Motivations for Knowledge Sharing in Free Software Communities

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Abstract: Knowledge sharing is a key aspect for a community of practice. Free software communities can be considered communities of practice, since they aggregate people interested in donating and collecting, that is, sharing knowledge about free software. According to the literature, the donation and collection of knowledge are motivated by different factors and these motivations may vary depending on the context. Free software communities may include members from different countries and backgrounds, which can make keeping such communities active and vigorous a challenge. This study aims to identify the motivations for knowledge sharing behaviour that are susceptible to leadership actions in free software communities. The research was carried out in three phases. First, a qualitative study involving twenty semi-structured interviews was conducted among members of a free software community, who suggested sixteen motivations for knowledge sharing behaviour. These motivations were then organized into three groups, each with a specific focus: three motivations only influence knowledge collection and focus on the knowledge itself; nine motivations only influence knowledge donation and focus on the individual; and four motivations influence both knowledge collection and knowledge donation, and focus on the relationships among individuals. After that, based on the groups of motivation identified in the previous phase, five leaders from different communities of practice were interviewed with the aim of identifying the main motivations that would be susceptible to their actions, which were knowledge quality, ease of access to knowledge, recognition, community support for knowledge sharing, learning and professional reasons. Finally, these six main motivations indicated by the leaders were tested in a quantitative phase involving 260 members of different free software communities. The results show that learning and ease of access to knowledge influence knowledge collection; recognition, community support for knowledge sharing and knowledge collection influence knowledge donation; and professional reasons influence both knowledge collection and knowledge donation in the context of free software communities.

Keywords: knowledge sharing, motivations, free software communities, communities of practice

1. Introduction

A free software is a computer program that offers its users four freedoms: to execute, study, redistribute and adapt the software in any way (Stallman, 2007). Free software affects many aspects of daily life in organizations (Schilling, 2014), and about 60% of all computer programs used in organizations are free software (Gartner Inc., 2008). One reason for this success is the free software communities, which are formed of persons who are connected in order to develop, generate and share knowledge about a free software (Shen, 2005, Raymond, 1999).

Free software communities (FSC) are communities of practice (Krishnamurthy, 2003), where the members are users of a free software (Raymond, 1999). Communities of practice are groups of people that gather to share knowledge about common expertise (Wenger and Snider, 2000). In FSC more than half of the participants are volunteers, hence their motivations for working in the communities are not monetary (Hsu *et al*., 2007, Fang and Neufeld, 2009, Endres *et al*., 2007).

Motivations are context-dependent and important to behaviour, including knowledge sharing behaviour (Deci and Ryan, 1987, Lin, 2007a). Knowledge sharing (KS) is a process in which individuals mutually choose to share their knowledge in order to create new knowledge together (Hooff and Ridder, 2004), which is the main goal of a FSC (Shen, 2005). Therefore, understanding the forms by which this knowledge is created and shared is important to establish an understanding of the complete free software development cycle (Sowe, Stamelos and Angelis, 2008). Keeping the communities operating effectively requires understanding the motivations for KS behaviour (Raymond, 1999, Shen, 2005).

Many aspects of FSC are not fully understood, especially when it comes to its relationship with knowledge management (Sowe, Stamelos and Angelis, 2008). Investigations into knowledge sharing behaviour consider different contexts (Witherspoon *et al*., 2013), but there is no specific research into FSC. To address this gap and provide community leaders with the information necessary to make FSC more efficient, this research aims to identify the motivations for knowledge sharing behaviour that are susceptible to the influence of leaders in FSC.

To achieve the objective, the research is divided into three phases: two qualitative, to investigate and understand the motivations, and one quantitative, to generalize the findings.

This article is structured in five sections. Following this introduction, there is a review of the literature on motivations for KS and on FSC. The methodological procedures are described in section 3. Section 4 contains the data analysis and a discussion of the results. The conclusions are presented in section 5.

2. Motivations for knowledge sharing behaviour and free software communities

Knowledge is a combination of experience, values, contextual information and insights (Davenport and Prusak, 1998). It is relational and dynamic process that depends on context and actions (Nonaka, Toyama and Nagata, 2000). It can be tacit - personal and difficult to communicate – or explicit – rational, theoretical and transmitted in formal and systematic language (Nonaka, 1994). Knowledge is a valuable intangible asset that can be used to obtain a sustainable competitive advantage (Wijk, Jansen and Lyles, 2008), because knowledge-based solutions are complex and difficult to copy, which represents an important factor for the sustainability of organizations (Grant, 1996).

