source code (Henkel, 2006). The delay creates a de facto first mover advantage, effectively delaying rival firms from utilizing the GPL code in its own products.

A further literature review uncovers various ways that firms practice selective revealing. Dahlander and Magnusson (2005) segment the approach of how Nordic OSS firms practice selective revealing into three categories: from most collaborative to least; symbiotic, commensalistic and parasitic. The firm MySQL, as discussed above, provides an example of how a firm can succeed by taking a symbiotic approach to IPR management, where both the firm and its community benefit from the relationship. The result of this approach entails segmenting the market into two tiers, where the base product is available for free and the more advanced, enterprise level, product is available at cost.

In addition to managerial decisions on the extent to which internal IP should be revealed, management also has to consider other ways in which open innovation practices can impact their businesses. The internal-R&D function uses a stage-gate process to develop, refine and test promising technologies. This construct, although effective, may leave room for improvement. The bio-pharmaceutical industry has traditionally used a stage-gate process, similar to manufacturing firms, in drug development. Recently firms in this industry have started to share technology and knowledge with “different types of partners along the phases of the drug discovery and development process” (Bianchi, et al, 2011). Along the discovery and development process bio-pharmaceutical companies will use inbound and outbound forms of open innovation. In the discovery stages firms will conduct inbound knowledge sourcing to do clinical testing of the products. In the later, developmental, stages firms will use outbound knowledge transfers to assess marketability.

Assessing marketability can be further refined. By splitting the stage-gate process into a more parallel, exploratory, process, firms can avoid the issue of false-negatives. False-negatives occur when a company erroneously identifies what could be a promising technology as not suitable to its core business. "The compound UK-92480 under development as a treatment for hypertension within Pfizer did not achieve sufficiently positive clinical results to warrant further development. Due to a rather unusual side effect, however, UK-92480 gave rise to one of Pfizer's most profitable compounds today - Viagra" (Chesbrough, 2004, p. 24). Chesbrough likens the process of using open innovation in drug discovery and development to a game of poker, as opposed to the traditional stage-gate method, which he likens to the game of chess. The differentiating factor between the two processes is the management of risk. Rather than minimizing false positives, a poker player manages false negatives. As industries across the spectrum of business move towards open innovation approaches the inherent management complexities will require leaders capable of better understanding and managing risk.

Lastly, the concept of breaking business process down into component parts, or modularity, has been used in the OSS industry. This practice allows users to contribute to specific areas. In this regard they are less hampered by competence deficiencies and can self-select which modules to work on (West and O'Mahony, 2008). There are very few users that that have both the technical skills and creativity that allow them to contribute to the complete development and design process. The process of breaking processes down into its parts puts an additional onus on management to determine how best to do so. The danger is that it could be difficult to reconnect the parts to develop a complete product or service process. It could also stifle the creative solution finding process that the user goes through by limiting their understanding of the overall task at hand.

4. Discussion

> *"The future lies in an appropriate balance of the open innovation approach, where the company or the institution uses every available tool to create successful products and services faster than their competitor and at the same time fosters the building of core competencies and protects their intellectual property" (Chesbrough, et al, 2009, p. 312).*

Open innovation (OI) is being discussed and utilized in several goods-producing industries, including software, video gaming, telecommunications, sports equipment, and pharmaceuticals. Each company discussed in this paper is sharing internal knowledge and gaining outside input in different ways. Economists in the academic arena are researching and writing about open innovation. There are two basic findings based on the research and the case studies: 1) There are six characteristics common to how the open innovation process has been implemented; and 2) There is no established, best practices process to implement open innovation.

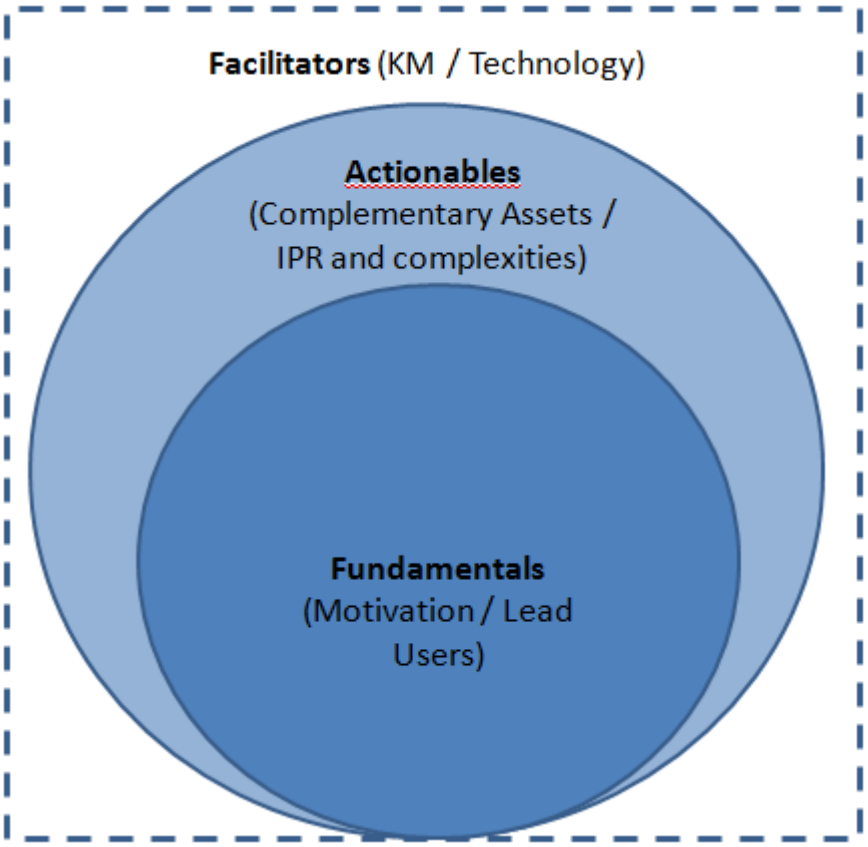
Because of the lack of a best practices direction, we cannot rule out the service industry's ability to adopt OI processes, even though little is found in the literature specifically referencing this industry (Pedersen and Aas, 2012). Service industries by definition provide (sell) expert skills or knowledge for a fee.

