

Community's Knowledge Need and Knowledge Sharing in Wikipedia

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Abstract

In practice, showing the community's need for knowledge (e.g., listing requests for new articles) is used to drive knowledge sharing in Wikipedia. Yet, theoretical understanding of *how* it influences one's knowledge sharing is still lacking. This study develops a model of the influence and shows that one takes others' utility into account (utility interdependence). Specifically, others' knowledge need affects one's perceived forgone benefit of free riding (i.e., a cost of knowledge sharing) and thereby increases the intention to share knowledge. This study contributes to research by identifying utility interdependence in knowledge sharing. For practice, the findings provide empirical support for the general belief that showing others' knowledge need is useful for promoting sharing.

Keywords: Others' need, knowledge sharing, utility interdependence, knowledge codification effort, Wikipedia

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Introduction

Wikipedia seeks to “create a web-based, free content encyclopedia of all branches of knowledge” (Wikipedia, 2016). As of September 2017, Wikipedia has more than 43 million articles in more than 250 languages (Wikipedia, 2017). The comprehensiveness and accessibility of Wikipedia have made it a popular collaborative knowledge repository. Wikipedia has been consistently ranked among the ten most-visited websites globally, with more than 500 million unique visitors a month (Alexa, 2016).

At the core of Wikipedia's development is voluntary knowledge sharing, which occurs as knowledgeable users address others' need for knowledge. All the articles in Wikipedia are written and edited by volunteers. Wikipedia is described as “the product of thousands of editors' contributions, each one bringing something different to the table, whether it be: researching skills, technical expertise, writing prowess or tidbits of information, but most importantly a willingness to help” (Wikipedia, 2016). New users of Wikipedia are explicitly encouraged to address the knowledge needs of the community, such as by improving existing articles to meet quality criteria (indicated by tags such as “expert needed”) and creating articles on requested topics (Wikipedia, 2016).

Others' need is also emphasized in the concept of altruism, which has been found to be an important antecedent of Wikipedians' voluntary knowledge sharing (e.g., Kuznetsov, 2006; Prasarnphanich and Wagner, 2009; Rafaeli and Ariel, 2008; Xu and Li, 2015). Conceptually, altruism is a selfless concern for the welfare of others (Jensen, 1994), and leads one to perform actions that are costly but benefit others, without the expectation of reciprocity, compensation, or external rewards. Despite the convenience of the Wiki technology, writing and editing articles require significant effort to codify knowledge. Wikipedians' work is often anonymous, not explicitly rewarded, and not permanent (Cho et al., 2010; Kuznetsov, 2006; Prasarnphanich and Wagner, 2009). Knowledge sharing in Wikipedia is voluntary and return, if any, is not guaranteed. It appears that users sharing their knowledge in Wikipedia are driven, at least partly, by a concern for others.

Although showing others' knowledge need is done in practice and is emphasized in studies of altruistic knowledge sharing, how others' knowledge need comes to influence one's knowledge sharing is not well understood. The majority of prior studies have measured altruism in terms of intrinsic motivation or personal belief and focused on the utility of sharing to oneself. For example, Xu and Li (2015) examined Wikipedians' enjoyment in helping others in their conceptualization of altruism; Prasarnphanich and Wagner (2009) anchored Wikipedians' altruistic motives on fulfilling the personal belief of doing good for the humanity and the belief of collaborative effort. There has been a lack of studies that directly account for others' need. This study seeks to address the gap.

This study's objective is to shed light on *how* others' knowledge need influences one's knowledge sharing intention. A model is developed by drawing upon on the concept of utility interdependence and tested with data collected from Wikipedia users. Utility interdependence describes how people take others' utility into account when determining behavioral options (Becker, 1974) and has been shown to be relevant for understanding

altruistic volunteering (Unger, 1991). More specifically, community's need for volunteer influences one's perceived cost of volunteering (e.g., opportunity cost, free-riding tendency) and subsequently volunteering, along with the amount of resource available (e.g., socioeconomic status; Unger, 1991). Accordingly, this study proposes that others' knowledge need influences knowledge codification effort and foregone benefit of free-riding (costs of knowledge sharing), and subsequently knowledge sharing intention, along with one's knowledge level (i.e., resources available). We focus on intention, defined as the degree to which one is willing to try to perform a behavior (Ajzen, 1991), rather than behavior, because consideration of utility should influence intention (behavioral decision) more directly than it affects actual behavior (Bagozzi, 1982).

Findings of a survey of 323 Wikipedia users indicate that one takes others' utility into account (utility interdependence) in knowledge sharing. Specifically, others' knowledge need affects one's perceived forgone benefit of free riding and thereby increases the intention to share knowledge. This study contributes to research and practice in several ways. First, this is one of the earliest attempts to model *how* others' knowledge need influences one's knowledge sharing intention, grounded on the theoretical concept of utility interdependence. Second, this study provides empirical evidence for the significance of others' knowledge need. This supports the practice of showing knowledge needs to promote sharing. Third, the findings point towards a new line of research inquiry that focuses on characterizing others' knowledge need in greater detail.

Conceptual Background

This section first reviews the conceptualization and research on others' knowledge need in studies of Wikipedia. This is followed by a description of the concept of utility interdependence as an important theoretical basis of the proposed model.

Community's Knowledge Need in Wikipedia

Since others' need is emphasized in the concept of altruism, we reviewed studies on the altruism of Wiki users to understand the state of research. Relevant studies were identified by searching the Scopus database and Google Scholar for documents containing the keywords "Wiki" and "altruism" (or "altruistic"). Table 1 organizes the studies chronologically and summarizes each study's conceptualization of altruism, measure, and key findings.