In the KS process, individuals, teams, units and organizations are influenced by each other's knowledge and create new knowledge cooperatively (Wijk, Jansen and Lyles, 2008). It can be seen to consist of two mechanisms: donation, by which one communicates their intellectual capital to others, and collection, in which one consults the intellectual capital of another (Hooff and Ridder, 2004). Knowledge is shared following four conversion patterns (externalization, combination, internalization and socialization) that combine tacit and explicit knowledge (Nonaka, 1994) and can be shared in different *bas*, places that enable KS (Nonaka and Konno, 1998). The KS process has many consequences for organizational success, including improvements in productivity, organizational learning, innovation capability and corporative performance (Karkoulian, Harake and Messara, 2010, Tseng, 2010).

Motivations are antecedents that influence the KS process (Zboralski, 2009, Lin, 2007alocke, Osterloh and Frey, 2000) and are classified as either extrinsic, guided by results, or intrinsic, guided by the pleasure of performing an activity (Locke, 1975). To investigate the most recently studied motivations for KS, a search was conducted in ProQuest® using the terms "motivation" or "antecedent" and "knowledge sharing" in the title of articles published between 2011 and 2014. Based on that search and the listed papers, 25 motivations were identified, as shown in Table 1.

Table 1: Motivations for KS

Motivation	Reference
Altruism	Olatokun and Nawfor (2012); Chang and Chuang (2011)
Learning	Matzler and Mueller (2012)
Self-efficacy	Witherspoon et al. (2013); Kankanhalli et al. (2005b)
Leadership	Liu and Phillips (2011)
Innovation	Huang and Huang (2012)
Commitment	Witherspoon et al. (2013)
Trust	Chang and Chuang (2011)
Fun	Hau et al. (2013)
Identification	Lee, Reid and Kim(2014); Chang e Chuang (2011)
Financial Incentives	Witherspoon et al. (2013);
Social Ties	Chang and Chuang (2011); Witherspoon et al. (2013); Lin (2007a)
Shared Language	Chang and Chuang (2011)
Extrinsic Motivations	Bakan, Eraahan and Büyükbese (2011); Witherspoon et al. (2013)
Autonomous Motivation	Rheinholt, Pedersen and Foss (2012); Oyfolahan, Dominic and Karim (2012)
Subjective Norm	Witherspoon et al. (2013)
Results Orientation	Mueller (2012); Mueller (2014)
Prizes	Chen, Chang and Liu (2012)
Knowledge Quality	Oliveira et al. (2013)
Reciprocity	Kankanhalli et al. (2005b); Witherspoon et al. (2013); Chang and Chuang (2011)
Recognition	Kankanhalli et al. (2005b); Witherspoon et al. (2013);
Personal Responsibility	Mueller (2012); Mueller (2014)
Job Satisfaction	Bakan, Eraahan and Büyükbese (2011)
Flow Sensation	Lin and Joe (2011)

Motivation	Reference
Support for KS	Witherspoon et al. (2013); Lin (2007b)
Technology and Structure	Witherspoon et al. (2013); Mueller (2014); Kankanhalli et al. (2005a)

Free software development may provide a reduction in costs and an increase in the quality of final products (Raymond, 1999), and has achieved notable success, delivering established operational systems, web browsers and mobile systems, among others (Fang and Neufeld, 2009). In contrast to the traditional software development cycle, where only the author has access to the source code, free software offers the users access to the source code, which enhances the capacity for innovation (Krishnamurthy, 2003, Raymond, 1999).

FSC are communities of practice (CoP) that provide informal support to free software users and act as forums where the latest information is disseminated (Krishnamurthy, 2003). The FSC follow a "private-collective" model, where participants use their private resources to create knowledge and donate it to the community. Participants get personal benefits by making such contributions for the common good (Hippel and Krog, 2003). The communities are meritocratic, where leaders are highly active contributors who participate in several discussions at the same time (Barcellini *et al*., 2008). Leadership is based on the principle of understanding, not on power relationships (Raymond, 1999). FSC are organized around knowledge (Endres *et al*., 2007) and aim to collectively build and share knowledge (Shen, 2005, Barcellini *et al*., 2008). Therefore, understanding how this knowledge is generated, archived and shared would help increase the understanding of the free software development process as a whole (Sowe, Stamelos and Angelis, 2008).