Service firms, like goods-dominated firms adherent to service-dominant logic, are in the business of monetizing skills and knowledge. Open innovation is about involving internal and external stakeholders in this process. The two concepts, open innovation and services, are compatible.

If a company in the service industry is to adopt an OI process, it needs to evaluate and prioritize the six characteristics so as to establish its own best practice process. For it to do

so, we propose that the six characteristics are grouped into three categories; fundamentals, facilitators, and actionables (see Figure 3). The characteristics in the "fundamental" category include the lead user and motivational factors. This category is fundamental to open innovation. The characteristics in the "facilitator" category include knowledge management and technology. This category facilitates open innovation projects. The characteristics in the "actionables" category include complementary assets and IPR and related managerial complexities. The actionables category includes various trade-offs that must be managed. The fundamentals category is the most important, but needs to coincide with the facilitator's category. The actionables category provides management with the basis of a strategic decision making process.

Figure 3: Three Categories of the Open Innovation Characteristics



Source: Authors own figure

Lead users are the most important of the characteristic of open innovation. Lead users, whether internal or external to a firm, drive the contribution process through their own

involvement and facilitation of user contributions. A lead user is most likely someone internal to a firm who has a high-level, cross-functional role in the company. The lead user has to be able to aggregate, analyze. and act upon information. This level of proactive engagement would most likely come from a person internal to the company, given the level of transparency and operational knowledge which they must possess. The lead user must also supply motivation to employees and contributors. The form of motivation used is important because, although extrinsically motivating factors are important, an intrinsically motivated contributor base is capable of more creative and technically challenging work. (Fuller, 2006)

In the context of a privately owned boutique hotel, which is a service-based firm, a lead user would be the hotel executive manager. Boutique hotels can struggle to make money because they cannot compete with larger hotel chains as they do not benefit from economies of scale, both from a cost and demand management standpoint. Also, the hotel industry is generally considered a low level knowledge-intensive industry, suffering from low margins as a result. Because of this, the boutique hotel executive manager has to be extremely capable and creative. He or she must understand what motivates employees to provide high levels of service. He or she must also be well versed in the intricacies of consumer heterogeneity. For example, a boutique hotel may orientate itself around a concept that resonates with a particular segment of consumers (i.e., eco-tourism, adventure, or specialized sports travel). By organizing a hotel around a sports concept, it can become a destination for a targeted consumer, rather than a tourist industry commodity (Chesbrough, 2011). In this sense, the hotel executive manager fully embraces the concept of providing a unique service, rather than providing an accommodation.

In order to find out whether a targeted consumer would be interested in these specialized travel concepts, the boutique hotel could engage in an ongoing dialog with potential customers, and even others in industry circles who could benefit from the new and specialized service. One way of doing this is to facilitate Web discussions, basing the discussions on the hotel's geographic or cultural strengths. For example, if the hotel is situated in the mountains of Norway, it could present services specialized in skiing or

snowboarding. Or, it could stimulate demand by creating family packages where the adults could engage in nature walks while the children could take part in specially planned games and events. These concepts would provide consumers with the necessary motivation for booking a trip to the boutique hotel rather than with a competing or alternative hostelry.

The foundational category, then, provides a basis for a service-based company working collaboratively with its community. The importance of a lead user becomes evident in that he or she must provide a vision for a service which his or her customers are motivated to purchase, and whose employees are motivated to support.

The second category of characteristics, facilitator, observed in our review section of open innovation practices, is also applicable to service-based firms. A boutique hotel, although not a knowledge intensive industry, needs to establish a web presence and a knowledge management system. The hotel can use its web presence and interact with customers and potential customers to determine the content of vacation packages. By establishing a virtual catalog of available activities, a customer can design her own vacation. The consumer can then design a package that is compelling enough that she would be willing to purchase the package. This is an example of the user-as-innovator approach where the design process is iterative. The feedback loop can then be used by the hotel to negotiated deals with local vendors. Consumer insights would then be aggregated throughout the hotel hierarchy, and within its systems, to aggregate the information in order to better tailor its offerings to future customers. The hotel can then get a sense of its customer segments and anticipate demand.

