Knowledge Sharing Profiles in Free Software Communities

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Abstract: Knowledge is an obtainable, renewable, dynamic, context-dependent resource that is capable of providing competitive advantage in organizations. Knowledge can be shared, and the knowledge sharing cycle has two processes: knowledge donation, when a person voluntarily offers his intellectual capital to others, and knowledge collection, when a person consults other people's intellectual capital. Knowledge sharing is important for, among other reasons, improving organizational learning, innovative capacity, organizational success and productivity. Knowledge can be shared among individuals, groups and organizations. One kind of group organized to share knowledge is the community of practice, where people have mutual relationships involving a regular flow of knowledge between them, which facilitates the generation of new knowledge. A free software community is a type of community of practice arranged around a specific free software. The knowledge shared in free software communities is complex and the knowledge sharing processes have scarcely been studied in this environment. This investigation aims to identify the profiles of knowledge sharing processes in free software communities i.e., whether members of free software communities collect more, donate more or collect and donate equally. To accomplish this objective, a survey method was adopted, with 260 respondents belonging to free software communities. Cluster analysis was used to interpret the data. Four clusters, corresponding to the sharing profiles of the respondents, were identified: Sporadic Sharer (low donation and low collection); Collector (low donation and high collection); Donator (high donation and low collection); and Constant Sharer (high donation and high collection). The k-means algorithm showed four well-defined clusters. Interestingly, with the exception of the Sporadic Sharer, all the clusters presented high values of both collection and donation, including the Donators (that emphasize donation) and Collectors (that emphasize collection). These results confirm the view of free software communities as communities of practice that are organized to share knowledge, and highlight the importance of knowledge sharing and collaboration in the free software development cycle. Furthermore, the results show that the Constant Sharer (that both collects and donates intensely) is the profile that donates and collects more, even more than Donators and Collectors, indicating that this profile is key to the correct functioning of the community.

Keywords: knowledge sharing, sharing profiles, free software communities, clusters, communities of practice

1. Introduction

The free software movement is the result of a technological trend that arose to challenge and criticize the copyright laws, and which has come to develop numerous variations regarding the nature of freedom in software development and artistic expression (Chen, 2006; Sullivan, 2011). Free software provides information justice, i.e. a fair rearrangement of the social goods derived from information technology (Chopra and Dexter, 2011). Participants in the movement fight against proprietary software by developing and distributing alternative software products to those offered in closed source systems (Sullivan, 2011). Free software developers are organized in communities (Elliott and Scacchi, 2008), and give their time and know-how voluntarily to improve the software to which they are dedicated (Demazière, Horn and Zune, 2007).

Free software communities structure themselves around a particular software and ethical issues of freedom regarding that software (Stallman, 2009). While free software communities often referred to, very little data are available on them (Ghosh and Prakash, 2000), especially in relation to knowledge management (Sowe, Stamelos and Angelis, 2008). Free software communities are considered an excellent context investigation into knowledge sharing (KS) because they have large numbers of participants who interact with each other, a collaborative environment, and are knowledge-intensive (Iskoujina and Roberts, 2015).

Knowledge sharing is one of the most important processes in knowledge management (Kuo and Young, 2008), as it contributes to the development of new products (McAdam, O'Hare and Moffett, 2008) and enhances performance (Husain and Husain, 2013) and innovation (Oliveira *et al.*, 2015). Knowledge sharing can be represented by two processes: "knowledge donating, communicating to others what one's personal intellectual capital is; and knowledge collecting, consulting colleagues in order to get them to share their intellectual capital" (Hooff and Ridder, 2004, p. 118). These two processes are necessary for knowledge sharing (Sorakraikitikul and Siengthai, 2014), and constitute an integral part of a programmer's work (Hooff and Ridder, 2004). However, the intensity with which each of these processes occurs may be associated with certain characteristics, such as how long the individual has participated in the community, how many communities each the individual participates in, and the age range of the members. Thus, the objective of this research is to identify the sharing

knowledge profiles in relation to the collection and donation of knowledge in free software communities and the characteristics associated with those profiles.

This article is divided into five sections. Following this introduction, there is a review of the literature on knowledge sharing. Section 3 includes a description of the methodological practices adopted in this research. Section 4 provides an analysis and discussion of the results, and section 5 presents the conclusions, limitations and offers some suggestions for future studies.