The review shows that most studies acknowledge the importance of concern for others and benefit for others (see the second column of Table 1) in the conceptual definition of altruism. They consistently highlight that altruism is other oriented. Specifically, Rafaeli and Ariel (2008) pointed out that altruism is an other-oriented motive that could drive knowledge sharing in Wikipedia; Jensen (1994) defined altruism as the concern for the wellbeing of others; Sober and Wilson (1999, p. 7) highlighted that "the case for psychological altruism requires showing that an ultimate concern for the welfare of others is among the psychological mechanisms that evolved to motivate adaptive behavior".

Study	Conceptualization	Measure/Indicator of Altruism	Research Method	Key Finding/Conclusion
Kuznetsov (2006)	- Altruism emphasizes a concern for the good of others over one's own personal welfare - A person who acts out of altruism aims solely to benefit others without any intent to promote a gain or improve his or her situation	Not reported	Informal survey of 102 university students	Altruism is the primary motive for sharing in Wikipedia
Rafaeli and Ariel (2008)	An other-oriented motive that focuses on concern for others	None	Conceptual discussion of Wikipedians' motivation	Altruism is one of the factors that could explain Wikipedians' knowledge sharing
Prasarnphanich and Wagner (2009)	Users driven by altruism have collaborative motives and stress group benefits	- Belief of collaborative effort to help each other or groups - Belief of doing good for humanity	Survey of 200 Wikipedians identified by Google search	Collaborative (altruistic) motives dominate over individualistic motives for Wikipedians
Baytiyeh and Pfaffman (2010)	Altruism involves working together for the greater good	An open-ended survey question asking for reasons behind joining the Wikipedia community	Survey of 115 Wikipedia administrators	Altruism is one of the most important motivating factors for Wikipedians
Cho et al. (2010)	Altruistic behavior is performed without expecting any future reward and is carried out mainly to benefit others	- I enjoy helping others by sharing my knowledge - It feels good to help someone by sharing my knowledge	Survey of 223 registered Wikipedians in the United States and Singapore	Altruism (an intrinsic motivator) is positively related to attitudes toward knowledge sharing, whereas reputation (an extrinsic motivator) is not significant
Xu and Li (2015)	Altruism involves doing something for another at some cost to oneself. It exists when people derive intrinsic enjoyment from helping others without expecting anything in return	- I enjoy helping others by sharing my knowledge - I enjoy sharing my knowledge with others - It feels good to help others by sharing my knowledge - Sharing my knowledge with others gives me pleasure	Survey of 233 registered users of Chinese Wikipedia	Altruism significantly affects users' contribution to Wikipedia

Although being other oriented is a key aspect of altruism, studies on the aspect have remained limited. Most prior studies have focused on the egoistic aspect, measuring altruism in terms of the enjoyment derived from helping others or the fulfillment of personal belief to do good (see the third column of Table 1). *How* others' knowledge need comes to influence one's knowledge sharing remains understudied. This study seeks to shed light on the effect of others' need.

In practice, Wikipedia highlights the community's knowledge need through several features to drive knowledge sharing. New Wikipedia users are specifically asked to contribute by improving or creating articles as requested by other users (Wikipedia, 2016); The need for knowledge is shown conspicuously in articles that require improvement; Knowledge need is also indicated through "template messages", which appear as tags in articles to identify the parts and types of improvement needed; "Red links" communicate the need for knowledge by highlighting notable topics that do not yet have an article Wikipedia also maintains lists of requested articles and most-wanted articles.

Utility Interdependence

The concept of utility interdependence posits that the community's need influences one's behavioral decision to volunteer because people account for others' utility or welfare when determining own utility in a social setting (Becker, 1974; Unger, 1991; Warr, 1982). Specifically, one's volunteering is affected by the community's need for volunteer, cost of contribution, and the level of resource available (Unger, 1991). The level of resource available is indicated by socioeconomic status, and cost of contribution includes the forgone opportunity to free ride (i.e., rely on others to volunteer) and time cost (measured inversely in terms of time available). Socioeconomic status is a valid indicator of resource available because volunteering would incur some costs. Adequate income is necessary to cover the costs, thereby enabling individuals to engage in volunteering (Unger, 1991). The findings of a survey indicate that community's need, forgone benefit of free-riding (as a cost of contribution), and resource available are significantly related to volunteering, indicating significant utility interdependence (Unger, 1991).

The concept of utility interdependence provides a useful basis for understanding how Wikipedia community's knowledge need influences one's knowledge sharing intention (i.e., intention to add new or edit to improve Wikipedia articles). Wikipedia seeks to attract contributors who have the required knowledge to contribute or improve articles and it follows that the most important resource enabling knowledge sharing is knowledge. In line with this, Priedhorsky et al. (2010) found some evidence that geographical wiki users work more in areas they are familiar with (indicated by past edits or ratings). Knowledge constitutes a resource for individuals as well as communities in that it can be used to generate value when applied to problem solving and innovation in daily lives, in organizations, and for tackling wicked social issues (Grant, 1996; Palloff and Pratt, 1999). Although time available is one of the key reasons for not sharing in Wikipedia, it is necessary but not sufficient for driving knowledge sharing (Glott et al., 2010). Wikipedia users are more strongly motivated by the wish to share their knowledge and the desire to fix errors instead, and having some relevant knowledge is a prerequisite for recognizing and executing these. Having more relevant knowledge better enables a user to engage in knowledge sharing, just as having more income makes it more feasible to cover the costs of

volunteering. Considering knowledge as the focal resource that enables knowledge sharing, utility interdependence suggests that the community's knowledge need influences one's decision to share knowledge through affecting the perceived cost of doing so. Accordingly, this study develops a model explicating the effect of community's knowledge need, as detailed in the next section.

