

A public goods model of outcomes from online knowledge sharing mediated by mental model processing

Ronald E. Rice, Marni Heinz and Ward van Zoonen

Abstract

Purpose – This study aims to take a public goods approach to understand relationships between collecting and contributing knowledge to an online knowledge sharing portal (KSP), mental model processing and outcomes at the individual and collective levels.

Design/methodology/approach – This study reports on a survey (N = 602) among tax professionals, examining the perceived individual and collective benefits and costs associated with collecting and contributing knowledge. Hypotheses were tested using structural equation modeling.

Findings – Collecting and contributing knowledge led to considerable mental model processing of the knowledge. That in turn significantly influenced (primarily) individual and (some) collective costs and benefits. Results varied by the kinds of knowledge sharing. Whether directly from knowledge sharing, or mediated through mental modeling, the perceived costs and benefits may be internalized as an individual good rather than being interpreted at the collective level as a public good.

Research limitations/implications – The study is situated in the early stages of a wiki-type online KSP. A focus on the learning potential of the system could serve to draw in new users and contributors, heightening perceptions of the public goods dimension of a KSP.

Practical implications – A focus on the learning potential of the system could serve to draw in new users, and thus the number of subsequent contributors, heightening perceptions of the collective, public goods dimension of a KSP.

Originality/value – This study explores how knowledge sharing and mental model processing are directly and indirectly associated with individual and collective costs and benefits. As online knowledge sharing is both an individual and public good, costs and benefits must be considered from both perspectives.

Keywords Public goods, Collective level, Individual level, Mental modelling, Online knowledge sharing

Paper type Research paper

Ronald E. Rice is based at the University of California Santa Barbara, Santa Barbara, California, USA. Marni Heinz is based at Salesforce.com Inc, San Francisco, California, USA. Ward van Zoonen is based at ASCoR, University of Amsterdam, Amsterdam, The Netherlands.

1. Introduction

Knowledge sharing is a precondition for creating and effectively using knowledge in organizations (Hislop, 2013; Huysman and De Wit, 2003; Nonaka and Takeuchi, 1995). Shared knowledge can empower individuals, improve individual and group decision-making, and increase organizational performance, innovativeness, and the ability to respond to environmental changes (Mirzaee and Ghaffari, 2018). Knowledge sharing is especially critical for knowledge workers and professionals (Singh *et al.*, 2018), and in turbulent and limited-resource environments (Sedighi *et al.*, 2016). Non-market benefits accrue as well, such as employee satisfaction, a sense of organizational or community coherence, challenges to currently held beliefs, and greater awareness of other actors and expertise (Prusak and Cohen, 1998).

Received 9 June 2018
Revised 4 September 2018
20 October 2018
Accepted 24 October 2018

The authors would like to thank the organizational contact, the stakeholder interviewees and the many survey respondents for their participation. The authors also thank Bart Van den Hooff for his suggestions and access to his surveys and Samer Faraj and Ann Majchrzak for their prior discussions about many of the concepts and measures used in this study.

Theory, research, and technological innovation have extended the process and analysis of knowledge sharing to include the role of online sites and services. These include blogs, e-mail distribution lists, intranets, multimedia contribution sites, online communities, online calendars, peer-to-peer file sharing, social media, wikis, etc. Web 2.0 and social media are becoming pervasive contexts for diverse kinds of information sharing for a wide range of purposes by dispersed participants (Ellison *et al.*, 2015; Kim and Adler, 2015; Osatuyi, 2013) (for example, Wikipedia and Researchgate). For reviews, diverse names, and categories of online knowledge sharing systems, see Khansa *et al.* (2015), Malinen (2015), Phang *et al.* (2014), and Phelps *et al.* (2012). We use the general term *knowledge sharing portal* (KSP). KSPs help in creating, sharing, integrating, and applying knowledge within, across, and outside of organizations (Cheung *et al.*, 2013; Deng and Poole, 2011). KSPs facilitate *commons-based peer production*, involving large numbers of users who “cooperate effectively to provide information, knowledge or cultural goods without relying on either market pricing or managerial hierarchies to coordinate their common enterprise” (Benkler and Nissenbaum, 2006, p. 394; Shirky, 2008). Knowledge producers are becoming more important social and economic actors, providing increasingly greater, but still often undervalued, contributions in both organizational and online contexts (Caputo and Evangelista, 2017).

Much research has explored the many influences on online knowledge sharing on the individual level (among others, see Chen and Hung, 2010; Heinz and Rice, 2009; Hocevar *et al.*, 2019; Kraut and Resnick, 2011; Malinen, 2015; Razmerita *et al.*, 2016; Singh *et al.*, 2018). But influences on individual use are only part of the process. In a sense, much prior research on KSPs leaves out how the user engages with their knowledge collecting and contributing, and implications of such sharing for the user’s online community. Thus, a fuller picture would also distinguish among using KSPs for 1) collecting or 2) contributing knowledge and their influences on 3) costs and 4) benefits at both 5) individual and 6) collective levels. Further, little work on KSPs has assessed 7) how knowledge sharing affects processing of that knowledge, and 8) how that processing in turn influences those costs and benefits at the different levels.

2. Conceptual foundations

2.1 A public goods approach

A core tenet of public goods theories is that typical incentive structures favor using or taking from public resources over contributing one’s own resources voluntarily (Hardin, 1968). However, production of online public goods involves collaboration, coordination, and shared user assistance (Zhang and Wang, 2012). This tension pits the interests (costs and benefits) of the individual against the interests (costs and benefits) of the collective (Cabrera and Cabrera, 2002; Dawes, 1980; Razmerita *et al.*, 2016), resulting in a social dilemma.