2. Free software communities and knowledge sharing

Free software is a set of programs, platforms and operating systems developed by communities of people who waive ownership rights over any final product and make the source code of programs freely available (McInerney, 2009). Free software was first introduced by Richard Stallman in the definition of the GNU License, which gives the user four freedoms: to run, improve, modify and distribute a computer program (Free Software Foundation, 1996). Free software is a philosophical and political movement, with implications for software development (Wolf, Miller and Grodzinsky, 2009). Free software is developed through collaborative and informal networks of programmers. In addition, the software is collaboratively distributed which means it is free for developers and users (Ghosh, 2007). Nevertheless, free software primarily concerns freedom and not necessarily whether it is free of charge (Free Software Foundation, 1996; Moglen, 1999).

An important aspect of free software is that the participants are organized in communities (Elliott and Scacchi, 2008). In free software communities, the source of the program is available to the participants who mainly interact online (Iskoujina and Roberts, 2015). This availability creates an environment to innovation, since the member have incentives to innovate, to reveal the innovations freely and allows user-led diffusion of innovation (Hippel, 2001). The communities offer their members flexible roles, are meritocratic and have key contributors who take on leadership roles (Barcellini *et al.*, 2008; Iskoujina and Roberts, 2015). Since the members are in the communities voluntarily (Demazière, Horn and Zune, 2007), satisfaction with the community may increase the participation and a greater participation makes a better promotion of the community (Casaló, Flavián and Guinalíu, 2010).

The communities influence members' behaviour since the participants influence each other about products, brands and organisations (Kozinetz, 2002). People in free software communities have emotional ties with the community and the free software that is developed by the community, so there's a high level of trust and loyalty (Casaló, Flavián and Guinalíu, 2007). Participants have different reasons for joining the communities: learning, extrinsic factors (such as professional or academic achievement), social factors, creativity, feeling of flow, self-determination, recognition, self-promotion and altruism (Baytiyeh and Pfaffman, 2010; Hars and Ou, 2001).

The members of free software communities are part of a large social movement that advocates the adoption of free software by end users, governments and organizations (Sullivan, 2011). Free software communities are one kind of community of practice (Krishnamurthy, 2003). Communities of practice (CoPs) are groups of people that share knowledge about their common areas of expertise (Wenger and Snider, 2000). Knowledge sharing is a central issue in free software communities (Iskoujina and Roberts, 2015; Raymond, 1999).

Knowledge sharing behaviour is represented in different ways. Oliveira *et al.* (2015) compared two knowledge sharing behaviour scales. One focuses on the individual's involvement in sharing (leads or participates in sharing activities), which was adapted from Xue, Bradley and Liang (2011); and the other considers the type of knowledge (implicit and explicit), which was previously validated by Huang (2009). Hooff and Ridder (2004) use two processes, knowledge donation and knowledge collection, which were defined based on a combination of various perspectives. The knowledge sharing behaviour represented by the collection and donation processes is used by several authors (Tohidinia and Mosakhani, 2010; Sorakraikitikul and Siengthai, 2014; Tuan, 2015).

In online communities, Sowe, Stamelos and Angelis (2008) adopt the terms knowledge seekers and knowledge providers to describe the people who collect and donate knowledge at the base of the community. These processes are similar to those of knowledge donation and collection, which shows that, as in free software communities, in online communities the separation of knowledge sharing into two processes is applicable.

3. Method

A cross-sectional survey was conducted among members of free software communities attending specialized events from December 2013 to January 2014. The survey data were collected in Portuguese and English using an online tool and printed questionnaires to which there were 260 respondents. The use of these two procedures can be considered a limitation of this research.

The questionnaire consists of questions on knowledge sharing behaviour, considering the knowledge collection and donation processes, and three characteristics (time in the free software community, number of free software communities in which they participate and age). The items for the constructs knowledge donation and knowledge collection use an adapted 7-point Likert scale, (from 1 – 'strongly disagree' to 7 – 'strongly agree'). The scales for knowledge collection and donation were adapted from the study by Vries, Hooff and Ridder (2006). Below Table 1 shows the items from the scale used for knowledge collection and knowledge donation. Reverse translation, content validation and face validation were carried out to increase the quality of the instrument.

Table 1: Scales used in the study

Knowledge sharing	Scale
Donation	1. When I learn something new, I tell the community members about the subject. 2. I share the information I have with the community members. 3. I think it is important the community members know about the contributions I am making. 4. I regularly inform the community members about what I'm doing.
Collection	1. When I need some specific knowledge, I look in the free software community to which I belong. 2. I like to be informed about the knowledge that the community members have. 3. I ask community members about their skills when I need to learn something. 4. When a member of the community is good at something, I ask them to teach me how to do it.