The third category of characteristics, actionables, observed in our review section of open innovation practices, provides a number of managerial decision points relevant for service related firms. In our hypothetical boutique hotel example, a hotel could develop complementary assets to drive demand to its core product. For example, by setting up a free skateboard park adjacent to its property, the hotel would increase demand for its offerings from customers interested in booking a room near a mountain with a snowboard park. This

also accommodates snowboard enthusiasts during the off season who are looking for a weekend retreat.

Applying the concept of selective revealing of IPR, from our review of open innovation characteristics, to a boutique hotel is a bit more difficult. However, with the understanding that IP can be extended to the hotel's brand concept, parallels can be made. A service firm is reliant on the perception of its brand and service quality. By opening up its web interface to user comments, a hotel can gain credibility in the consumer marketplace. There will be negative comments that need to be addressed, but even this sort of feedback can be used in a constructive manner. By addressing concerns and tailoring its offerings, the hotel's brand can become more credible and recognizable.

If we look at more knowledge-intensive, service-based firms, such as financial institutions, insurance firms, and consulting companies, we can use the same categorization method of applying open innovation characteristics. However, from the fundamentals category, the concept of motivation becomes more abstract. Humans are fickle creatures and motivations behind human action, or inaction, can often times seem contradictory. It is commonly accepted knowledge that a more engaged employee is a more motivated employee. We also know that the more engaged a consumer is with a brand, the more likely he she will be to buy its products. As such, it is important to understand the mechanisms of human motivation.

Psychologist Mihaly Csikszentmihalyi (1990) has identified the root cause of human motivation as "flow". Flow is the state in which people are so engaged in an activity that they are not conscious of the outcome. They are operating in a state of outcome independence where the process itself is of concern. Flow is the extreme form of intrinsic motivation.

The example of John Harrison's involvement in developing a system for determining longitude at sea was initially structured as a contest with a monetary prize awarded to the winner (extrinsic motivation). However, John Harrison had been working on the solution prior to the announcement of the prize and continued to work on it after his initial submission (intrinsic motivation). And although Harrison was a novice in the field of sea exploration, he was a professional in another complementary field, which held the key to solving the problem. So, it was Harrison's autodidactic personality, a characteristic of a person who experiences "flow" that accounted for his motivation for solving the centuries-old problem of navigation at sea.

A manager's role of a service firm, then, is to structure, or enable, an organization model that is conducive to the employees achieving high levels of intrinsic motivation, or flow. It is also his duty to get stakeholders outside his firm to actively engage in the user-as-innovator cycle by challenging their creativity and capabilities in a manner that will produce flow while doing so.

The actionable category, as derived from the characteristics of successful open innovation processes, can be applied to more knowledge intensive service firms in a number of ways. A service firm must first understand and separate its core business from its ancillary business. A financial services firm, for example, has a great deal of resources and product offerings. A financial adviser has to understand complex topics such as estate planning, portfolio management, and the regulatory environment. However, a financial advisor's real job is helping his clients mitigate risk. That is, a financial advisor's core competency must be his ability to make his clients understand how much money they are willing to lose for every basis point of potential gain. Taken to the extreme, once his core business is addressed, all other activities are ancillary. He can outsource the work of portfolio management and estate planning to specialist firms. These specialty firms can be seen as complementary to his core business. The success of a particular independent portfolio manager can be a selling point when a financial advisor conveys his wealth creation or preservation plan to his client. By outsourcing such ancillary activities to complementary firms, he can also insulate himself from conflicts of interest inherent to the financial services industry. By advertising his

affiliation with complementary firms, he is selectively revealing his own money management processes, or IP. This selective revealing can be strategically used to establish himself as a credible professional due to his transparent business practices.

Another example from open innovation that we can apply to a knowledge intensive services firm comes in the form of using technology as a facilitator. A consulting firm can create a website, like iConsult, that could be free to use by current or potential clients that could contain best practices and case studies of successful client engagements. These best practices and case studies could then be used by interested firms to reorganize its processes and procedures. However, if the interested firms were not able to implement the best practices or learn from the case studies on their own, due to lack of resources or competencies, the consulting company could be called in - for a fee. There is danger of IP leakage, but generally best practices and case studies are well known among competing firms. Consulting companies are generally called in due to the quality of the personal or successful track record, as opposed to their white papers. The opening up of professional service firms via transparency into their operations could give those who do so a competitive advantage in the market place. A credible firm is more likely to get, and keep, business.

Business model design provides service based firms with a way to move to an open innovation based approach without risking the profitability of the entire firm. Business models can be used to leverage (exploit) profitable business units in order to build out new (explore) business model concepts. This concept was first referred to as explore and exploit by March (1991) and has been used by goods-based firms to launch new product lines. It takes a commitment from management to properly fund new product lines. In fact, funding is the key success factors involved in the success of new business lines using this approach (O'Reilly and Tushman, 2011). They should also be given the same management coordination that exploited products lines, with a track record of profitability, are already given. "Organizations that develop effective instruments of coordination and communication probably can be expected to do better (on average) than those that are more loosely coupled, and they also probably can be expected to become more reliable, less likely to deviate significantly from the mean of their performance distributions" (March, 1991).

