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O que Leva à Doação do Conhecimento em Comunidades de Software Livre?

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Abstract: The aim of this research is to study motivations that drive knowledge sharing in free software communities as explained by Social Exchange Theory. A survey method was adopted in which a questionnaire was administrated during a free software event, answered by members of free software communities. Structural Equation Modelling was used in the data analysis. From a social exchange view, trust, feedback, altruism, status, self-efficacy and reciprocity motivate knowledge sharing in free software communities and some have an indirect influence on knowledge collection and knowledge donation processes. Altruism is the only motivation that directly influences knowledge sharing. Reciprocity is directly linked to knowledge collection and self-efficacy and status are directly linked to knowledge donation. Status is directly and negatively related to knowledge donation. Influence of knowledge collection on knowledge donation was supported. The main contribution is showing the existence of relationships between motivations driving knowledge sharing in free software communities as explained by Social Exchange Theory, instead of investigating a direct relationship between each motivation and knowledge sharing. The findings of this research are useful for leaders of communities who can use them to leverage knowledge sharing.

Keywords: Free software community, Knowledge sharing, Social exchange theory, Motivations.

Resumo: O objetivo desta pesquisa é estudar as motivações que impulsionam o compartilhamento de conhecimento em comunidades de software livre, como explicado pela Teoria da Permuta Social. O método de pesquisa adotado foi o *survey*, com um questionário administrado durante um evento de software livre e respondido por membros de comunidades. Modelagem de Equações Estruturais foi utilizada na análise de dados. Confiança, feedback, altruísmo, status, auto-eficácia e reciprocidade motivam o compartilhamento de conhecimento em comunidades de software livre e algumas destas motivações têm uma influência indireta nos processos de coleta e doação. O altruísmo é a única motivação que influencia diretamente o compartilhamento de conhecimento. A reciprocidade está diretamente ligada à coleta de conhecimento e a auto-eficácia e status estão diretamente ligadas à doação de conhecimento. O status está direta e negativamente relacionada à doação de conhecimento. A influência da coleta de conhecimento na doação de conhecimento foi suportada. A principal contribuição do artigo está em mostrar a existência de relações entre motivações que levam ao compartilhamento ao invés de investigar somente uma relação direta entre cada motivação e o compartilhamento de conhecimento. As descobertas são úteis para líderes de comunidades que podem usá-las para alavancar o compartilhamento de conhecimento.

Palavras-chave: Comunidade de software livre, Compartilhamento do conhecimento, Teoria da permuta social, motivações.

Introduction

Social Exchange Theory (SET) suggests that a social behaviour is the result of an exchange process. Social exchanges are long-term relationships involving trust, loyalty and mutual commitments that evolve over time (Cropanzano & Mitchell, 2005), i.e., they evolve in a way that generates obligations on both parts (Emerson, 1976). Exchange efficiency can be achieved through knowledge sharing (Wang, 2013), which is a kind of exchange behaviour (Cyr & Choo, 2010; Huang, Davison, & Gu, 2008; Lin, 2014).

Knowledge sharing (KS) is defined as the transfer of knowledge from one party to another (Staples & Webster, 2008), where an individual voluntarily provides knowledge to other individuals (Cyr & Choo, 2010). Knowledge sharing is important not only to better employ the knowledge existing within an organization, but also to create new knowledge (Huang et al., 2008), since knowledge is an organization's most important resource (Grant, 1996). Knowledge sharing is the precursor to collaborative success in teams, groups and networks, especially in the post-industrial digital economy (Tiwana & Bush, 2001). Communities of practice are a means of leveraging knowledge sharing (Hartung & Oliveira, 2013). They consist of groups of people that gather to share knowledge about common passions and expertise (Wenger & Snyder, 2000).

A free software community is a form of community of practice (Krishnamurthy, 2003; Lichand, Diniz & Christopoulos, 2008), in which the main purpose is to develop, improve, disseminate and share knowledge about a specific software (Carillo & Okoli, 2008; Shen, 2007). Such communities have implicit norms, are meritocratic and their leaders are highly active contributors (Barcellini, Détienne, Burkhardt, & Sack, 2008). Participation in free software communities is voluntary and membership is determined by active contribution (Endres, Endres, Chowdhury, & Alam, 2007; Studer, Mueller, & Ritschard, 2007). Peer-to-peer knowledge sharing is the heart of the participation in free software communities and their members report a willingness to share complex knowledge (Endres et al., 2007).