3. Method

This research adopted a qualitative and quantitative approach and consists of three phases. In the first phase, the goal was to explore the motivations for KS in free software communities. Data was collected during twenty semi-structured interviews, each of which, on average, lasted 30 minutes. The intentionally selected respondents were aged between 18 and 44 years; predominantly male (17) and of various nationalities (The United States - five, Brazil - four, Paraguay - two and Argentina, Canada, France, Israel, Japan, Mexico, Kenya, Senegal, Zimbabwe - one). The interview guide has open questions about the motivations for knowledge collection and donation, in addition to sociodemographic questions. Data collection was performed during a global meeting of contributors to a free software community held in Canada. This community was chosen as the research focus because it is one of the largest FSC, with over 10 thousand participants, and because 40% of the code for its main product is written by volunteers. The interviews were transcribed and analysed using content analysis, following the principles described by Bardin (2008). The analysis was performed with the aid of MaxQDA® software.

In the second phase, the aim was to explore the perception of leaders of FSC regarding which motivations they might be able to influence. Data collection occurred during five interviews, as determined by saturation of information, with open source community leaders. The respondents, aged between 24 and 49 years old, were selected because they are leaders of FSC that range in size from a hackerspaces and regional communities to worldwide communities. The interview guide was based on the findings of the first phase. The average duration of the interviews was 45 minutes. They were transcribed and analysed using content analysis, according to Bardin (2008).

In the third phase, a survey was conducted in order to test the influence of those motivations identified as being subject to the influence of leaders on the knowledge donation and collection processes. The sample was non-probabilistic by judgment. The respondents were selected from among participants in FSC with national and international representation. The respondents were contacted in two ways: electronically, through mailing lists and Facebook groups; and by distributing printed fliers among participants at free software events. The survey includes sociodemographic questions and scales to represent the constructs. A 7-point Likert scale was used, the first point meaning ‘strongly disagree’ and the last meaning ‘strongly agree’. The adopted scales were adapted from the authors: KS processes - Vries, Hooff and Ridder (2006); learning – Matzler and Mueller (2011); community support for KS - Lin (2007b); perceived knowledge quality (KQ) - Yoo (2014); ease of access - Kankanhalli, Tan and Wei (2005a); recognition - Kankanhalli, Tan and Wei (2005b); professional reasons - developed by the authors based on the answers from the first phase. Reverse translation and content and face validation were used to refine the instrument. The questionnaire was administered using Qualtrics®. In total 290 questionnaires were answered, 260 of which were considered valid. The respondents have the following characteristics: 91.9% male; 25.8% aged 18-24 years old, 23.8% aged 25-29 years old, 18.1% aged 30-34 years

old, 8.5% aged 35-39 years old, 8.1% aged 40-44 years old and 15.8% aged over 45 years old; 11.5% have complete or incomplete high school, 63.1% have complete or incomplete college and 25.4% have a graduate degree. The FSC most cited by respondents were Mozilla (17.6%), Ubuntu (8.8%), Linux (6.4%) and TchêLinux (6.0%). To analyse the data, PLS (Partial Least Squares), with the aid of SmartPLS® (Smart Partial Least Squares) and SPSS (Statistical Package for Social Sciences) were used.

4. Analysis

The analysis consists of three sections: section 4.1 – the results of the first phase (qualitative), which aimed to identify the motivations for KS among participants of one FSC; section 4.2 – the results of the second phase (qualitative), in which those motivations thought to be susceptible to the influence of leaders of FSC were identified; and section 4.3 – the results of the third phase (quantitative), which aimed to assess the influence of the KS motivations among participants of FSC.

4.1 Qualitative phase - motivations identification

Codifying the data from the Interviews enabled the identification of 16 motivations, which were organized into three groups according to their influence on knowledge: collection only, donation only and on both knowledge collection and donation. Each of these groups has a specific focus: motivations that influence collection - associated to knowledge; motivations that influence donation - related to the individual donor; and motivations that influence both donation and collection - focused on the relationship between individuals. The motivations are shown below in Figure 1.