Hypotheses Development

This study's objective is to model and empirically assess utility interdependence as a potential mechanism through which others' knowledge need influences one's knowledge sharing intention. We focus on knowledge sharing intention because the evaluation of utility function is a cognitive process that affects intention more directly than it affects behavior. Behavioral intention is a strong predictor of actual behavior, as observed in prior studies of wiki-based communities (e.g., Liu, 2010), as well as Wikipedia (e.g., Yang and Lai, 2011).

As discussed earlier, we model utility interdependence in voluntary knowledge sharing by accounting for the community's knowledge need, forgone benefit of free riding and knowledge codification effort (as costs of volunteering), and level of knowledge (as resource available). Hypotheses related to these factors are discussed next.

Community's Knowledge Need

The concept of utility interdependence suggests that others' welfare enters one's utility function and affects the person's behavioral choice in a social setting (Becker, 1974; Unger, 1991). In a similar vein, Bergstrom (1999) showed several systems of benevolent utility functions, in which people gain pleasure from observing the happiness of others.

Prior studies on helping behavior have specifically emphasized the importance of others' need. Schwartz (1977) suggested that helping begins with an awareness of others' need. Perceiving the existence of a need activates one's cognitive processing about the actions required and leads to the formation of helping intention. In a literature review of more than 500 studies on various helping behaviors such as blood donation, organ donation, and money donation, Bekkers and Wiepking (2010) concluded that awareness of others' need is an important determinant and the first prerequisite of philanthropy, and the degree of need for help is positively related to the likelihood that help will be given (Bekkers and Wiepking, 2010).

The subjective perception of others' need is at least as important as actual need in influencing one's propensity to volunteer. In many cases, individuals may be inaccurate in assessing the actual level of need in a community because of imperfect or incomplete information (Unger, 1991). Individuals who are not aware of others' need are unlikely to consider helping, even if the need actually exists. In line with this, experiments often manipulate need by exposing participants to people in need (Bekkers and Wiepking, 2010). A study testing effects of need on donations has specifically shown that it is not objective need but subjective perception of need that is crucial (Wagner and Wheeler, 1969).

Accordingly, this study hypothesizes that individuals' perception about Wikipedia community's knowledge need is positively related to their knowledge sharing intention (see Figure 1). Awareness of others' knowledge need is likely to activate one's consideration and

formation of knowledge sharing intention. In a similar vein, Dearman et al. (2008) observed that people generally like to share knowledge, but only if they know that it would be useful for others. Other studies have shown that technological features indicating the community's knowledge need or the potential value of one's contribution to the community significantly increases knowledge sharing (e.g., Rossi et al., 2010). Testing the hypothesis in this study will provide additional empirical evidence for the relationship by directly measuring others' need as perceived by users:

H1: Perceived community's need for knowledge is positively related to one's knowledge sharing intention.

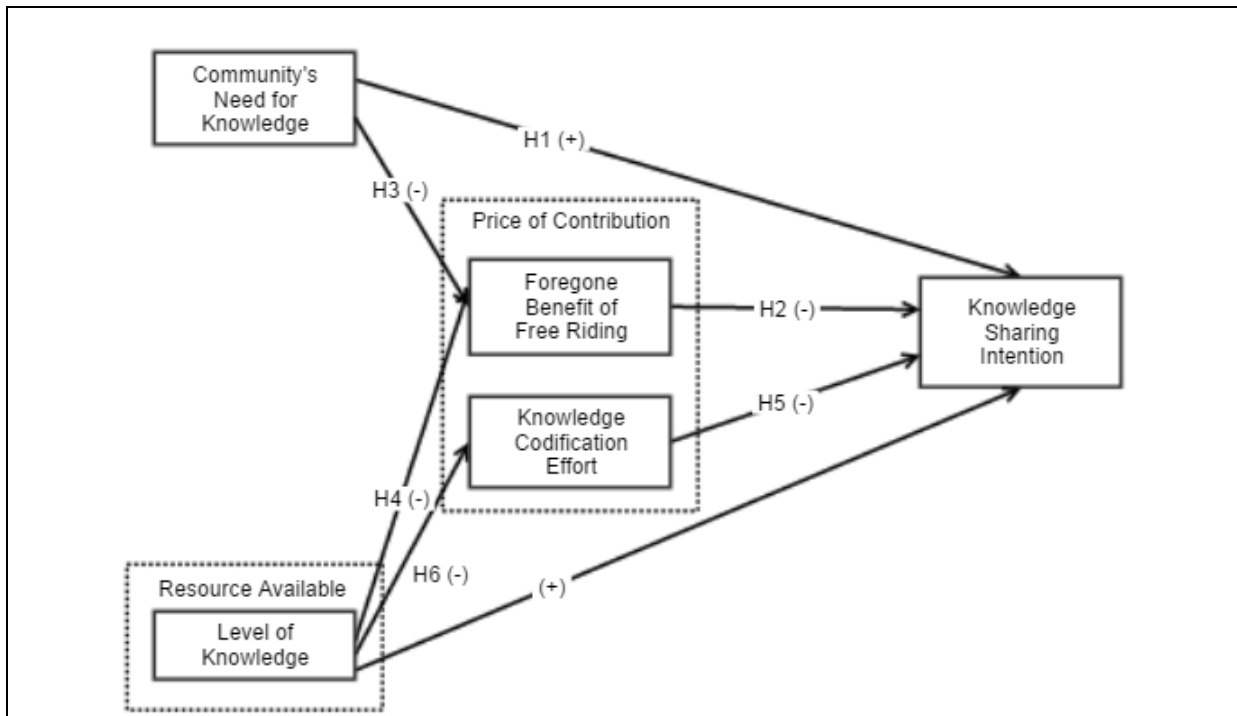


Figure 1. Model of Utility Interdependence in Voluntary Knowledge Sharing

Forgone Benefit of Free Riding

A significant cost of volunteering is the forgone benefit of free riding, i.e., forgone advantage of relying on others to contribute knowledge. Those with a stronger free-riding tendency will perceive the forgone benefit more strongly (Unger, 1991). Free riding is of central concern in volunteering, because volunteering involves the production of a collective good, where the benefits are not confined to those who actually incur the cost (Wilson and Musick, 1997). The volunteer's dilemma describes the situation in which each of the potential volunteers faces the decision of either making a small sacrifice from which all will benefit, or free riding. There is generally greater incentive to free ride than to produce the collective good and incur the cost of volunteering.