While recent papers have looked into the motivations that drive knowledge sharing in free software communities (Balle & Oliveira, 2015; Iskoujina & Roberts, 2015), they have not adopted a specific theoretical lens through which to examine the motivations. Of the various theories that have been applied in the study of what influences knowledge management, social exchange theory is one of the most widely used (Tsai & Cheng, 2012; Xavier, Oliveira, & Teixeira, 2012). Therefore, it is interesting to investigate how this theory, which has been frequently applied in other contexts, behaves in this new and scantily studied context. Based on the above, the aim of this research is to study the

motivations that drive knowledge sharing in free software communities as explained by Social Exchange Theory.

The main academic contribution of this research is to show the existence of the relationships between the motivations driving knowledge sharing in free software communities as explained by Social Exchange Theory, instead of investigating a direct relationship between each motivation and knowledge sharing. This research also would also be useful for leaders by helping them to identify which actions leverage knowledge sharing.

Theoretical Model and Hypothesis Development

Knowledge sharing (KS) is a social activity in which knowledge is seen as a valuable resource (Davenport &Prusak, 1998). It is a process where teams, units and organizations receive and influence each other in the creation of knowledge (Argote & Ingram, 2000; Wijk, Jansen, & Lyes, 2008). Knowledge sharing can be seen as two active mechanisms, according to the individual action: knowledge donation – communicating one's personal capital to others – and knowledge collection – consulting colleagues in order to obtain their intellectual capital (Hooff & Ridder, 2004; Hooff & Van Weenen, 2004). Different factors and conditions can influence knowledge sharing, its consequences and moderators (Wijk et al., 2008). These factors are explained by several theories and are broadly grouped into intentions and attitudes, organizational culture and rewards for knowledge sharing (Witherspoon, Bergner, Cockrell, & Stone, 2013).

Knowledge sharing is the most important process in knowledge management (Chiang, Han, & Chuang, 2011). Knowledge flows can occur through more formal mechanisms, such as knowledge sharing systems (Tsai, Chang, Cheng, & Lien, 2013), or more informally, as in virtual communities (Gang and Ravichandran, 2015). Knowledge sharing is strategic not only among individuals within organization, but also for alliances between organizations (Li et al., 2012).

Social Exchange Theory (SET) assumes that individuals respond to situations based on the consequences of previous experience (Gang & Ravichandran, 2015). SET was developed by Homans (1958) and brings together concepts from the fields of economics, psychology, sociology and anthropology (Cropanzano & Mitchell, 2005). Social behaviour can be seen as an exchange of goods, both material and non-material (Homans, 1958). As in an economic exchange, what a person gives in a social exchange may generate some cost, and the return may be seen as a reward; the final operation may be seen as profiting the parts involved (Homans, 1958). Social exchanges are different from economic exchanges because in the former the obligations are implicit, while in the latter they are clearly specified; in social exchange people do each other favours with the general idea that the favour can be returned (Kankanhalli, Tan, & Wei, 2005).

Social Exchange Theory explains interactions based on the subjective assessment of profit, because people expect to benefit from any behaviour; when one's expectations are positive, one is motivated to engage in the

behaviour (Gang & Ravichandran, 2015). From this perspective, SET is related to intrinsic motivations (Gang & Ravichandran, 2015; Tsai & Cheng, 2012), but also with extrinsic motivations (Huang et al., 2008; Staples & Webster, 2008). Social exchange is a rational behaviour (Cyr & Choo, 2010) and is based on feelings of each party, like personal obligation, gratitude, trust, and the sense of fairness at work (Tsai & Cheng, 2012; Tsai et al., 2013; Yu & To, 2013).