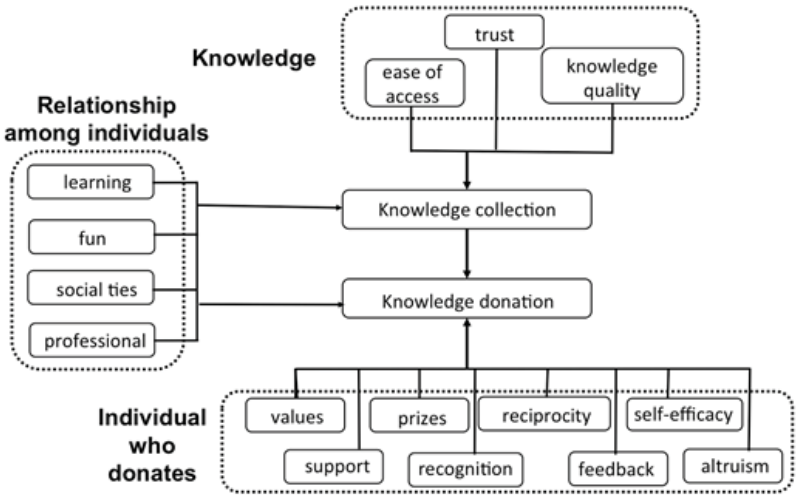

Figure 1: Motivations for KS behaviour in free software communities

All the motivations had been previously found in the literature, although in different contexts. Knowledge collection as an antecedent for knowledge donation is aligned with Hooff and Ridder (2004) in the organizational context.

FSC leaders may consider actions related to the motivations for KS in order to invigorate their communities. However, the degree to which the different motivations are susceptible to the influence of leaders may vary, which is a matter that will be considered in the next phase of this research.

4.2 Qualitative phase – leadership influence

The motivations cited by the FSC leaders were identified in the analysis of the second phase interviews, and are listed in Table 2. The"#cit" column indicates how many leaders cited each motivation.

Table 2: Motivations susceptible to the influence of FSC leaders

	Motivation	Interviewee					# cit
		1	2	3	4	5	
Donation	**Ease of access**	x	x	x	x	x	**5**
	Trust			x			1
	Knowledge Quality	x			x	x	**3**

	Motivation	Interviewee					# cit
		1	2	3	4	5	
Collection	Altruism						0
	Self-efficacy						0
	Feedback				x		1
	Reciprocity			x			1
	Recognition	x	x		x	x	**4**
	Prizes						0
	Support for KS	x	x	x			**3**
	Values					x	1
Donation and Collection	**Learning**	x	x	x		x	**4**
	Fun				x		1
	Social Ties	x		x			2
	Professional Reasons		x		x	x	**3**

The two most cited motivations in each group were used in the quantitative phase of this research, which is presented below.

4.3 Quantitative phase

The structural model of the qualitative phase has eight constructs: knowledge collection (KC), knowledge donation (KD), ease of access (EA), perceived knowledge quality (PKQ) - divided into intrinsic quality (IKQ), contextual quality (CKQ) and actionable quality (AKQ), recognition (REC), community support for knowledge sharing (SKS), learning (LEA) and professional reasons (PR).

Corrected item total correlation (CITC) and Cronbach's Alpha were used to determine the reliability of the constructs. Hair *et al*. (2005) recommends the elimination of any items with a CITC below 0.5. Three items were removed: LEA scale lost one item (LEA1: CITC = 0.293) and KC lost two items (KC1: CITC = 0.262; KC2: CITC = 0.313). Once these items were eliminated, all the constructs obtained a Cronbach's Alpha score greater than 0.6, as recommended by Hair *et al*. (2014).

Exploratory factorial analysis was conducted using Principal Component Analysis (PCA) with the Varimax Rotation Method, as recommended by Hair *et al*. (2005). The Kaiser-Meyer-Olkin (KMO) value was 0.884, above the recommended (KMO > 0.8) and the significance according to the Bartlett's sphericity test was 0.000, which indicates the data are suitable for the analysis. Eight components were identified on the rotated matrix. All the items presented a factor loading above 0.6, with the exception of CKQ2. The latter item was maintained in order to retain the meaning of the scale and because it presented a lower factor loading in all the other dimensions.