Wikipedia is prone to the problem of free riding (Hoisl et al., 2007; Rafaeli and Ariel, 2008). Since Wikipedia pages are freely accessible, it is possible for users to benefit from the knowledge shared by others without contributing anything of their own. Free riders in Wikipedia are also difficult to identify. The prevalence of free riding in Wikipedia has been

observed in empirical studies (e.g., Huang et al., 2015).

In line with the concept of utility interdependence, this study hypothesizes that the forgone benefit of free riding is negatively related to Wikipedia users' knowledge sharing intention. A rational person tends to minimize costs incurred and maximize benefits received (Albanese and Van Fleet, 1985). Sharing knowledge in Wikipedia involves incurring the cost of sharing and forgoing the benefit of relying on others to contribute. Those who perceive greater forgone benefit are likely to have less intention to share their knowledge, due to the tendency to maximize their own benefit.

H2: Perceived forgone benefit of free riding is negatively related to one's knowledge sharing intention.

The concept of utility interdependence suggests that the forgone benefit of free riding (as a cost of volunteering) is considered in relation to others' need in one's utility function (Becker, 1974; Unger, 1991). Awareness of others' need should precede the conscious deliberation of costs of volunteering, since the awareness is often beyond one's control (Unger, 1991). Needs originate from beneficiaries and awareness of needs is often the result of actions of beneficiaries (who seek help) or charitable organizations (who communicate needs to potential volunteers; Bekkers and Wiepking, 2010).

This study hypothesizes that a Wikipedia user's awareness of the community's knowledge need is negatively related to the perceived forgone benefit of free riding. The social information processing theory of task design supports this hypothesis. The theory posits that task uniqueness serves as a special incentive for public-good contribution and reduces free-riding tendency (Albanese and Van Fleet, 1985). A Wikipedia user's awareness of a knowledge need may serve as a social cue that the knowledge sharing task is unique, in that he or she possesses the knowledge that many others do not have. Taken together, these suggest that others' knowledge need would reduce a user's perceived forgone benefit of free riding.

H3: A user's awareness of the community's knowledge need is negatively related to the perceived forgone benefit of free riding.

The forgone benefit of free riding is also affected by the resource available for volunteering in one's utility function (Becker, 1974; Unger, 1991). In general, the more available a resource is to an individual, the lesser the forgone benefit of free riding (i.e., rely on others to contribute). This is in line with the concept of marginal utility of income, which describes how the effect on subjective well-being of an increase in income becomes progressively smaller the higher the initial level of income (Harsanyi, 1953). Accordingly, the level of resource available should be negative related to the forgone benefit of free riding.

In voluntary knowledge sharing, the focal resource enabling sharing is knowledge. One's level of knowledge is likely to be negatively related to the perceived forgone benefit of free riding in Wikipedia. The key benefit of free riding in Wikipedia is accessing knowledge for free, without having to incur the cost of sharing. For those who are knowledgeable on a topic (i.e., possess high level of knowledge), the marginal benefit of having access to a Wikipedia article on the topic is likely to be less compared to those who

are less knowledgeable and the perceived foregone benefit of relying on others to share should be less:

H4: Level of knowledge is negatively related to a user's perceived forgone benefit of free riding.

Knowledge Codification Effort

Another important cost of knowledge sharing in Wikipedia is knowledge codification effort, that is, time and effort required to codify and input knowledge into Wikipedia. Sharing knowledge in Wikipedia requires the user to codify knowledge in the form of typed texts and sometimes images using information technology. The cognitive demands of composing texts can strain the user's attentional capacity and working memory. Indeed, writers, novelists, and academic writers typically portray writing as a cognitively burdensome task (Kellogg, 1987). The knowledge codification effort constitutes an opportunity cost that precludes a user from investing the effort in alternative tasks and accruing the corresponding benefits (Kankanhalli et al., 2005; Mohammadbashir et al., 2016).

This study hypothesizes that knowledge codification effort is negatively related to one's knowledge sharing intention. In line with this hypothesis, prior studies on the ease of use of technology found that mental effort is negatively related to individuals' intention to use a technology (e.g., Venkatesh, 2000). A study on enterprise Wikis showed that codification effort hinders users' creation and editing of articles (Beck et al., 2015).

H5: Knowledge codification effort is negatively related to a user's knowledge sharing intention.

Knowledge codification effort is also likely to be affected by one's level of knowledge. Those who are more knowledgeable in a topic have a better established knowledge structure and should find it less effortful to recall and codify the knowledge. In support, Kellogg (1987) observed that in the writing process, which involves planning, translating, and reviewing texts, high-knowledge writers expended less effort overall than did the low-knowledge writers; Priedhorsky et al. (2010) argued that editing something one is familiar with in Wiki is easier and involves less cost.

H6: Level of knowledge is negatively related to a Wikipedia user's knowledge codification effort.

Hypotheses H5 and H6 indicate that intention to share knowledge should increase with one's level of knowledge. In data analysis, we would account for the relationship between them to assess whether knowledge codification effort mediates the relationship and to control for other mediating factors not indicated by the concept of utility interdependence.