The sample presents the following socio-demographic characteristics:

- 91.9% are male and 8.1% female;
- 25.8% are aged from 18 to 24 years, 23.8% from 25 to 29 years, 18.1% from 30 to 34 years, 8.5% from 35 to 39 years, 8,1% from 40 to 44 years and 15.8% over 45 years;
- 5% have finished not high school, 6.5% have finished high school, 30% have incomplete undergraduate degrees, 33.1% hold bachelor degrees and 25.4% hold post-graduate degrees;
- 20% participate in only one community; 62.3% participate in from one to five communities; 6.5% participate in from six to ten communities; and 11.2% participate in more than ten communities.

The number of clusters can be determined *a priori* based on theory, which is a valid non-statistical tool as indicated by Hair *et al.* (2005) and Ketchen and Shook (1996). Four clusters were determined based on the definition of knowledge sharing provided by Hoof and Ridder's (2004), namely: the sporadic sharer, who rarely donates or collects; the collector, who frequently collects, but rarely donates; the donator, who frequently donates but rarely collects; and the constant sharer, who constantly both collects and donates.

With the defined clusters, the group means were analysed. Then, the non-hierarchical k-means algorithm was applied to determine the centroids of each group, according to Hair *et al.* (2005) and Ketchen and Shook (1996). Finally, three characteristics were associated with the four clusters, namely: the number of communities, time in the community and age of the participant.

4. Analysis

The constructs used in this study have been validated in other studies. The means of the items for the two constructs (knowledge donation and knowledge collection) show a positive trend, as only one item, for the construct knowledge donation, obtained a mean lower than 4.00 on a scale of 7 points. This might be explained by the item's content (*I regularly inform the community members about what I'm doing*), which concerns the dissemination of the person's area of interest, while the other items deal with the person's knowledge. Table 2 shows the mean and standard deviation of each item for the knowledge donation and collection constructs, and Cronbach's Alpha of the constructs, considering the 260 respondents.

Table 2: Means, standard deviations and Cronbach's Alpha of the constructs

Construct		Mean	Standard Deviation	Cronbach's Alpha
Donation	1	5.05	1.658	0.769
	2	5.75	1.365	
	3	4.70	1.710	
	4	3.87	1.683	
Collection	1	5.60	1.595	0.708
	2	5.48	1.495	
	3	4.41	1.946	
	4	4.62	1.770	

Cluster analysis with the non-hierarchical k-means method was used to identify the sharing behaviour profiles of knowledge in communities. The four clusters were determined and their centroids are shown in Table 3.

Table 3: Cluster centroids

	Sporadic sharer	Constant sharer	Collector	Donator
Donation	3.26	6.00	4.07	5.39
Collection	3.24	6.22	5.42	4.35

The number of cases in each cluster is as follows: Sporadic Sharer - 46 respondents; Constant Sharer - 81 respondents; Collector - 71 respondents; Donator - 62 respondents. Figure 1 shows the plotted centroid of each cluster.

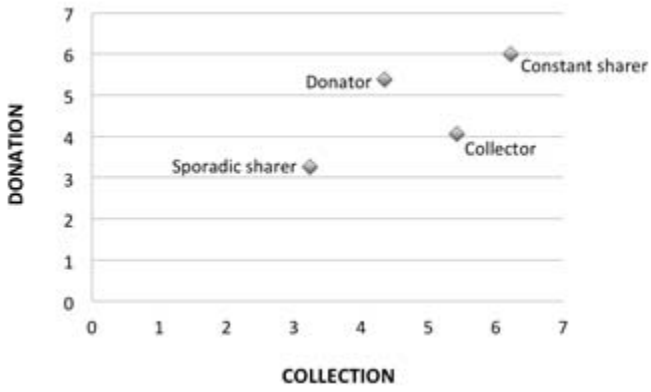

Figure 1: Cluster centroids

Table 3 and Figure 1 show that all the clusters have centroids with high values for collection and donation, with the expected exception of the Sporadic Sharer. This confirms that the free software communities are structured around the sharing of knowledge and highlights the importance of sharing in the development of free software. The results also show that the Constant Sharer profile collects and donates more knowledge than either the Donator or Collector profiles. This shows the importance of this role for the functioning of the community, as it is the profile that shares more knowledge as a whole.