Analysis of Variance Extracted (AVE) and the Composite Reliability (CR) were tested to ensure the Convergent Validity: all the AVEs were greater than 0.5 and all CR were greater than 0.7, which is adequate according to Hair *et al*. (2014). Discriminant validity (DV) was tested using the *Fornell-Larcker* criterion, where the square root of the AVE for each construct is larger than the construct's cross loading (Hair *et al*., 2014). The DV was acceptable for all the constructs. Table 3 shows the values for the Cronbach's Alpha, AVE, Composite Reliability and the *Fornell-Larcker* criterion for all the constructs (the bold numbers on the diagonal are the square roots of the AVEs).

Table 3: Reliability, convergent validity and discriminant validity of the constructs

	LEA	EA	REC	AKQ	CKQ	IKQ	KC	KD	PR	SKS
LEA	**0.866**									
EA	0.155	**0.794**								
REC	0.202	0.123	**0.873**							
AKQ	0.263	0.318	0.163	**0.911**						
CKQ	0.293	0.419	0.230	0.654	**0.838**					
IKQ	0.159	0.406	0.145	0.668	0.609	**0.877**				
KC	0.262	0.200	0.200	0.096	0.205	0.118	**0.901**			
KD	0.281	0.254	0.329	0.166	0.225	0.159	0.452	**0.769**		
PR	0.379	0.150	0.469	0.315	0.452	0.177	0.288	0.360	**0.891**	
SKS	0.297	0.419	0.400	0.465	0.439	0.429	0.305	0.403	0.413	**0.830**
AVE	0.750	0.630	0.762	0.830	0.703	0.769	0.812	0.592	0.795	0.689

	LEA	EA	REC	AKQ	CKQ	IKQ	KC	KD	PR	SKS
CR	0.857	0.870	0.941	0.936	0.876	0.909	0.896	0.850	0.939	0.898
# items	3	4	5	3	3	3	4	4	4	4
Cronbach's α	0.672	0.806	0.920	0.898	0.791	0.850	0.769	0.770	0.914	0.849

Tolerance values of the model constructs are above 0.2 and variance inflation factors (VIF) are all below 5.00, which according Hair *et al*. (2005) indicate no colinearity. The model also has predictive relevance, since all Q^2 values are above zero. Figure 2 shows the structural model used to check the hypotheses.

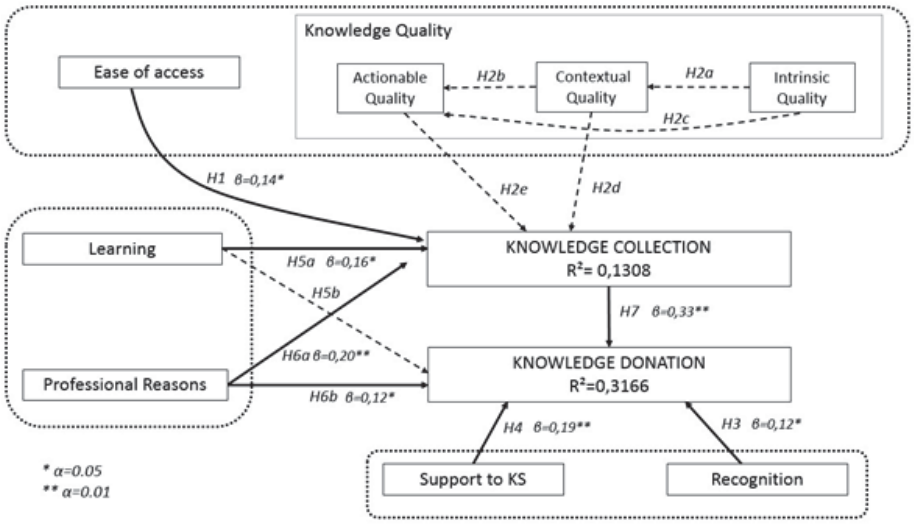

Figure 2: Structural model and results of the hypothesis test

The significance of the relationships was checked using Student's *t* test in combination with a Bootstrapping algorithm. With *t* values above 1.96, $\alpha < 0.05$ is inferred and the hypotheses are considered supported. Since H2d and H2e were rejected, all the constructs related to perceived knowledge quality were removed from the model and H2a, H2b and H3c were also rejected. Table 4 summarises the results of the hypothesis test.