Research Method

The proposed model was assessed with data collected through a survey. We chose survey over other methods because the key constructs in our model (i.e., awareness of community's knowledge need, perceived forgone benefit of free riding, knowledge

codification effort, and knowledge sharing intention) focus on the perception of Wikipedia users (i.e., what they think), which is best measured through the survey method (Denscombe, 2014). Although a survey is cross-sectional and does not allow us to establish the temporal order of constructs in our model, the relationships are hypothesized with support from the theoretical concept of utility interdependence and related research. As explained earlier, the awareness of others' need is necessary to activate, and therefore naturally precedes, one's cost-benefit analysis of volunteering and subsequently behavioral intention. With regard to the hypothesized relationships involving level of knowledge, there is a lack of sound theoretical rationale for expecting that the relationships would reverse – that one's level of knowledge would change following cost-benefit analysis of knowledge sharing or the formation of knowledge sharing intention. To control for potential confounding factors, the data analysis accounted for the effects of demographic variables as well as factors that have been found significant in prior studies, as detailed in the data analysis section.

Construct Operationalization

We adapted existing validated scales as much as possible (see Table 2). Community's knowledge need was measured with items from Unger (1991)'s community need scale and Shiarella et al. (2000)'s awareness of need scale. In line with research on utility interdependence, which used socioeconomic status as the indicator of resource (time) available, we used education level as the indicator of one's knowledge level. The survey asked respondents to indicate their highest level of education. Forgone benefit of free riding was measured with the scale of free-riding tendency, following Unger (1991). Free-riding tendency is an appropriate measure because those with a stronger free-riding tendency should perceive the forgone benefit of free riding more strongly than those with a lower tendency. Knowledge codification effort and knowledge sharing intention were measured with items adapted from Kankanhalli et al. (2005) and Cho et al. (2010) respectively. Other than education level, all items were measured with a seven-point Likert scale, anchored by labels such as strongly disagree and strongly agree.

Sample and Data Collection

The target population of this study is Wikipedia users. To ensure adequate variance in the data, we sought to include both users who actively share knowledge and those who read articles but do not share. Wikipedia does not require users to register and most users, especially those who only read but not share, tend to remain anonymous (Rafaeli and Ariel, 2008). Considering these and that Wikipedia has been consistently ranked among the ten most-visited websites (Alexa, 2016), we used a sample comprising members of a large online discussion forum, instead of limiting only to the registered users of Wikipedia. The forum has many sub-forums on topics related to information technology, consumer electronics, travel, and current affairs. It had 651,222 members at the time of our survey.

Invitations to participate in the survey and a hyperlink to the online questionnaire were sent to all forum members via private messages. A total of 1,713 members accessed the link, where they were asked to indicate their age, frequency of reading Wikipedia pages, and frequency of sharing knowledge in Wikipedia. Those who were at least 21 years old and had read Wikipedia pages were invited to complete the rest of the questionnaire. They were

asked to identify a knowledge topic that they felt competent with and were instructed to replace “topic X” in the survey with the chosen knowledge topic. For example, a respondent who has chosen the topic of search engine optimization would consider the Wikipedia community’s need for knowledge on the topic when completing the survey questionnaire. This design seeks to create a clearer, more natural setting for respondents to consider the community’s knowledge need and their knowledge sharing intention than simply referring to knowledge generally. It is also in line with the fact that Wikipedia seeks to attract users who are knowledgeable in the topic that they contribute to. A total of 323 respondents completed the questionnaire.

Table 2. Survey Instrument		
Construct	Items	Source
Wikipedia community’s knowledge need	KN1: There is a demand for knowledge about topic X* in Wikipedia KN2: The Wikipedia community has a need for knowledge about topic X that is not being met KN3: Many Wikipedia users will need knowledge about topic X	Adapted from Shiarella et al. (2000); Unger (1991)
Level of knowledge (indicated by education level)	ED: My highest level of education is (choose one)...primary school/secondary school/ junior college/ bachelor’s degree/ master’s degree/ doctor of philosophy/ others (please specify)	Developed based on Becker (1974), Unger (1991)
Forgone benefit of free riding (indicated by free-riding tendency)	FR1: By not sharing my knowledge in Wikipedia, I will come out better off than those who share FR2: When others put a large amount of effort into sharing their knowledge in Wikipedia and I do not, that is my gain and their loss FR3: By not sharing my knowledge in Wikipedia, I will not end up worse off than anyone else FR4: I prefer to rely on others to provide the needed knowledge about topic X in Wikipedia, rather than sharing my own knowledge	FR1-FR3 adapted from Gabbiadini et al. (2013); FR4 developed based on Unger et al. (1991)
Knowledge codification effort	KC1: It would take me much effort to codify (i.e., describe) my knowledge about topic X for sharing in Wikipedia KC2: It would be laborious to codify (i.e., describe) my knowledge about topic X for sharing in Wikipedia KC3: I do not have the time to share my knowledge about topic X in Wikipedia	Adapted from Kankanhalli et al. (2005)
Knowledge sharing intention (formative)	KS1: I intend to share my knowledge about topic X in Wikipedia in the near future KS2: I plan to edit existing Wikipedia pages related to topic X in the near future KS3: I will add new Wikipedia pages on topic X and/or related topics in the near future	KS1-KS3 adapted from Cho et al. (2010)
Control variables	Internal self-concept ISC1: In general, I make sure that my decisions are consistent with my personal standards of behavior ISC2: In general, I consider myself a self-motivated person ISC3: In general, sharing knowledge gives me a sense of personal achievement	ISC1-ISC3 adapted from Yang and Lai (2010); SOB1-SOB3 adopted from Xu and Li

	Sense of belonging SOB1: I feel that I belong to the Wikipedia community SOB2: I feel that other Wikipedia users are my close friends SOB3: I feel a sense of membership in Wikipedia	(2015)
* In the survey questionnaire, X is replaced with the knowledge topic that a respondent has chosen		

Data Analysis and Result

The sample's demography was first analyzed, followed by tests of the proposed model and hypotheses. In the model analysis, we controlled for the effects of demographic variables as well as other factors that have been found to significantly affect knowledge sharing of Wikipedia users in prior studies (see Appendix A for a summary).