The number of parties involved in an exchange relationship can influence the nature and complexity of that relationship (Li et al., 2012). A relationship can be classified as restricted or generalized, where a generalized relationship has at least three participants and does not involve direct reciprocity among all the parties; the perceived reciprocal benefits from the partnership can be indirect (Staples & Webster, 2008). Negotiation is a critical element in an exchange relationship that will influence the future interaction among the parties, including knowledge sharing (Thomas, Thomas, Manrodt, & Rutner, 2013). Contracts, even those between employers and employees, are subjective in the context of SET and are based on emotional benefits and mutual trust (Staples and Webster, 2008; Tsai et al., 2013). This means the obligations are unclear and the time of the reciprocity "payment" is uncertain (Staples & Webster, 2008; Zhang & Ng, 2012).

Social Exchange Theory is widely used to explain knowledge sharing (Tsai & Cheng, 2012) and both concepts share common points. One key point is the view of knowledge sharing as a form of social exchange behaviour (Cyr & Choo, 2010; Huang et al., 2008; Lin, 2014; Staples & Webster, 2008; Swift & Virick, 2013; Wu, 2013), in which the parties involved aim to share knowledge in the expectation of receiving knowledge in the future and obtaining mutual benefits (Huang et al., 2008; Kembro, Selviaridis, & Näslund., 2014; Lin, 2014; Zhang & Ng, 2012). Donating knowledge, which is just one part of this exchange, is motivated by what the donor expects to get in return (Staples & Webster, 2008). When the exchange relationship is generalized, with a large number of actors, knowledge sharing becomes more complex and challenging (Li et al., 2012). Individuals build relationships with each other by sharing their knowledge, in order to receive returns in the future (Tsai et al., 2013).

The fundamental reason to achieve knowledge sharing in organizations is the pursuit of exchange efficiency (Wang, 2013). Knowledge sharing plays a significant role in aligning important employee behaviours and the organizational goals. Employee behaviours are explained by SET, especially when they align with perceptions of fairness, and KS is used to disseminate relevant information, such as performance criteria or reward schemes (Yu & To, 2013). Social exchange and norms improve inter-organizational cooperation, which leads to operational efficiency (Kembro et al., 2014; Wei, Wong, & Lai, 2012).

SET is also used to explain the beliefs and motivations that influence knowledge sharing attitudes, intentions and behaviours (Gang & Ravichandran, 2015). SET suggests there are many different antecedents

for knowledge sharing, such as power (Huang et al., 2008), job relevance (Gang & Ravichandran, 2015), organizational commitment (Tsai & Cheng, 2012) and perceived costs and benefits (Cyr & Choo, 2010), among others. This research will examine some of those antecedents, namely: trust (Chiang et al., 2011; Chong & Besharati, 2014; Gang & Ravichandran, 2015; Konstantinou & Fincham, 2011; Qi & Chau, 2013; Staples & Webster, 2008; Topchyan, 2015; Tsai & Cheng, 2012; Tsai et al., 2013); reciprocity (Gang & Ravichandran, 2015; Kankanhalli et al., 2005; Konstantinou & Fincham, 2011; Tsai et al., 2013); feedback (Zhang &Ng, 2012); self-efficacy (Kankanhalli et al., 2005; Zhang & Ng, 2012); status (Chong & Besharati, 2014; Huang et al., 2008; Kankanhalli et al., 2005; Konstantinou & Fincham, 2011) and altruism (Kankanhalli et al., 2005; Konstantinou & Fincham, 2011, Ullah, Akhtar, Shahzadi, Farooq, & Yasmin, 2016), because they influence knowledge sharing in free software communities (Balle & Oliveira, 2015; Iskoujina & Roberts, 2015).

Reciprocity is the heart of exchange theory. Reciprocity is a motivation that drives knowledge sharing based on self-interest, but with intangible returns (Wasko & Faraj, 2000) and it is linked with the individual perception of the fairness of mutually sharing content (Chang & Chuang, 2011). It can have two sides: one positive, where reciprocity is a mutually contingent exchange of benefits, and one negative, where reciprocity includes either feelings of retaliation and reprisal for perceived injury (Thomas et al., 2013) or the decision to cease of the relationship (Zhang & Ng, 2012). People participate in communities motivated by reciprocity, as a way to promote KS within the community (Wasko & Faraj, 2000). Accordingly, reciprocity motivates individuals to share their knowledge (Tsai et al., 2013; Kankanhalli et al., 2005).

H1a: Reciprocity positively influences knowledge collection in free software communities.

H1b: Reciprocity positively influences knowledge donation in free software communities.