Table 4: Results of the hypothesis test

Hypothesis	Path	Path Coefficient	*t* value	Status
H1	*EA→KC*	0.144	2,3515	*Supported*
H2a	IKQ→CKQ	-	-	Rejected
H2b	CKQ→AKQ	-	-	Rejected
H2c	IKQ→AKQ	-	-	Rejected
H2d	CKQ→KC	0.070	0,8629	Rejected
H2e	AKQ→KC	-0.105	1,3930	Rejected
H3	*REC→KD*	0.126	2,0386	*Supported*
H4	*SKS→KD*	0.191	2,8520	*Supported*
H5a	*LEA→KC*	0.161	2,5191	*Supported*
H5b	LEA→KD	0.077	1,2857	Rejected
H6a	*PR→KC*	0.205	3,2376	*Supported*
H6b	*PR→KD*	0.122	2,1637	*Supported*
H7	*KC→KD*	0.331	5,5751	*Supported*

Predictive accuracy was calculated using Pearson's determination (R^2). The corresponding values are 0.1308 knowledge collection and 0.3166 knowledge donation, indicating a predictive accuracy of 13% and 31% respectively.

5. Conclusions

This research attempted to identify the motivations for knowledge sharing behaviour that are susceptible to the influence of leaders in FSC. To achieve this objective, the research was conducted in three phases. The first phase aimed to identify the motivations for KS in FSC. Sixteen motivations were found and grouped according to the aspect of knowledge sharing they influence: three only influence knowledge collection - ease of access, trust and knowledge quality; nine only influence knowledge donation - altruism, self-efficacy, feedback, reciprocity, recognition, prizes, support for KS, values and knowledge collection; and four motivations influence both

knowledge collection and knowledge donation - learning, fun, social ties and professional reasons. In the second phase, the motivations most susceptible to the influence of community leaders were identified as knowledge quality, ease of access, recognition, community support for knowledge sharing, learning and professional reasons. Finally, in the third phase, we assessed which of those motivations influenced knowledge collection and knowledge donation. Seven hypotheses from the model were accepted: learning and ease of access influence knowledge collection; recognition, community support for KS and knowledge collection influence knowledge donation; and professional reasons influence both knowledge collection and knowledge donation in FSC.

Among the academic contributions provided by this research are: sixteen motivations for knowledge sharing found in the literature and identified in a new context; organization of the motivations into groups with specific foci; the understanding of a leadership perspective regarding KS motivations on FSC; confirmation of six motivations for KS in the context of FSC. This research has also contributes to the managerial field, as: leaders of FSC can use it to guide actions designed to stimulate KS in their communities.

This research is limited in some respects. In the first phase, data were only collected from one community. This limitation was mitigated in phase three. In addition, in the quantitative phase, the data were collected using printed and online questionnaires, which may have influenced the interpretation of the questions. Finally, the scales for the two constructs learning and knowledge collection had low CITC values and only had two items each.

Future research might usefully seek to establish what actions leaders can take to influence KS and whether such actions are effective when applied in communities. Moreover, it would be relevant to quantitatively assess the motivations identified in the first qualitative phase of this research that were not explored in the quantitative phase. Finally, it would be interesting to investigate what tools used in FSC are linked to the processes of KS in these communities.

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References

Bakan, I., Eraahan, B. and Büyükbeşe, T. (2011) "A research model on the effects of job satisfaction, extrinsic motivation and knowledge sharing intention on knowledge sharing", *China-USA Business Review*, Vol. 10, No. 10, pp 1047-1060.

Barcellini, F., Détienne, F., Burknardt, J.M. and Sack, W. (2008) "A socio-cognitive analysis of online design discussions in an Open Source Software community", *Interacting with Computers*, Vol. 20, No. 1, pp. 141–165.

Bardin, L. (1977) *L'analyse de contenu*. Presses Universitaires de France, Paris.

Chang, H.H. and Chuang, S. (2011) "Social capital and individual motivations on knowledge sharing: Participant involvement as a moderator". *Information & Managemen*t, Vol. 48, No. 1, pp 9-18.

Chen, C., Chang, S. and Liu, C. (2012) "Understanding knowledge-sharing motivation, incentive mechanisms and satisfaction in virtual communities", Social Behaviour and Personality, Vol. 40, No. 4, pp 639-647.

Davenport, Thomas H. and Prusak, L. (1998) *Working knowledge: How organizations manage what they know*. Harvard Business Press.

Deci, E.L. and Ryan, R.M. (1987) "The support of autonomy and the control of behaviour", *Journal of Personality and Social Psychology*, Vol. 53, No. 6, pp 1024-1037.