Sample Demography

Most of the respondents were between 21 to 40 years old (78.6%; see Table 3). There were more male respondents (61.6%) than female. The education level of respondents ranged from primary school (0.6%) to Doctor of Philosophy (2.2%), with the majority attaining a Bachelor's degree (50.2%). Almost all of the respondents accessed the Internet several times a day (95%). While the majority reads Wikipedia pages at least once a week (75.2%), 40.2% had never edited a Wikipedia page.

Table 3. Sample Demography					
Characteristic	Frequency	Percentage*	Characteristic	Frequency	Percentage*
Age			Internet use frequency		
21-30	157	48.6	Several times a week	7	2.2
31-40	97	30.0	Once a day	9	2.8
41-50	33	10.2	Several times a day	307	95.0
51-60	24	7.4	Wikipedia editing frequency		
>61	12	3.7	Never	130	40.2
Gender			Less than once a year	193	59.8
Female	124	38.4	Wikipedia reading frequency		
Male	199	61.6	Once a month	35	10.8
Education			Several times a month	45	13.9
Primary school	2	0.6	Once a week	21	6.5
Secondary school	26	8.0	Several times a week	128	39.6
Junior college	48	14.9	Once a day	40	12.4
Bachelor's degree	162	50.2	Several times a day	54	16.7
Master's degree	78	24.1	*Sum might not be exactly 100% due to rounding		
Doctor of philosophy	7	2.2			

Partial Least Squares Analysis – Tests of Measurement Model

The proposed model was assessed using the partial least squares (PLS) approach of structural equation modeling because knowledge sharing intention is a formative construct. The measurement model was tested for reliability, convergent validity, and discriminant validity (Wetzels et al., 2009). To evaluate reliability, Cronbach's alpha and composite

reliability were calculated. We found that all the values exceeded the requirement of 0.70 (see Table 4). Convergent validity was assessed by calculating average variance extracted (AVE). All the AVEs exceeded the recommended value of 0.50. Discriminant validity was assessed by examining square root of AVE. For all the constructs, the square root of AVE (italic, diagonal entries in Table 5) exceeded corresponding correlations with other constructs (non-diagonal entries in Table 5). Additional support for discriminant validity comes through inspection of the cross loadings, which were low compared with the loadings. For the formative construct of knowledge sharing intention, these tests were not applicable. Instead, significance of item weight was examined to determine the contribution of items constituting the construct. The results were favorable, with all the item weights significant at $p < 0.01$. Multi-collinearity among items was assessed using variance inflation factor (VIF). All exogenous constructs had VIF that was less than 1.95, below the recommended threshold of 3.33. Overall, the measurement model was satisfactory.

Common method bias was also assessed, considering that all data were collected in a survey. We conducted two different tests: Harman's one-factor test with the confirmatory factor analysis (CFA) setting and comparison of the goodness of fit of the multi-factor model with the one-factor model (Wetzels et al., 2009). In Harman's one-factor test, the largest factor extracted did not explain the majority of the variance (only 39.6%), indicating that common method bias was not significant. The test of goodness-of-fit measures (Wetzels et al., 2009) showed that the one-factor model had considerably worse fit than the multi-factor model ($GOF_{one-factor} = 0.64$ vs. $GOF_{multi-factor} = 0.76$). This further supported the conclusion that common method bias was not significant.

In addition to ex-post statistical assessment, we employed several ex-ante strategies suggested by Podsakoff et al. (2003) to minimize common method bias. First, the survey questions were measured using only positive values rather than bipolar values (e.g., -3 to +3) to avoid acquiescence bias. Second, respondents were assured of their anonymity and instructed to select the responses that best described their opinions and perceptions rather than the "correct" response. Third, survey questions were pretested to ensure that the wording was clear to respondents. Combining multiple statistical and methodological strategies offered greater confidence for limiting common method bias than employing only one of them (Craighead et al., 2011).

Table 4. Assessment of Reliability and Convergent Validity					
Construct	Item	Loading*	Construct	Item	Weight*
Wikipedia community's knowledge need $\alpha = .85$; $CR = .91$; $AVE = .77$	KN1	0.89	Knowledge sharing intention (formative)	KS1	0.37
	KN2	0.83		KS2	0.30
	KN3	0.91		KS3	0.37
Forgone benefit of free riding $\alpha = .87$; $CR = .91$; $AVE = .71$	FR1	0.83	Control Variable	Item	Loading[^]
	FR2	0.82	Internal self-concept $\alpha = .79$; $CR = .84$; $AVE = .70$	ISC1	0.82
	FR3	0.86		ISC2	0.81
	FR4	0.86		ISC3	0.86
Knowledge codification effort $\alpha = .96$; $CR = .97$; $AVE = .92$	KC1	0.98	Sense of belonging $\alpha = .92$; $CR = .95$; $AVE = .86$	SOB1	0.94
	KC2	0.97		SOB2	0.90

	KC3	0.93		SOB3	0.93
α : Cronbach's Alpha; CR: Composite Reliability; AVE: Average Variance Extracted; * All item loadings were significant at $p < 0.001$; ^All item weights were significant at $p < 0.01$					