With the impact that globalization and instant communication have had on empowering people to contribute to open innovation projects (Shirky, 2010), the service industry needs to join the goods-dominant industry in including the marketplace in decisions of innovation. Service-based companies can implement open innovation processes by combining the six defined characteristics to meet the strategic goals of their business models.

5. Implications

The key component of open innovation is the human element. Active involvement from board level executives is critical to driving the adoption of open innovation processes - in any industry category, and especially in services where knowledge is more tacit. High level management, due to the nature of its position, has the ability to work at a high-level, cross-functional manner while understanding the details and nuances of the business. Development of the core product or service process is the starting point.

From there, it is up to management to deal with the trade-offs inherent to today's businesses, which operate in a highly-competitive, network-based environment with eroding IP protection, such as: 1) Risk versus reward of investment decisions; 2) Free revealing versus appropriation of intellectual property; 3) Identification and development of intrinsically motivated key personnel; 4) Core versus ancillary technology and processes; and 5) To what degree processes and problem solving can be broken into modular, workable parts, without marginalizing user contributions.

An entrepreneurial mindset is critical because high level management needs to understand both what resources are needed and how to pull them together so that they work in concert with each other to make the business profitable. If management understands the difference between what resources, technology and process are core to the business, as opposed to what is ancillary to the business, its decision making-process is simplified.

Consumer demand will always fluctuate. Trends come and go. Management is powerless to control it. But by involving consumers in the ancillary stages of development, consumers will be empowered to self-segment themselves and fulfill their own heterogeneous demands. This process, known as the customer-as-innovator approach, must be led by leaders that have the ability to codify tacit knowledge into actionable directives that employees can deliver on.

More research should be done to better understand how the management of innovative companies shares knowledge. The service industry can learn from the identified success characteristics of open innovation projects, especially the role of the lead user in OSS projects. The challenge service industry management has is to answer the question of how to include the marketplace in the value creation, delivery, and capture process. To do so will require complete commitment to the open innovation approach.

References

Articles

Allen, R.C., (1983), ‘Collective Invention’, Journal of Economic Behavior and Organization, Vol 4, pp. 1-24.

Bianchi, M. and Cavaliere, A. and Chiaroni, D. and Frattini, F. and Chiesa, V. (2011), 'Organisational modes for Open Innovation in the bio-pharmaceutical industry: An exploratory analysis', Technovation, Vol 31, No 1, pp. 22-23.

Bogers, M. and Afuah, A. and Bastian, B. (2010), 'Users as Innovators: A Review, Critique, and Future Research Directions', Journal of Management, Vol 36, No 4, pp. 857-875.

Bonaccorsi, A. and Giannangeli, S. and Rossi, C. (2006), 'Entry strategies under competing standards: Hybrid business models in the open source software industry', Management Science, Vol 52, No 7, pp. 1085-1098.

Chesbrough, H.W. (2011), 'The Case for Open Services Innovation: The Commodity Trap', California Management Review, Vol 53, No 3, pp. 5-20.

Chesbrough, H.W. (2003), 'The era of open innovation', MIT Sloan Management Review, Vol 44, No 3, pp. 35-41.

Chesbrough, H.W. (2004), 'Managing open innovation', Research Technology Management, Vol 47, No 1, pp. 23-26.

Chesbrough, H.W. and Crowther, A.K. (2006), 'Beyond high tech: early adopters of open innovation in other industries', R&D Management, Vol 36, No 3, pp. 229-236.

Chesbrough, H.W. and Rosenbloom R. (2002), ‘The Role of the Business Model in Capturing Value from Innovation: Evidence from Xerox Corporation’s Technology Spinoff Companies’, Industrial and Corporate Change, Vol 11, No 3, pp. 529–555.

Chesbrough, H.W. and Schwartz, K. (2007), 'Innovating business models with co-development partnerships', Research Technology Management, Vol 50, No 1, pp. 55-59.

Christensen, J.F. and Olesen, M.H. and Kjaer, J.S. (2005), 'The industrial dynamics of Open Innovation - Evidence from the transformation of consumer electronics', Research Policy, Vol 34, No 10, pp. 1533-1549.

Cohen, W. and Levinthal, D. (1990), ‘Absorptive capacity: a new perspective on learning and innovation’, Administrative Science Quarterly, Vol 35, pp. 128-152.

Dahlander, L. and Gann, D.M. (2010), 'How open is innovation?', Research Policy, Vol 39, No 6, pp. 699-709.

Dahlander, L. and Magnusson, M. (2008), 'How do Firms Make Use of Open Source Communities?', Long Range Planning, Vol 41, No 6, pp. 629-649.

Dahlander, L. and Magnusson, M.G. (2005), 'Relationships between open source software companies and communities: Observations from Nordic firms', Research Policy, Vol 34, No 4, pp. 481-493.

Dahlander, L. and Wallin, M.W. (2006), 'A man on the inside: Unlocking communities as complementary assets', Research Policy, Vol 35, No 8, pp. 1243-1259.

Dodgson, M. and Gann, D. and Salter, A. (2006), 'The role of technology in the shift towards open innovation: the case of Procter & Gamble', R&D Management, Vol 36, No 3, pp. 333-346.

Enkel, E. and Gassmann, O. and Chesbrough, H.W. (2009), 'Open R&D and open innovation: exploring the phenomenon', R&D Management, Vol 39, No 4, pp. 311-316.