Trust is associated with an individual's expression of confidence in the consistency of the intentions and motives of others (Chang & Chuang, 2011; Lewicki, McAllister, & Bies, 1998), being defined as "one party's optimistic expectation of the behaviour of another" (Lewicki et al., 1998, p. 439). Trust is conceptualized in terms of competence, the individual ability to perform a task, and compassion, the individual's benevolence and integrity (Gang & Ravichandram, 2014). In a virtual community, an environment with high levels of anonymity, trust among the members is critical (Gang & Ravichandram, 2014), but the effects of trust on KS are found in all environments: local, distributed or hybrid (Staples & Webster, 2008). So the member's trust will be positively associated with knowledge sharing.

H2a: Trust positively influences knowledge collection in free software communities.

H2b: Trust positively influences knowledge donation in free software communities.

Feedback happens when an individual shares knowledge with colleagues and receives comments, suggestions and has their errors pointed out by them (Zhang & Ng, 2012). The amplifications and modifications suggested in the feedback process "add value for the original sender, creating exponential growth" (Quinn, Anderson, & Finkelstein, 1996, p. 8). Participants in communities of practice value feedback more than simple access to information, since it is an import form of obtaining solutions and ideas (Wasko & Faraj, 2000). Feedback is a perceived benefit of knowledge sharing and motivates individuals to share (Zhang & Ng, 2012).

H3a: Feedback positively influences knowledge collection in free software communities.

H3b: Feedback positively influences knowledge donation in free software communities.

Status is the form individuals are differentiated in a group, based on prestige, honour and influence (Willer, 2009). It is defined by the perception of gaining a more positive reputation by demonstrating expertise (Kankanhalli et al., 2005) and earning respect through participation in activities (Chang & Chuang, 2011). A good status helps people advance in their career, and one way of gaining expert status is by sharing knowledge with colleagues (Huang et al., 2008). So the perception of gaining a more positive status influences the individual's attitude towards knowledge sharing (Huang et al., 2008; Kankanhalli et al., 2005).

H4a: Status positively influences knowledge donation in free software communities.

H4b: Status positively influences knowledge donation in free software communities.

Self-efficacy is the belief of an individual in his/her capacity to perform a specific task (Bandura, 1997). Knowledge self-efficacy is manifested in the individual's perception of the degree to which he/she can make a difference to the group (Wasko & Faraj, 2000). When the individual shares knowledge, a sense of fulfilment is expressed, increasing the self-efficacy (Constant, Kiesler, & Sproull, 1994), which serves as a motivation to contribute knowledge (Kankanhalli et al., 2005). The degree of knowledge self-efficacy influences the degree to which the individual shares knowledge (Zhang & Ng, 2012; Kankanhalli et al., 2005).

H5a: Self-efficacy positively influences knowledge collection in free software communities.

H5b: Self-efficacy positively influences knowledge donation in free software communities.

Altruism is an intrinsic motivation for sharing. It is considered the perceived pleasure in helping other people (Hung, Lai, & Chang, 2011; Wasko & Faraj, 2000). Since altruism is classically defined as a form of unconditional kindness (Hung et al., 2011; Krebs, 1975), it seems to be a concept contradictory to the reciprocal nature of SET (Konstantinou & Fincham, 2011). However, the pleasure obtained in helping others, the challenge involved and the satisfaction gained through the act is

the reward for the knowledge sharing (Kankanhalli et al., 2005; Wasko &Faraj, 2000; Wasko & Faraj, 2005).

H6a: Altruism positively influences knowledge collection in free software communities.

H6b: Altruism positively influences knowledge donation in free software communities.

The knowledge sharing processes are also linked. There is evidence that the more knowledge a person collects, the more knowledge that person donates (Hooff & Ridder, 2004; Hooff & Van Weenen, 2004; Vries, Hooff, & Ridder, 2006). Therefore, knowledge collection is a positive influence on knowledge donation.

H7: Knowledge collection influences knowledge donation in free software communities.

Figure 1 shows the research model with all the hypotheses.