Table 5. Descriptive Statistics and Assessment of Discriminant Validity

	Mean	SD	Knowledge need (KN)	Education (ED)	Forgone benefit of free riding (FR)	Knowledge codification Effort (KC)	Internal self concept (ISC)	Sense of belonging (SOB)
KN	4.75	1.42	0.88					
ED	3.96	0.93	0.21	N. A.				
FR	4.05	1.42	-0.45	-0.16	0.84			
KC	4.83	1.48	0.20	0.05	0.01	0.96		
ISC	5.40	1.08	0.17	0.24	-0.29	0.14	0.83	
SOB	3.94	1.72	0.42	0.31	-0.40	0.01	0.39	0.92
KS[#]	4.27	1.84	0.46	0.26	-0.50	0.04	0.47	0.54

SD: Standard deviation; * $p < 0.05$; ** $p < 0.01$; #KS: knowledge sharing intention; N. A. Education is not a latent variable

Partial Least Squares Analysis – Tests of Structural Model

The hypotheses were tested in the structural model analysis. A model with only control variables was first assessed. Among them, internal self-concept and sense of belonging had significant effect on knowledge sharing intention. The demographic variables of age and gender, and the technology-use variables of Internet use frequency and Wikipedia reading frequency were not significant. Control variables that were not significant were excluded from subsequent analyses to ensure model parsimony.

Table 6. Results of Hypothesis Tests

Hypothesis	Path Coefficient	T Statistic	P Value	Result
Community's knowledge need → Knowledge sharing intention (KS)	0.12**	2.77	0.006	H1 was supported
Forgone benefit of free riding → KS	-0.14**	3.47	0.001	H2 was supported
Community's knowledge need → Forgone benefit of free riding	-0.37***	6.78	<0.001	H3 was supported
Level of knowledge → Forgone benefit of free riding	-0.003	0.05	0.958	H4 was not supported
Level of Knowledge → Knowledge codification effort	0.033	0.51	0.613	H6 was not supported
Level of knowledge → KS	-0.02	0.61	0.544	Control relationship was not significant
Knowledge codification effort → KS	-0.03	0.61	0.542	H5 was not supported
Internal self-concept	0.14**	2.99	0.003	Control variable was

Sense of belonging	0.41***	7.61	<0.001	significant
Wikipedia editing frequency	0.11**	3.43	0.001	
*p<0.05; **p<0.01; ***p<0.001				

The results indicate that Wikipedia community’s knowledge need is significantly related to forgone benefit of free riding (i.e., H3 was supported), which is in turn positively related to knowledge sharing intention (i.e., H2 was supported). The direct relationship between community’s knowledge need and knowledge sharing intention was also significant (H1 was supported; see Table 6). Level of knowledge was not significantly related to foregone benefit of free riding, knowledge codification effort, and knowledge sharing intention (i.e., H4 and H6 were not supported). Knowledge codification effort was not significantly related to knowledge sharing intention (i.e., H5 was not supported). The model with control variables explained 65% of the variance in knowledge sharing intention, while the model without controls explained 34.4%.

To assess the mediating role of forgone benefit of free riding, we assessed the additional explanatory power of competing models. The full-mediation model explained 65% of the variance in knowledge sharing intention, while the partial-mediation model explained 66.2%. The change in variance explained was assessed by computing pseudo-F statistics. We found that the additional direct path significantly added to the variance explained in knowledge sharing intention ($F=11.1$, $p<0.01$). This suggests that forgone benefit of free riding partially mediated the effect of community’s knowledge need.

Discussion

The survey results support the proposed model – Wikipedia users who perceive a greater knowledge need in the community tend to perceive less forgone benefit of free riding and have a stronger knowledge sharing intention. In sum, others’ need influences one’s knowledge sharing due to utility interdependence. The finding that others’ knowledge need is significant also indicates that it is important to account for the other-oriented aspect of altruism in knowledge sharing. As shown in our review of prior studies, although being other oriented is a key aspect of altruism, studies on the aspect have remained limited. Unexpectedly, the results showed that level of knowledge (as resource available) did not have any significant effect on knowledge sharing intention. This and other unexpected findings are considered next, followed by a discussion of this study’s theoretical and practical implications.

A potential explanation for the insignificance of level of knowledge is that the objective indicator of education level does not fully reflect one’s level of knowledge and the capacity to provide knowledge in Wikipedia. As explained earlier, we used education level as the indicator of one’s knowledge level, following prior studies on utility interdependence in volunteering, in which socioeconomic status is used as the indicator of resource available for enabling volunteering (Becker, 1974; Unger, 1991). Further studies might consider other objective measures, such as years of experience with a topic. In retrospect, a perception-based measure, such as knowledge self-efficacy, which is individuals’ judgment of their ability to organize and execute courses of action related to knowledge sharing (Kankanhalli et al., 2005), may be at least as appropriate for measuring the level of knowledge. Fortunately, we measured users’ knowledge self-efficacy in the survey (considering that it

has been found to affect knowledge sharing in general) and were therefore able to evaluate this possibility post hoc. We tested a model that includes both education level and knowledge self-efficacy. Knowledge self-efficacy was found to be strongly related to forgone benefit of free riding ($b=-0.25$; $p<0.001$) and knowledge sharing intention ($b=0.24$; $p<0.001$), but not related to knowledge codification effort ($b=0.05$; $p=0.49$). This suggests that future studies should include perception-based measures to better capture the effect of knowledge level.

Knowledge codification effort did not have a significant effect on knowledge sharing intention. The knowledge management literature suggests a plausible explanation. Studies on voluntary knowledge sharing in electronic knowledge repositories showed that codification effort interacts with social factors (e.g., generalized trust among users; Kankanhalli et al., 2005) to affect knowledge sharing, rather than having a direct effect. Further studies testing the model can consider relevant social factors such as generalized trust and norm of reciprocity in the community when examining the effect of knowledge codification effort.