Franke, N. and von Hippel, E. (2003), 'Satisfying heterogeneous user needs via innovation toolkits: the case of Apache security software', Research Policy, Vol 32, No 7, pp. 1199-1215.

Fuller, J. (2010), 'Refining Virtual Co-Creation from a Consumer Perspective', California Management Review, Vol 52, No 2, pp. 98-122.

Gassmann, O. and Enkel, E. and Chesbrough, H.W. (2010), 'The future of open innovation', R&D Management, Vol 40, No 3, pp. 213-221.

Henkel, J. (2006), 'Selective revealing in open innovation processes: The case of embedded Linux', Research Policy, Vol 35, pp. 953-969.

Huizingh, E.K. (2011), 'Open innovation: State of the art and future perspectives', Technovation, Vol 31, No 1, pp. 2-9.

Jeppesen, L.B. and Lakhani, K.R. (2010), 'Marginality and Problem-Solving Effectiveness in Broadcast Search', Organization Science, Vol 21, No 5, pp. 1-18.

Kohler, T. and Matzler, K. and Fuller, J. (2009), 'Avatar-based innovation: Using virtual worlds for real-world innovation', Technovation, Vol 29, No 4, pp. 395-407.

Lakhani, K.R. and von Hippel, E. (2003), 'How open source software works: "free" user-to-user assistance', Research Policy, Vol 32, No 6, pp. 923-943.

Lichtenthaler, U. (2011), 'Open Innovation: Past Research, Current Debates, and Future Directions', Academy of Management Perspectives, Vol 25, No 1, pp. 75-93.

Lichtenthaler, U. and Lichtenthaler, E. (2009), 'A Capability-Based Framework for Open Innovation: Complementing Absorptive Capacity', Journal of Management Studies, Vol 46, No 8, pp. 1315-1337.

March, J.G., (1991), 'Exploration and Exploitation in organizational learning', Organizational Sciences, Vol 2, No 1, pp. 71-87.

O'Reilly, C.A., Tushman, M.L., (2011), 'Organizational Ambidexterity in Action: How Managers Explore and Exploit', California Management Review, Vol 53, No 4, pp. 5-22.

Pedersen, P.E., Aas, T.H., (2012), 'Open Service Innovation: A Feasibility Study', NHH Center for Service Innovation, Discussion paper, Bergen: Norges handelshøyskole, (for reprint email author at per.pedersen@nhh.no).

Piller, F.T. and Walcher, D. (2006), 'Toolkits for idea competitions: a novel method to integrate users in new product development', R&D Management, Vol 36, No 3, pp. 307-318.

Spithoven, A. and Clarysse, B. and Knockaert, M. (2010), 'Building absorptive capacity to organise inbound open innovation in traditional industries', Technovation, Vol 30, No 2, pp. 130-141.

Stuermer, M. and Spaeth, S. and von Krogh, G. (2009), 'Extending private-collective innovation: a case study', R&D Management, Vol 39, No 2, pp. 170-191.

Teece, D.J., (1986), 'Profiting from technological innovation: implications for integration, collaboration, licensing and public policy', Research Policy, Vol 15, No 6, pp. 285-305.

Teece, D.J. and Pisano, G. and Shuen, A., (2007), 'Dynamic Capabilities and Strategic Management', Strategic Management Review, Vol 18, No 7, pp. 509-533.

Vargo, S. and Lusch R.F., (2004). 'The four service marketing myths: Remnants of a goods-based, manufacturing model', Journal of Service Research, Vol 6, No 4, pp. 324-335.

von Hippel, E. and von Krogh, G. (2003), 'Open source software and the "private-collective" innovation model: Issues for organization science', Organization Science, Vol 14, No 2, pp. 209-223.

von Hippel, E. and von Krogh, G. (2006), 'Free revealing and the private-collective model for innovation incentives', R&D Management, Vol 36, No 3, pp. 295-306.

von Krogh, G. and von Hippel, E. (2006), 'The promise of research on open source software', Management Science, Vol 52, No 7, pp. 975-983.

West, J. and Gallagher, S. (2006), 'Challenges of open innovation: the paradox of firm investment in open-source software', R&D Management, Vol 36, No 3, pp. 319-331.

West, J. and Lakhani, K.R. (2008), 'Getting Clear About Communities in Open Innovation', Industry & Innovation, Vol 15, No 2, pp. 223-231.

West, J. and O'Mahony, S. (2008), 'The Role of Participation Architecture in Growing Sponsored Open Source Communities', Industry & Innovation, Vol 15, No 2, pp. 145-168.

Books

Csikszentmihalyi, M., Flow: The Psychology of Optimal Experience, (New York, NY: Harper & Row, 1990).

Schumpeter, J., The Theory of Economic Development: An Inquiry into Profits, Capital, Credit, Interest, and the Business Cycle, (Cambridge, MA: Harvard University Press, 1934, Reprint 1996).

Shirky, C., Cognitive Surplus: Creativity and Generosity in a Connected Age, (New York, NY: The Penguin Press, 2010)

Websites

TaleWorlds discussion forums 2012, TaleWorlds, accessed July 1, 2012,

http://forums.taleworlds.com/.