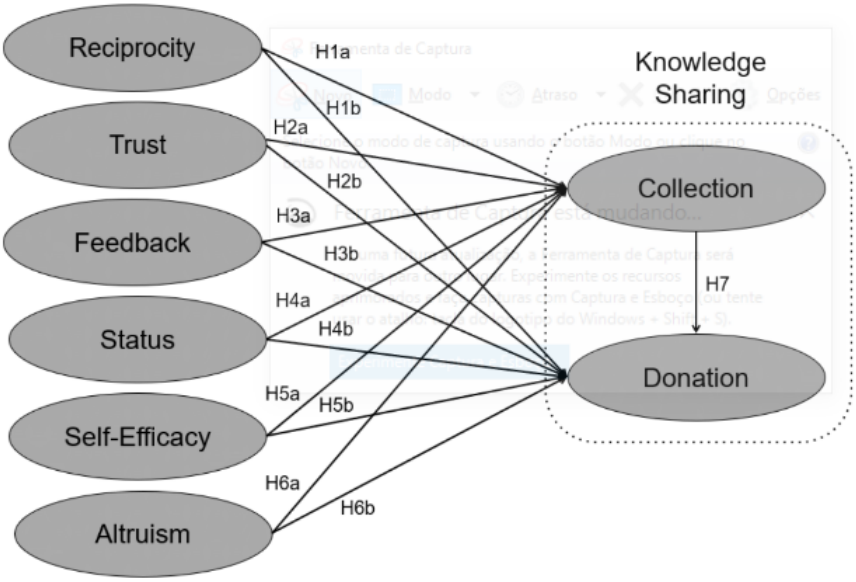

Figure 1.
Research Model

n the next section, the methodological procedures adopted to achieve the research aim are presented.

Method

In this research, a survey was conducted using a questionnaire administrated during a free software event that held in Brazil in 2015. The event is the biggest annual event in South America dedicated exclusively to free software, being attended by more than five thousand free software enthusiasts. The sample was non-probabilistic by judgment. The respondents are event attendees who also participate in free software communities.

All the scales were adapted from the literature: trust and altruism from Chang and Chuang (2011), reciprocity and status from Kankanhalli

et al. (2005), feedback and self-efficacy from Zhang and Ng (2012), and knowledge sharing from Vries et al. (2006). The items were measured using a 7-point Likert scale. Translation and back-translation (English-Portuguese-English), face validation (interviews with experts) and content validation (the questionnaire was applied to potential respondents) were used to develop and to refine the questionnaire, which was applied in Portuguese. It has a total of 34 items and five questions designed to characterize the respondents. During the event, 180 instruments were collected, but after the data cleaning, 174 remained in the sample. This gives 5.11 respondents per item, which is adequate based on Hair, Black, Babin, Anderson and Tatham (2006).

The sample has the following characteristics: the most cited occupations are developer (21%), student (14%), system analyst (9%) and teacher (6%); ages vary from 18 to 61 years, the average age is 30 years; regarding education, 2% have not finished High School, 2% have completed High School, 36% have incomplete university degree, 36% have complete university degree, and 21% have complete post-graduate degree; 87% are male and 13% are female; 56% participate in two or more communities and the average number of communities per respondent is 2.24.

Analysis

Given the research objective, Structural Equation Modelling (SEM) was used to specify and estimate models of linear relationships between the studied variables, according to Kline (2011). The reliability of the constructs was evaluated using Cronbach's Alpha and Corrected Item-Total Correlation (CITC). Out of a total of 34 items, 5 presented a CITC below the value recommended by Hair et al. (2006) and factor loadings below 0.5 (Hair et al., 2006), and were thus removed from the final instrument. The final reliability scores for all the constructs exceeded 0.7 and the CITC exceeded 0.5 (Hair et al., 2006).

Measurement Model

Confirmatory Factor Analysis (CFA) was performed by applying AMOS 21.0® to the 174 completed questionnaires, as recommended by Byrne (2010) and Kline (2011). The results suggest that the measurement model is a good fit. Convergent validity was assessed by examining the factor loadings in SEM (see Table 1) and the average variance extracted (AVE) of each construct (see Table 2). The value of 0.6 for composite reliability, considered acceptable by Fornell and Larcker (1981), was found for all the constructs, except Knowledge collection. The composite reliability for knowledge collection was accepted because they approximated 0.6.