Limitations

The limitations of this study should be taken into account when interpreting the results. As discussed earlier, the survey method did not allow us to conclusively determine the temporal order of constructs. Although the proposed model is theory grounded and reverse causation in the relationships hypothesized makes little sense, longitudinal data would provide stronger evidence for the model. Since others' knowledge need has a significant effect, as shown in this study, it is worthwhile to expend more effort to further ascertain its effect by collecting longitudinal data.

We focused on knowledge as the resource available for volunteering since our interest is in knowledge sharing. Further studies might test a more comprehensive model by including other resources such as the level of income and time available.

As with survey-based studies in general, our model was tested with a sample rather than the population and its generalizability is therefore limited. More studies are needed to test the hypotheses with different samples. Replication can also help to identify and control for potential confounds not identified in this study by testing the robustness of findings under alternative study conditions or alternative analyses.

Implications for Theoretical Development and Research

The key finding of this study is that others' need is taken into account in one's utility function and reduces the perceived forgone benefit of free riding when one is considering behavioral options regarding knowledge sharing in Wikipedia. The effect of utility interdependence was significant even when other salient factors identified in prior studies were controlled for (e.g., sense of belonging, internal self-concept; reviewed in Appendix A). This is one of the first theory-grounded studies to identify and assess *how* others' need influences one's knowledge sharing intention.

The empirical results also support the practice of clarifying and highlighting others' knowledge need in Wikipedia, and indicates the value of further examining others'

knowledge need directly. One line of inquiry for further research is clarifying the characteristics of others' need. This is important because different characteristics might affect knowledge sharing intention through different mechanisms, or the same mechanism might not apply to all types of need. For example, utility interdependence might be more significant when the expected beneficiaries are perceived to be "in group" and appear to be similar to themselves. Other than characteristics of the users needing knowledge, characteristics of the knowledge needed (e.g., codifiability, specificity of knowledge request, complexity) might also be relevant for conceptualizing others' need and its effect on knowledge sharing.

Another potentially fruitful line of inquiry is to examine other issues related to utility, such as utility independence. For example, studies may look into the relationship of others' knowledge need with other antecedents of knowledge sharing, such as extrinsic motivation. Do they have additive independence or preferential independence (Fishburn, 1974)? Which is preferred over others? Do they have different effects on different knowledge sharing behavior (e.g., editing versus adding new article)?

Further research can also identify other theoretical mechanisms underlying the relationship between community's knowledge need and knowledge sharing intention. This study has shown that one significant mechanism is utility interdependence. Nevertheless, the results indicate that other mechanisms may be at work, as the direct effect of community's knowledge need on knowledge sharing intention remained significant. For example, research on volunteering behavior suggests that people tend to offer more help in high-need situations, driven by the belief in a just world and the need to rectify injustice (Unger, 1991). This suggests that awareness of others' knowledge need may trigger a sense of responsibility with respect to knowledge getting its value for the community as a whole. Other's need might also influence one's knowledge sharing intention when it is perceived as indicating opportunities for expressing one's altruistic value (i.e., serves a value-expressive function; Lavelle, 2010). Assessing the significance of these mechanisms should deepen our conceptual understanding of the effect of others' need.

Our findings also have implications for the referent theory of utility interdependence and research on volunteering. We have extended the theory's usefulness beyond the volunteering of time and money, for conceptually understanding knowledge sharing behavior. Our results also offer empirical support for the robustness of findings in research on volunteering, by showing that utility interdependence remains significant in knowledge sharing.

Implications for Practice

This study provides direct empirical evidence for the effect of others' need on one's knowledge sharing, thus supporting the practice of showing knowledge need on Wikipedia. This evidence can serve to justify further investment of resources, both financial and non-financial, for the advancement of technological features that effectively indicate what knowledge is needed.

Although this study does not test specific technological features for showing knowledge need, the findings indicate what to focus on when developing the features. We found that one's perception of others' knowledge need is related to the demand for knowledge (KN1 in

Table 2), unmet needs (KN2), and the number of users needing knowledge (KN3). It follows that technological features conveying these information are likely to be effective for driving knowledge sharing and Wiki developers could focus their effort on advancing such features. For example, in Wikipedia, there is a software named SuggestBot, that can recommend articles a user might be interested in editing based on their contribution history, editing history, articles read, and watch lists (Cosley et al., 2007). Based on our findings, the software would be more effective in promoting knowledge sharing if it shows the number of users needing knowledge or the extent of demand by drawing from “Talk Pages” where improvements to articles are discussed.

In our follow-up analysis for the insignificance of level of knowledge, we found that knowledge self-efficacy (i.e., confidence in the ability to share knowledge) is significant. A practical implication of this finding is that increasing users’ perception of self-efficacy, e.g., by prompting them to identify their areas of expertise during account registration or as they access Wikipedia articles, could be useful for enhancing knowledge sharing intention in practice.

Appendix A. Factors Affecting the Knowledge Sharing Intention of Wikipedia Users

Study	Theoretical Basis	Significant Factors	Method and Final Sample
Hargittai and Shaw (2015)	(Not specified)	Internet skill	Survey; 547 students in a university
Lai and Yang (2014)	- Expectation confirmation theory - Expectancy value theory for achievement motivations	Satisfaction with Wikipedia, commitment, and procedural justice	Survey; 288 users of English Wikipedia
Shen et al. (2009)	Social cognitive theory	We-intention	Survey; 246 Wikipedia users in China
Wang and Wei (2011)	(Not specified)	Community participation (e.g., care for community members)	Survey; 232 Wikipedia users in Taiwan
Xu and Li (2015)	Self-determination theory	Altruism and sense of belonging	Survey; 233 users of Chinese Wikipedia
Yang and Lai (2010)	- Self-concept - Social identity theory	Internal self-concept	Survey; 219 Wikipedia users

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