6. Appendix

6.1 List of Reviewed Articles

No. of Citations (ISI)	No.	Reference
231	1	von Hippel, E. and von Krogh, G. (2003), 'Open source software and the "private-collective" innovation model: Issues for organization science', *Organization Science* , Vol 14, No 2, pp. 209-223.
218	2	Lakhani, K.R. and von Hippel, E. (2003), 'How open source software works: "free" user-to-user assistance',
176	3	Chesbrough, H.W. (2003), 'The era of open innovation', *MIT Sloan Management Review* , Vol 44, No 3, pp. 35-41.
97	4	Franke, N. and von Hippel, E. (2003), 'Satisfying heterogeneous user needs via innovation toolkits: the case of Apache security software', *Research Policy* , Vol 32, No 7, pp. 1199-1215.
78	5	Chesbrough, H.W. and Crowther, A.K. (2006), 'Beyond high tech: early adopters of open innovation in other industries', *R&D Management* , Vol 36, No 3, pp. 229-236.
73	6	von Hippel, E. (2001), 'Innovation by user communities: Learning from open-source software', *MIT Sloan Management Review* , Vol 42, No 4, pp. 82-86.
60	7	Henkel, J. (2006), 'Selective revealing in open innovation processes: The case of embedded Linux', *Research Policy* , Vol 35, pp. 953-969.
57	8	von Krogh, G. and von Hippel, E. (2006), 'The promise of research on open source software', *Management Science* , Vol 52, No 7, pp. 975-983.
52	9	Dahlander, L. and Magnusson, M.G. (2005), 'Relationships between open source software companies and communities: Observations from Nordic firms', *Research Policy* , Vol 34, No 4, pp. 481-493.
52	10	Christensen, J.F. and Olesen, M.H. and Kjaer, J.S. (2005), 'The industrial dynamics of Open Innovation - Evidence from the transformation of consumer electronics', *Research Policy* , Vol 34, No 10, pp. 1533-1549.
52	11	Dodgson, M. and Gann, D. and Salter, A. (2006), 'The role of technology in the shift towards open innovation: the case of Procter & Gamble', *R&D Management* , Vol 36, No 3, pp. 333-346.
52	12	Piller, F.T. and Walcher, D. (2006), 'Toolkits for idea competitions: a novel method to integrate users in new product development', *R&D Management* , Vol 36, No 3, pp. 307-318.
44	13	Chesbrough, H.W. (2003), 'The logic of open innovation: Managing intellectual property', *California Management Review* , Vol 45, No 3, pp. 33+.
43	14	West, J. and Gallagher, S. (2006), 'Challenges of open innovation: the paradox of firm investment in open-source software', *R&D Management* , Vol 36, No 3, pp. 319-331.
41	15	Chesbrough, H.W. andAppleyard, M.M. (2007), 'Open innovation and strategy', *California Management Review* , Vol 50, No 1, pp. 57+.
39	16	Dahlander, L. and Wallin, M.W. (2006), 'A man on the inside: Unlocking communities as complementary assets', *Research Policy* , Vol 35, No 8, pp. 1243-1259.
38	17	Bonaccorsi, A. and Giannangeli, S. and Rossi, C. (2006), 'Entry strategies under competing standards: Hybrid business models in the open source software industry', *Management Science* , Vol 52, No 7, pp. 1085-1098.
36	18	Chesbrough, H.W. (2007), 'Why companies should have open business models', *MIT Sloan Management Review* , Vol 48, No 2, pp. 22+.
30	19	Chesbrough, H.W. and Schwartz, K. (2007), 'Innovating business models with co-development partnerships', *Research Technology Management* , Vol 50, No 1, pp. 55-59.
30	20	Lichtenthaler, U. (2008), 'Open innovation in practice: An analysis of strategic approaches to technology transactions', *IEEE Transactions on Engineering Management* , Vol 55, No 1, pp. 148-157.
29	21	Chesbrough, H.W. (2004), 'Managing open innovation', *Research Technology Management* , Vol 47, No 1, pp. 23-26.
29	22	van de Vrande, V. and de Jong, J.P.J. and Vanhaverbeke, W. and de Rochemont, M. (2009), 'Open innovation in SMEs: Trends, motives and management challenges', *TECHNOVATION* , Vol 29, No 6-7, pp. 423-437.
25	23	von Hippel, E. (2007), 'Horizontal innovation networks - by and for users', *Industrial and Corporate Change* , Vol 16, No 2, pp. 293-315.
23	24	Enkel, E. and Gassmann, O. and Chesbrough, H.W. (2009), 'Open R&D and open innovation: exploring the phenomenon', *R&D Management* , Vol 39, No 4, pp. 311-316.
23	25	Lichtenthaler, U. and Lichtenthaler, E. (2009), 'A Capability-Based Framework for Open Innovation: Complementing Absorptive Capacity', *Journal of Management Studies* , Vol 46, No 8, pp. 1315-1337.