Table 1.
Measurement Model: Standardized Loadings, Composite Reliabilities, Fit Statistics

Construct	Items	Standard loadings	Composite reliabilities	Construct	Items	Standard loadings	Composite reliabilities
Knowledge collection	KSC1	0.697	0.592	Knowledge donation	KSD1	0.801	0.642
	KSC2	0.661			KSD2	0.745	
	KSC3	0.620			KSD4	0.565	
Reciprocity	RECIP1	0.602	0.811	Trust	TRUST2	0.727	0.867
	RECIP2	0.789			TRUST3	0.772	
	RECIP3	0.790			TRUST4	0.889	
	RECIP4	0.689			TRUST5	0.754	
Feedback	FEED1	0.776	0.916	Status	STA 1	0.809	0.909
	FEED2	0.923			STA 2	0.957	
	FEED3	0.865			STA 3	0.881	
	FEED4	0.851			STA 4	0.717	
Self-Efficacy	SELF1	0.833	0.935	Altruism	ALT1	0.902	0.928
	SELF2	0.910			ALT2	0.956	
	SELF3	0.807			ALT3	0.884	
					ALT4	0.741	

Fit Statistics: $\chi 2/df = 1.726$; IFI= 0.918; CFI= 0.916; TLI= 0.903; RMSEA= 0.066
Note: $p < 0.001$ for all loadings

The AVE is at least 0.5, as recommended by Bagozzi and Yi (1988), although for knowledge collection it is slightly less than 0.5. The model presents a suitable convergent validity. Discriminant validity was confirmed for all the constructs, except the relationship between knowledge collection and knowledge donation, by comparing the square root of the AVE for each construct and the correlation of each construct with the other constructs in the model (Bock, Zmud, Kim, & Lee, 2005). On the other hand, Discriminant Validity was confirmed using the criterion proposed by Kline (2011, p.72), i.e., "a set of variables presumed to measure different constructs shows discriminant validity if their intercorrelations are not too high". According to the author, values up to 0.90 are acceptable.

Table 2.
Construct reliability, AVE, and correlations

Construct	Items	Cronbach's Alpha	AVE	1	2	3	4	5	6	7	8
1. Knowledge collection	3	0.699	0.436	0.660							
2. Knowledge donation	3	0.719	0.505	0.772	0.711						
3. Reciprocity	4	0.802	0.52	0.333	0.149	0.721					
4. Trust	4	0.865	0.62	0.173	0.217	0.029	0.787				
5. Feedback	4	0.913	0.731	0.402	0.411	0.111	0.293	0.855			
6. Status	4	0.896	0.715	0.294	0.121	0.379	0.139	0.330	0.846		
7. Self-Efficacy	3	0.886	0.724	0.245	0.368	0.403	0.185	0.415	0.403	0.851	
8. Altruism	4	0.918	0.764	0.500	0.636	0.106	0.311	0.646	0.258	0.414	0.874

Note: The bold numbers in the diagonal row are square roots of average variance extracted.

Convergent validity, discriminant validity, and reliability of the scales were demonstrated in Tables 1 and 2.

Hypotheses testing

The hypotheses were examined using the structural model, shown in Figure 1, according to the procedures suggested by Hair et al. (2006). Table 3 demonstrate the results of the performed path analysis.

Table 3.
Hypotheses testing results

Hypotheses	Relationship			Standardized Regression Weights	Result
H1a	Reciprocity	->	Knowledge collection	0.268*	Supported
H1b	Reciprocity	->	Knowledge donation	-0.052	Not supported
H2a	Trust	->	Knowledge collection	0.013	Not supported
H2b	Trust	->	Knowledge donation	0.021	Not supported
H3a	Feedback	->	Knowledge collection	0.119	Not supported
H3b	Feedback	->	Knowledge donation	-0.058	Not supported
H4a	Status	->	Knowledge collection	0.09	Not supported
H4b	Status	->	Knowledge donation	-0.186*	Opposite
H5a	Self-Efficacy	->	Knowledge collection	-0.009	Not supported
H5b	Self-Efficacy	->	Knowledge donation	0.174*	Supported
H6a	Altruism	->	Knowledge collection	0.412***	Supported
H6b	Altruism	->	Knowledge donation	0.324**	Supported
H7	Knowledge collection	->	Knowledge donation	0.644***	Supported