Endres, M.L., Endres, S.P., Chowdhury, S.K. and Alam, I. (2007) "Tacit knowledge sharing, self-efficacy theory, and application to the Open Source community", *Journal of Knowledge Management*, Vol. 11, No. 3, pp 92–103.

Fang, Y. and Neufeld, D. (2009) "Understanding sustained participation in open source software projects", *Journal of Management Information Systems*, Vol. 25, No. 4 , pp 9-50.

Gartner Inc. (2008) "Gartner Highlights Key Predictions for IT Organizations and Users in 2008 and Beyond", [online], http://www.gartner.com/it/page.jsp?id=593207 .

Grant, R.M., "Toward a Knowledge-Based Theory of the Firm". *Strategic Management Journal*, Vol. 17, Winter Special Issue, pp 109-123.

Hair, J.F., Anderson, R.E., Tatham, R.L. and Black, W.C. (2005). *Multivariate data analysis*. Upper Saddle River: Prentice-Hall.

Hair, J. F., Hult, G.T.M., Ringle, C.M. and Sarstedt, M. (2014) *A primer on partial least squares structural equations modelling (PLS-SEM)*, SAGE, Los Angeles.

Hau, Y. S., Kim, B., Lee, H. and Kim, Y. G. (2013) "The effects of individual motivations and social capital on employees' tacit and explicit knowledge sharing intentions", *International Journal of Information Management*, Vol. 33, No. 2, pp 356-366.

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

Hooff, B.V.D. and Ridder, J.A. (2004) "Knowledge sharing in context: the influence of organizational commitment, communication climate and CMC use on knowledge sharing", *Journal of Knowledge Management*, Vol. 8, No. 6, pp 117 – 130.

Hsu, M.H., Ju, T.L., Yen, C.H. and Chang, C.M. (2007) "Knowledge sharing behavior in virtual communities: the relationship between trust, self-efficacy and outcome expectation", *International Journal of Human-Computer Studies*, Vol. 65, No. 2, pp 153-169.

Huang, E.Y. and Huang, T.K. (2012) "Investigating the antecedents of user's knowledge sharing intention", *The Journal of Computer Information Systems*, Vol. 53, No. 2, pp 93-102.

Kankanhalli, A., Tan, B.C.Y., and Wei, K. (2005a) "Understanding seeking from electronic knowledge repositories: An empirical study". *Journal of the American Society for Information Science and Technology*, Vol. 56, No. 11, pp 1156-1166.

Kankanhalli, A., Tan, B.C.Y., and Wei, K. (2005b) "Contributing knowledge to electronic knowledge repositories: an empirical". *MIS Quarterly*, Vol. 29, No. 1, pp. 113-143.

Karkoulian, S., Harake, N. and Messarra, L. (2010) "Correlates of organizational commitment and knowledge sharing via emotional intelligence", *The Business Review*, Vol. 15, No. 1, pp 89-96.

Krishnamurthy, S. (2003) "A managerial overview of open source software", *Business horizons*, Vol. 46, No. 53, pp 47-56.

Lee, H., Reid, E. and Kim, W.G. (2014) "Understanding Knowledge Sharing in Online Travel Communities: Antecedents and the Moderating Effects of Interaction Modes", *Journal of Hospitality & Tourism Research*, Vol. 38, No. 2, pp 222-242.

Lin, C. (2007a) "To share or not to share: modeling tacit knowledge sharing, its mediators and antecedents", *Journal of Business Ethics*, Vol. 70, No. 4, pp 411-428.

Lin, H. (2007b) "Knowledge sharing and firm innovation capability: an empirical study". *International Journal of Manpower*, Vol. 28, No. 3, pp. 315-332.

Lin, C. and Joe, S. (2012) "To share or not to share: assessing knowledge sharing, interemployee helping, and their antecedents among online knowledge workers". *Journal of Business Ethics*, Vol. 108, No. 4, pp 439-449.

Liu, Y. and Phillips, J.S. (2011) "Examining the antecedents of knowledge sharing in facilitating team innovativeness from a multilevel perspective", *International Journal of Information Management*, Vol. 31, No. 1, pp 44-52.

Locke, E.A. (1975) "Personnel attitudes and motivation", *Annual review of psychology*, Vol. 26, No. 1, pp 457–480.