22	26	Kohler, T. and Matzler, K. and Fuller, J. (2009), 'Avatar-based innovation: Using virtual worlds for real-world innovation', *TECHNOVATION* , Vol 29, No 4, pp. 395-407.
20	27	von Hippel, E. and von Krogh, G. (2006), 'Free revealing and the private-collective model for innovation incentives', *R&D Management* , Vol 36, No 3, pp. 295-306.
18	28	Terwiesch, C. and Xu, Y. (2008), 'Innovation contests, open innovation, and multiagent problem solving', *Management Science* , Vol 54, No 9, pp. 1529-1543.
17	29	West, J. and Lakhani, K.R. (2008), 'Getting Clear About Communities in Open Innovation', *Industry & Innovation* , Vol 15, No 2, pp. 223-231.
14	30	West, J. and O'Mahony, S. (2008), 'The Role of Participation Architecture in Growing Sponsored Open Source Communities', *Industry & Innovation* , Vol 15, No 2, pp. 145-168.
14	31	Dahlander, L. and Magnusson, M. (2008), 'How do Firms Make Use of Open Source Communities?', *Long Range Planning* , Vol 41, No 6, pp. 629-649.
14	32	Spithoven, A. and Clarysse, B. and Knockaert, M. (2010), 'Building absorptive capacity to organise inbound open innovation in traditional industries', *Technovation* , Vol 30, No 2, pp. 130-141.
13	33	Gassmann, O. and Enkel, E. and Chesbrough, H.W. (2010), 'The future of open innovation', *R&D Management* , Vol 40, No 3, pp. 213-221.
11	34	Dahlander, L. and Gann, D.M. (2010), 'How open is innovation?', *Research Policy* , Vol 39, No 6, pp. 699-709.
10	35	Stuermer, M. and Spaeth, S. and von Krogh, G. (2009), 'Extending private-collective innovation: a case study', *R&D Management* , Vol 39, No 2, pp. 170-191.
10	36	Bogers, M. and Afuah, A. and Bastian, B. (2010), 'Users as Innovators: A Review, Critique, and Future Research Directions', *Journal of Management* , Vol 36, No 4, pp. 857-875.
10	37	Jeppesen, L.B. and Lakhani, K.R. (2010), 'Marginality and Problem-Solving Effectiveness in Broadcast Search', *Organization Science* , Vol 21, No 5, pp. 1-18.
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4	39	Bianchi, M. and Cavaliere, A. and Chiaroni, D. and Frattini, F. and Chiesa, V. (2011), 'Organisational modes for Open Innovation in the bio-pharmaceutical industry: An exploratory analysis', *TECHNOVATION* , Vol 31, No 1, pp. 22-23.
4	40	Huizingh, E.K. (2011), 'Open innovation: State of the art and future perspectives', *TECHNOVATION* , Vol 31, No 1, pp. 2-9.
3	41	Knudsen, M.P. and Mortensen, T.B. (2011), 'Some immediate - but negative - effects of openness on product development performance', *TECHNOVATION* , Vol 31, No 1, pp. 54-64.
3	42	Lichtenthaler, U. (2011), 'Open Innovation: Past Research, Current Debates, and Future Directions', *Academy of Management Perspectives* , Vol 25, No 1, pp. 75-93.

6.2 Breakdown of main authors referenced

Referenced			
Dahlander	**von Hippel**	**Chesbrough**	**Reference**
0	1	0	von Hippel, E. and von Krogh, G. (2003), 'Open source software and the "private-collective" innovation model: Issues for organization science', *Organization Science* , Vol 14, No 2, pp. 209-223.
0	1	0	Lakhani, K.R. and von Hippel, E. (2003), 'How open source software works: "free" user-to-user assistance', *Research Policy* , Vol 32, No 6, pp. 923-943.
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1	1	0	von Krogh, G. and von Hippel, E. (2006), 'The promise of research on open source software', *Management Science* , Vol 52, No 7, pp. 975-983.
1	0	0	Dahlander, L. and Magnusson, M.G. (2005), 'Relationships between open source software companies and communities: Observations from Nordic firms', *Research Policy* , Vol 34, No 4, pp. 481-493.
0	1	1	Christensen, J.F. and Olesen, M.H. and Kjaer, J.S. (2005), 'The industrial dynamics of Open Innovation - Evidence from the transformation of consumer electronics', *Research Policy* , Vol 34, No 10, pp. 1533-1549.
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0	1	1	Piller, F.T. and Walcher, D. (2006), 'Toolkits for idea competitions: a novel method to integrate users in new product development', *R&D Management* , Vol 36, No 3, pp. 307-318.
0	0	1	Chesbrough, H.W. (2003), 'The logic of open innovation: Managing intellectual property', *California Management Review* , Vol 45, No 3, pp. 33+.
0	1	1	West, J. and Gallagher, S. (2006), 'Challenges of open innovation: the paradox of firm investment in open-source software', *R&D Management* , Vol 36, No 3, pp. 319-331.
1	1	1	Chesbrough, H.W. andAppleyard, M.M. (2007), 'Open innovation and strategy', *California Management Review* , Vol 50, No 1, pp. 57+.
1	1	1	Dahlander, L. and Wallin, M.W. (2006), 'A man on the inside: Unlocking communities as complementary assets', *Research Policy* , Vol 35, No 8, pp. 1243-1259.
1	1	0	Bonaccorsi, A. and Giannangeli, S. and Rossi, C. (2006), 'Entry strategies under competing standards: Hybrid business models in the open source software industry', *Management Science* , Vol 52, No 7, pp. 1085-1098.
0	0	1	Chesbrough, H.W. (2007), 'Why companies should have open business models', *MIT Sloan Management Review* , Vol 48, No 2, pp. 22+.
0	0	1	Chesbrough, H.W. and Schwartz, K. (2007), 'Innovating business models with co-development partnerships', *Research Technology Management* , Vol 50, No 1, pp. 55-59.
0	1	1	Lichtenthaler, U. (2008), 'Open innovation in practice: An analysis of strategic approaches to technology transactions', *IEEE Transactions on Engineering Management* , Vol 55, No 1, pp. 148-157.
0	0	1	Chesbrough, H.W. (2004), 'Managing open innovation', *Research Technology Management* , Vol 47, No 1, pp. 23-26.
0	1	1	van de Vrande, V. and de Jong, J.P.J. and Vanhaverbeke, W. and de Rochemont, M. (2009), 'Open innovation in SMEs: Trends, motives and management challenges', *TECHNOVATION* , Vol 29, No 6-7, pp. 423-437.
0	1	0	von Hippel, E. (2007), 'Horizontal innovation networks - by and for users', *Industrial and Corporate Change* , Vol 16, No 2, pp. 293-315.
0	0	1	Enkel, E. and Gassmann, O. and Chesbrough, H.W. (2009), 'Open R&D and open innovation: exploring the phenomenon', *R&D Management* , Vol 39, No 4, pp. 311-316.
0	1	1	Lichtenthaler, U. and Lichtenthaler, E. (2009), 'A Capability-Based Framework for Open Innovation: Complementing Absorptive Capacity', *Journal of Management Studies* , Vol 46, No 8, pp. 1315-1337.