Fit Statistics: $\chi 2/df= 2.137$; IFI= 0.865; CFI= 0.864; TLI= 0.848; RMSEA= 0.083
Note: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

As shown in Table 3, only reciprocity and altruism (hypotheses H1a and H6a) influence knowledge collection. Only knowledge collection (H7), self-efficacy (H5b) and altruism (H6b) exert positive influence on knowledge donation. Despite the literature, the observed impact of status on donation is negative. However, the fit index does not indicate that the model is a good representation of the observed data (CFI=0.864; IFI=0.865; TI=0.848; RMSEA=0.083) as pointed out by Kline (2011) and Hair et al. (2006). Regarding this, the procedures suggested by Byrne (2010) were applied, in order to propose a structural model that correctly represents the observed data. This procedure consists of excluding non-significant relationships, and including new ones, one at a time, after a thorough analysis of the items and concepts of the constructs in the relationship suggested by the modification index. Table 4 presents the relationships in the proposed model.

Table 4.

Relationship			Standardized Regression Weights
Trust	->	Feedback	0.307***
Feedback	->	Altruism	0.656***
Feedback	->	Status	0.336***
Feedback	->	Self-Efficacy	0.328***
Altruism	->	Knowledge collection	0.473***
Altruism	->	Knowledge donation	0.307**
Status	->	Reciprocity	0.383***
Status	->	Self-Efficacy	0.292***
Status	->	Knowledge donation	-0.195*
Self-Efficacy	->	Knowledge donation	0.172*
Reciprocity	->	Knowledge collection	0.276**
Knowledge collection	->	Knowledge donation	0.625***

Fit Statistics: $\chi 2/df= 1.683$; IFI= 0.919; CFI= 0.918; TLI= 0.909; RMSEA= 0.064
Note: *** p < 0.001, ** p < 0.01, * p < 0.05

Proposed Model Relationships

Figure 2 shows the resulting model, which explains 71% of the variance of knowledge donation and 32% of collection. As presented in Table 4, the fit statistics are shown to be adequate as recommended by Kline (2011) and Hair et al. (2006).

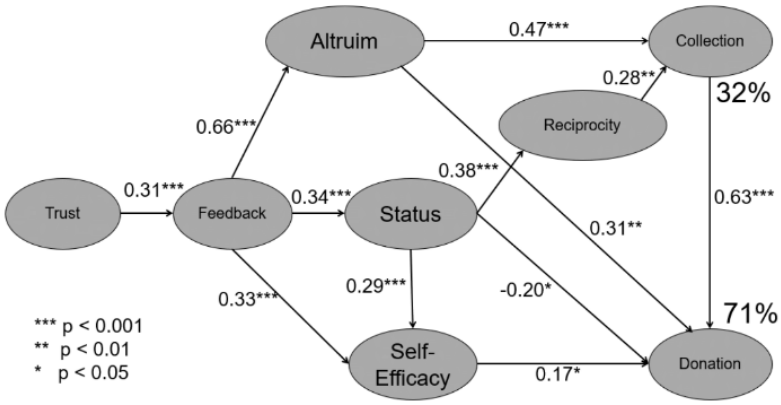

Figure 2.
Proposed Structural Model
Note: *** p < 0.001, ** p < 0.01, * p < 0.05

The results show the direct effects of altruism, status and knowledge collection on knowledge donation. Moreover, all the other constructs also exert indirect effects, as shown in Table 5.

Table 5.
Indirect Effects

	Trust	Feedback	Status	Altruism	Reciprocity
Status	0.092	0	0	0	0
Altruism	0.148	0	0	0	0
Reciprocity	0.029	0.148	0	0	0
Self-Efficacy	0.106	0.124	0	0	0
Collection	0.079	0.400	0.089	0	0
Donation	0.105	0.530	0.105	0.324	0.186

Note: All relations are significant at $p < 0.001$

These results and particularly the proposed relationships are discussed in the next section.

Discussion

Initially, the research model was built based on a literature review, regardless of the existence of any relationship between the constructs. This model was not a good representation of the data collected. However, some relationships were supported and retained in the proposed model. The relationships that are in accordance with the hypotheses in the original model are: reciprocity influences knowledge collection (H1a), self-efficacy influences knowledge donation (H5b), altruism influences knowledge collection (H6a) and knowledge donation (H6b) and knowledge collection influences knowledge donation (H7).