Table 4 shows the mean and standard deviations of the items per cluster. In the construct, donation, item 2 has the highest mean score in all the clusters, while item 4 has the lowest mean in each cluster. Item 2 focuses on the dissemination of results, that is, the knowledge held by the individual, while the item 4, by contrast focuses on the process, i.e. on what the individual is doing. Regarding the construct, collection, in all the clusters items 1 and 2 can be seen to have the highest means and items 3 and 4 the lowest. These findings may be linked to the content of the items, as items 1 and 2 the focus on knowledge, while items 3 and 4 address learning.

Table 4: Means and standard deviations for the items by cluster

Construct		Sporadic Sharer		Constant Sharer		Collector		Donator	
		Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Donation	1	3.07	1.34	6.27	0.96	4.23	1.19	5.87	1.03
	2	**4.67**	1.71	**6.59**	0.60	**5.04**	1.28	**6.27**	0.83
	3	3.15	1.52	5.95	1.13	3.90	1.41	5.11	1.38
	4	**2.13**	1.34	**5.20**	1.11	**3.10**	1.01	**4.31**	1.54

Construct		Sporadic Sharer		Constant Sharer		Collector		Donator	
		Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Collection	5.60	**4.09**	1.89	6.41	0.93	5.96	1.11	**5.24**	1.64
	5.48	**4.09**	1.69	6.49	0.88	5.59	1.10	**5.06**	1.38
	4.41	2.15	1.29	6.11	1.06	4.92	1.39	3.29	1.37
	4.62	2.63	1.40	5.86	1.18	5.20	1.21	3.81	1.49

Subsequently, the clusters were analysed by comparing the three respondent-related characteristics. The first is the age range of the respondents and how its relation to the clusters. Table 5 shows the age ranges and their frequencies in each cluster.

Table 5: Age range of the respondents in each cluster

Age range	Sporadic sharer		Constant sharer		Collector		Donator	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Up to 30 years	28	**60.9**	40	**49.4**	46	**64.8**	29	**46.8**
Over 30 years	18	39.1	41	**50.6**	25	35.2	33	**53.2**

The Sporadic Sharer and Collector profiles have younger members, while the Constant Sharer and Donator include both older and younger respondents. That is, the profiles that involve greater donation activity contain participants from both age groups. The older the individual, the greater is the experience with technology, which may increase the individual's confidence in sharing their knowledge in communities. However, for donation to take place there must be a recipient, which explains the existence of a similar number of people from the two age groups in the Constant Sharer and Donator clusters.

The number of communities in which each respondent participates was analysed in relation to the cluster. Table 6 shows the number of the communities in which the respondents participate according the clusters.

Table 6: Number of communities in which each respondent participates, by cluster

Number of communities	Sporadic sharer		Constant sharer		Collector		Donator	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
1 community	9	19.6	13	16.0	26	**36.6**	4	**6.5**
2 communities	7	15.2	24	29.7	14	19.7	18	29.0
3 or more communities	30	**65.2**	44	**54.3**	31	43.7	40	64.5

The respondents in the Donator cluster are least likely to participate in only one community. This may be associated with the profile of this cluster. By contrast, the Collector cluster has the highest number of respondents who participate in only one free software community. It can also be noted that in all clusters the highest concentration of respondents participated in 3 or more free software communities.

Table 7 shows the length of time the respondents have participated in free software communities, according to cluster. The Sporadic Sharer and Collector are formed mainly by respondents with the least amount of time participating in free software community. Whereas, the Donator and Constant Sharer clusters are formed mostly by participants with more time in the community.

Table 7: Time participating in communities, by cluster

Time in the community	Sporadic sharer		Constant sharer		Collector		Donator	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Up to 2 years	24	**52.2**	33	40.7	36	**50.7**	23	37.2
3 years	8	17.4	10	12.3	8	11.3	3	4.8
4 years	6	13.0	7	8.6	2	2,8	8	12.9
5 or more years	8	17.4	31	**38.3**	25	35.2	28	**45.1**

The results presented in Table 7 may indicate that the community participants shift from one profile to another over time. That is, individuals may start as a Sporadic Sharer, during which time they get to know the community and its participants and therefore contribute and access some knowledge. After a period, the individual would pass to the Collector cluster, by this stage, he/she would have identified the community's potential as a source of knowledge, but would not yet able to donate at the same intensity. In a third stage, the individual would attain a balance between knowledge collection and donation, i.e. the Constant Sharer. Finally, with extensive experience in the community, the individual begins to donate knowledge at a greater rate than he/she collects

knowledge, as represented by the Donator cluster. This is in line with Hooff and Ridder (2004) and Nodari, Oliveira and Maçada (2016), who find that the more a person collects, the more he/she donates.