0	1	1	Kohler, T. and Matzler, K. and Fuller, J. (2009), 'Avatar-based innovation: Using virtual worlds for real-world innovation', *TECHNOVATION* , Vol 29, No 4, pp. 395-407.
0	1	1	von Hippel, E. and von Krogh, G. (2006), 'Free revealing and the private-collective model for innovation incentives', *R&D Management* , Vol 36, No 3, pp. 295-306.
0	1	1	Terwiesch, C. and Xu, Y. (2008), 'Innovation contests, open innovation, and multiagent problem solving', *Management Science* , Vol 54, No 9, pp. 1529-1543.
1	1	1	West, J. and Lakhani, K.R. (2008), 'Getting Clear About Communities in Open Innovation', *Industry & Innovation* , Vol 15, No 2, pp. 223-231.
1	1	0	West, J. and O'Mahony, S. (2008), 'The Role of Participation Architecture in Growing Sponsored Open Source Communities', *Industry & Innovation* , Vol 15, No 2, pp. 145-168.
1	1	1	Dahlander, L. and Magnusson, M. (2008), 'How do Firms Make Use of Open Source Communities?', *Long Range Planning* , Vol 41, No 6, pp. 629-649.
0	1	1	Spithoven, A. and Clarysse, B. and Knockaert, M. (2010), 'Building absorptive capacity to organise inbound open innovation in traditional industries', *Technovation* , Vol 30, No 2, pp. 130-141.
0	1	1	Gassmann, O. and Enkel, E. and Chesbrough, H.W. (2010), 'The future of open innovation', *R&D Management* , Vol 40, No 3, pp. 213-221.
1	1	1	Dahlander, L. and Gann, D.M. (2010), 'How open is innovation?', *Research Policy* , Vol 39, No 6, pp. 699-709.
1	0	1	Stuermer, M. and Spaeth, S. and von Krogh, G. (2009), 'Extending private-collective innovation: a case study', *R&D Management* , Vol 39, No 2, pp. 170-191.
1	1	1	Bogers, M. and Afuah, A. and Bastian, B. (2010), 'Users as Innovators: A Review, Critique, and Future Research Directions', *Journal of Management* , Vol 36, No 4, pp. 857-875.
0	1	1	Jeppesen, L.B. and Lakhani, K.R. (2010), 'Marginality and Problem-Solving Effectiveness in Broadcast Search', *Organization Science* , Vol 21, No 5, pp. 1-18.
0	1	1	Fuller, J. (2010), 'Refining Virtual Co-Creation from a Consumer Perspective', *California Management Review* , Vol 52, No 2, pp. 98-122.
0	1	1	Bianchi, M. and Cavaliere, A. and Chiaroni, D. and Frattini, F. and Chiesa, V. (2011), 'Organisational modes for Open Innovation in the bio-pharmaceutical industry: An exploratory analysis', *TECHNOVATION* , Vol 31, No 1, pp. 22-23.
1	1	1	Huizingh, E.K. (2011), 'Open innovation: State of the art and future perspectives', *TECHNOVATION* , Vol 31, No 1, pp. 2-9.
1	0	1	Knudsen, M.P. and Mortensen, T.B. (2011), 'Some immediate - but negative - effects of openness on product development performance', *TECHNOVATION* , Vol 31, No 1, pp. 54-64.
1	1	1	Lichtenthaler, U. (2011), 'Open Innovation: Past Research, Current Debates, and Future Directions', *Academy of Management Perspectives* , Vol 25, No 1, pp. 75-93.

15	**32**	**33**	**Total Referenced**