Unexpectedly, in both the research model and the proposed model, status was found to have a negative relationship with knowledge donation (H4b), i.e., the greater the status, the fewer the contributions the person gives. At first sight, the relationship is counter intuitive, but it makes sense if analysed jointly with self-efficacy. Self-efficacy positively influences knowledge donation, which means that if the community member feels that his knowledge is accurate, he will contribute, but, on the other hand, if he feels that he lacks useful knowledge, he may refuse to contribute because he believes his contribution will not have a positive impact (Kankanhalli et al., 2005). Self-efficacy is also positively influenced by status. It means that if a member of the community that wants to build an status as an expert does not believe he is able to make a positive impact with his knowledge (in other words, if he does not have self-efficacy), he will not donate knowledge on the subject due to the fear of his inaccurate knowledge may hurt his status. Otherwise if the person wants to build his status and believes that his contributions are important and correct (he possesses high self-efficacy), he donates his knowledge.

Six new relationships emerged from the new proposed model: together with the above-mentioned influence of status on self-efficacy, there is the positive influence of trust on feedback; of feedback on altruism; of status on self-efficacy; and of status on reciprocity.

Trust expresses the confidence that an individual has regarding the behaviour of others. Since it is expressed not only on terms of compassion and benevolence, but also in terms of competence (Gang and Ravichandram, 2014). Trust influences feedback when the person believes that the feedback received will be correct, constructive and be of value to the receiver (Quinn et al., 1996). Thus, feelings of trust may increase the willingness to receive feedback, since the feedback is expected to be useful and accurate.

Feedback influences altruism, status and self-efficacy. People who get feedback "are more likely to understand how such actions have contributed to the work of others" (Bock et al., 2005, p. 93), which can provide a good feeling. This explains how feedback influences altruism, since altruism is described as an enjoyment in helping others. (Hung et al., 2011; Kankanhalli et al., 2005; Wasko & Faraj, 2000).

When people receive feedback, they perceive more clearly whether their status is positive or negative, and they can adjust their behaviour in order to approximate the intended expert image. Finally, the enhanced understanding that results from feedback can also increase self-efficacy, because feedback shows that the contribution is correct or helpful in solving the problem (Kankanhalli et al., 2005; Zhang & Ng, 2012). Status is the perception of enhanced respect due to participation (Chang & Chuang, 2011). A good status can be achieved by actively contributing to the free software community. In such participants, the expectancy of reciprocity is generated. According to Kankanhalli et al. (2005), participants expect to receive knowledge back when they share knowledge.

Conclusion

This research tested the relationship between a set of constructs and the two knowledge-sharing processes, knowledge collection and knowledge donation, and found that only a few of those constructs to be directly related to those processes. The influence of knowledge collection on knowledge donation was supported by the data collected in this research.

The current paper contributes to the literature on knowledge sharing in free software communities, by investigating the relationship between the motivations that drive knowledge sharing based on social exchange theory. The proposed model explains 71% of the variance in knowledge donation and 32% of the variance in knowledge collection, which highlights the relevance of social exchange theory in explaining knowledge sharing. The results show that while all the constructs influence knowledge sharing, not all of them directly influence either knowledge collection or knowledge donation.

Altruism is the only motivation that directly influences both knowledge collection and knowledge donation. Another finding from this research is that while status has a direct negative influence on knowledge donation, when that relationship is mediated by self-efficacy the influence is positive. This finding supports the existence of a

relationship between the motivations that drive knowledge sharing. In addition, the findings of this research could be useful for leaders of free software communities who can use them to choose actions for leveraging knowledge sharing.

This research has some limitations that will need to be dealt with in future studies. First, knowledge collection did not achieve the minimum value for AVE recommended by Bagozzi and Yi (1998), which implies the items require further analysis. Second, the sample size may have caused bias in the findings. The number of respondents could be enlarged by collecting data by other means. A wider range and greater number of respondents would enable the testing of variables such as the nationality of the participants, since in this study the respondents were exclusively Brazilian, as well as the number of communities they participate in. Finally, future research might consider longitudinal comparisons, since knowledge collection and knowledge donation occur at different moments.

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