Matzler, K. and Mueller, J. (2011) "Antecedents of knowledge sharing - Examining the influence of learning and performance orientation", *Journal of Economic Psychology*, Vol. 32, No. 3, pp 317-329.

Mueller, J. (2012) "Knowledge sharing between project teams and its cultural antecedents", *Journal of Knowledge Management*, Vol. 16, No. 3, pp 435-447.

Mueller, J. (2014) "A specific knowledge culture: Cultural antecedents for knowledge sharing between project teams", *European Management Journal*, Vol. 32, No. 2, pp 190-202.

Nonaka, I. (1994) "A dynamic theory of organizational knowledge creation", *Organizational Science*, Vol. 5, No. 1, pp 14-37.

Nonaka, I. and Konno, N. (1998) "The concept of 'ba': building a foundation for knowledge creation", *California Management Review*, Vol. 40, No. 3, pp 40-54.

Nonaka, I., Toyama, R. and Nagata, A. (2000) "A firm as a knowledge-creating entity: a new perspective on the theory of the firm", *Industrial and corporate change*, Vol. 9, No. 1, pp 1-20.

Olatokun, W. and Nwafor, C.I. (2012) "The effect of extrinsic and intrinsic motivation on knowledge sharing intentions of civil servants in Ebonyi State", *Information Development*, Vol. 28, No. 3, pp 216-234.

Oliveira, M., Maçada, A., Curado, C., Nodari, F. (2013) "A influência da qualidade do conhecimento no comportamento do compartilhamento do conhecimento e na inovação em times de tecnologia da informação". Paper read at XIII Conferência da Associação Portuguesa de Sistemas de Informação. Évora, Portugal.

Osterloh, M. and Frey, B.S. (2000) "Motivation, knowledge transfer, and organizational forms", *Organization Science*, Vol. 11, No. 5, pp 538-550.

Raymond, E. (1999) "The cathedral and the bazaar", *Knowledge, Technology & Policy*, Vol. 12, No. 3, pp. 23-49.

Schilling, A. (2014) "What Do We Know about FLOSS Developers' Attraction, Retention, and Commitment? A Literature Review", Paper read at 47th Hawaii International Conference, IEEE.

Shen, X. (2005) "Developing Country Perspectives on Software: Intellectual Property and Open Source - A Case Study of Microsoft and Linux in China", *International Journal of IT Standards & Standardization Research*, Vol. 3, No. 1, pp 21-43.

Sowe, S.K., Stamelos, I. and Angelis, L. (2008) "Understanding knowledge sharing activities in free/open source software projects: An empirical study", *The Journal of Systems and Software*, Vol. 81, No. 3, pp 431–446.

Stallman, R. (2007) "Why Open Software Misses the Point of Free Software", [online], http://www.gnu.org/philosophy/open-source-misses-the-point.html.

Tseng, S.M. (2010) "The correlation between organizational culture and knowledge conversion on corporate performance", *Journal of Knowledge Management*, Vol. 14, No. 2, pp 269-284.

Vries, R.E., Hoof, B.V.D. and Ridder, J.A. (2006) "Explaining knowledge sharing: The role of team communication styles, job satisfaction, and performance beliefs", *Communication Research*, Vol. 33, No. 2, pp 115-135.

Wenger, E.C. and Snyder, W.M. (2000) “Communities of practice: the organizational frontier”, *Harvard Business Review,* Vol. 78, No. 1, pp 139-145.

Wijk, R.V., Jansen, J.J.P. and Lyles, M.A. (2008) “Inter- and Intra-Organizational Knowledge Transfer: A Meta-Analytic Review and Assessment of its Antecedents and Consequences”, *Journal of Management Studies*, Vol. 45, No. 4, pp 830 – 853.

Witherspoon, C., Bergner, J., Cockrell, C.R. and Stone, D.N. (2013) “Antecedents of organizational knowledge sharing: a meta-analysis and critique”, *Journal of Knowledge Management*, Vol. 17, No. 2, pp 250-277.

Yoo, D.K. (2014) "Substructures of perceived knowledge quality and interactions with knowledge sharing and innovativeness: a sensemaking perspective", *Journal of Knowledge Management,* Vol. 18, No. 3, pp 523 - 537

Zboralski, K. (2009) “Antecedents of knowledge sharing in communities of practice”. *Journal of Knowledge Management*, Vol. 13, No. 3, pp 90–101.