5. Conclusions

The analysis of knowledge sharing behaviour as represented by two processes, donation and collection identified the existence of four profile-based clusters, namely: the Sporadic Sharer, the Collector, the Constant Sharer and the Donator. Furthermore, the three analysed respondent characteristics, time in the community, number of communities in which the respondent participates and age, were found to be closely associated with each of the clusters.

These results also indicate that, over time, individuals go from one cluster to another, suggesting the existence of an evolutionary process. Starting with cluster Sporadic Sharer, where participants have less time in the community and participate in various communities, the people are younger, and the intensity of both knowledge donation and collection is lower. The individuals in this cluster are in search of knowledge, but are not yet at the stage where they know where they can obtain the knowledge they need. The next stage would be the Collector cluster, in which participants collect more knowledge than they donate. This can be explained by their age, which would indicate less experience, and the individual participates in few communities and has spent relatively little time in the community. At this stage, he/she knows the knowledge they need and where to find it. Next comes the Constant Sharer cluster, where the individual collects and donates knowledge at a similar rate, the members of this cluster have been in the community for some time, but are still not among the older members, the age range is varied, and they participate in a larger number of communities, so they have acquired sufficient experience to allow them to diversify. Finally, in the Donator cluster, the focus is on donating knowledge, he/she participates in several communities and has been in the community for a considerable time, and tends to be older. Figure 2 summarizes the characteristics of the 4 clusters.

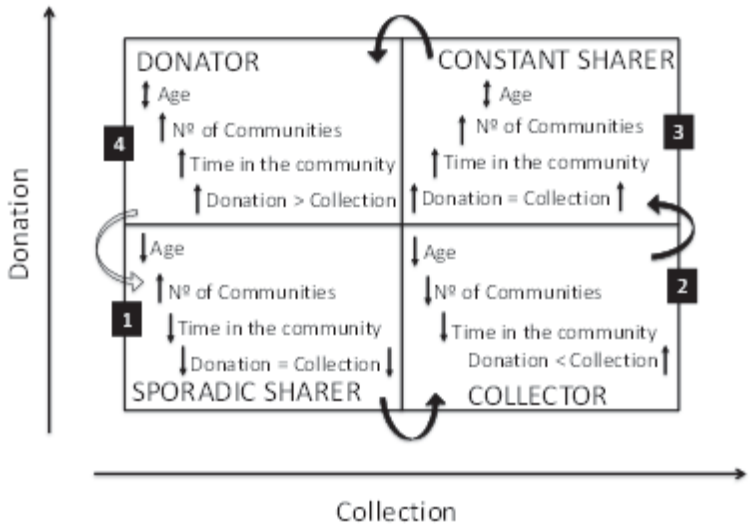

Figure 2: Knowledge sharing profiles in free software communities

The research presents some implications to practice. These practical implications can be interesting both for community managers and for project managers in firms. Managers defining teams' members must consider the experience of individuals, since the experience of the member impacts on knowledge donation. It should be a balance between more experienced and less experienced members to guarantee a knowledge flow. A potential problem in firms is the employee turnover, because the first profile is sporadic sharer, i.e., when the employee is new he collects knowledge; when he's more experienced and able to donate, he goes to another company and the knowledge cycle is not completed. Finally, community managers should be able to handle a high number of sporadic sharers and collectors on their communities, especially in relatively new communities. To assure that the member will stay on the community and will become constant sharers and donators, managers can influence the satisfaction and identification with the community, to increase participation and loyalty (Casaló, Flavián and Guinalíu, 2010).

This research has some limitations. One of which concerns the data collection, which occurred in two ways, one face-to-face and the other over the Internet. Another limitation concerns the diverse range of free software communities in which the respondents participate. The respondents answered the questions considering the free software community in which they most participate, so ensuring a diversity of communities. However, this diversity inhibited any comparison that would have identified whether the type of community is a factor that influenced the results. It is suggested that in further research, data collection be conducted among participants in specific free software communities, so allowing any influence that factor might have on the results to be identified. In addition, in future research, we intend to explore the idea of evolution in relation to the processes of knowledge collection and donation.

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