This issue is especially salient in the context of knowledge sharing, due to (at least) two unique characteristics of public goods: non-excludability, and jointness of supply or nonrivalrousness (Barry and Hardin, 1982). Individuals cannot be excluded from consuming a public good, and an individual’s consumption of the good typically does not diminish the amount available to others.

Many online sites provide content publicly available to anyone who visits; thus, they exhibit non-excludability. Content in most sites is a non-rivalrous good, part of what Kollock (1999) called the online “gift economy”; viewing or using the information does not remove it from others. Further, unlike most interpersonal and group exchanges, collecting and contributing knowledge in an online environment do not have to be dyadically or directly reciprocal. Instead, contributions generally constitute *generalized reciprocity*, where members (group, community, organization, society) contribute to, but also collect from, the general

community, without expectation of direct individual reciprocation. Generalized reciprocity seems to be more likely in online communities, due to the public goods aspect, but also appears to be both an evolutionary strategy influenced by sparse networks (van Doorn and Taborsky, 2012) (such as in online communities) and a common organizational behavior (through paying it forward or improving reputation; Baker and Bulkley, 2014).

So, from a public goods perspective, a fundamental challenge or tension in knowledge sharing is having participants willing to both collect knowledge from, *and* contribute knowledge to, the shared public good (Jarvenpaa and Staples, 2000; Kalman *et al.*, 2002), given that both can involve costs and benefits, at both the individual and collective levels.

2.2 Mental model processing

Few studies discuss how online users process shared knowledge in ways that might influence the costs and benefits of collecting and contributing, tending to assume that knowledge sharing directly and positively affects outcomes. Yet information in and of itself holds little value if it is not integrated with or reinforces existing knowledge, or used to build and develop new understandings and insights. New knowledge arises not from experiences alone, but also from prior experiences that people have reflected on and made sense of (Nonaka and Takeuchi, 1995), and how it is interpreted, framed, and integrated with their existing mental models and worldviews, either reconfirming or changing them (Brewer, 1987; Polanyi, 1966). A mental model is “an internal representation of a concept [...] or an inter-related system of concepts [...] that corresponds in some way to the external structure that it represents” (Chi, 2008, p. 67). Mental model processing is one aspect of learning, or using knowledge to develop new understandings to help shape behaviors (Chiu *et al.*, 2017). Wasko and Faraj (2000) demonstrated that mental model processing could help to refine individuals’ thinking, challenge preconceptions, and develop new insight in electronic communities of practice.

Thus we propose the importance of mental model *maintenance* and mental model *building* (Vandenbosch and Higgins, 1996) in understanding outcomes of online knowledge sharing. *Mental model maintenance* includes reproduction, assimilation, accretion, and routinization. It affects the extent to which the shared knowledge can be applied in a meaningful way (Alavi and Leidner, 2001). For example, shared knowledge may provide missing or corrected aspects of the mental model, or provide evidence reinforcing an existing model (Chi, 2008).

Mental model building includes production, accommodation, structuring, and risk. Mental model building occurs when existing mental models are changed to accommodate new knowledge. Modification of a flawed model requires more than just new, correct information; it requires mental model transformation (Chi, 2008). Calabrese *et al.* (2018, pp. 223-224) remark that “great historical revolutions were subsidiaries of the adoption of new interpretative schemes of reality.” One of the benefits of mental model building is its contribution to anticipating possible consequences of future actions, creating motivations, behavioral regulators, and efficacy about those future actions (Bandura, 1989). Self-efficacy can foster the motivation and effort to acquire knowledge and competencies in spite of required effort and difficulties. Further, to the extent that mental model maintenance is a form of memory, self-efficacy can also improve the cognitive effort to reinforce that memory.

Mental model maintenance and building may invoke different levels of effort, resistance, complexity, risk, changes, and improvements, thus influencing costs and benefits. Section 3.3 discusses plausible relationships between mental model maintenance and building, and knowledge contributing and collecting.

A highly related distinction is between the organizational learning concepts of *exploitation* and *exploration* (Gupta *et al.*, 2006; March, 1991). Exploitation is similar to maintenance in that both are based in applying existing knowledge and understandings. Exploitation

emphasizes transfer and use of knowledge, and small improvements. Exploration is similar to building in that both involve discovery, developing new knowledge, understandings and relationships, combining knowledge in innovative ways, and change. Both pairs are orthogonal concepts, not ends of a single continuum. Managers, business units, and firms may have lower or higher levels of ambidexterity, or the “ability to combine exploration and exploitation related activities” (Mom *et al.*, 2009, p. 812). We argue similarly that individuals engage in both kinds of mental model processing, whether high or low, depending on the type, context, and topic of knowledge sharing. However, mental model maintenance and building are primarily forms of cognitive processing of knowledge whereas much of the organizational literature treats exploitation and exploration as different kinds of actions based on that knowledge (see, for example, the scale items in Mom *et al.*, 2009). Referring to Katona (1964), Calabrese *et al.* (2018) note a distinction, similar to that between maintenance and building, between “habitual behaviors” (applying known rules or routines, often without a decision process, or without the need for one), and “authentic decisions” (based on perceiving a situation as new, requiring a new response and reorganization of knowledge). Other somewhat related concepts include the contrasting organizational orientations of *control* and *learning* (Simard and Rice, 2006), single-loop learning and double-loop learning (Martin, 2008), processing of superficial features vs. processing of structural relationships (Grégoire *et al.* (2010), and *capability* or the “ability to assimilate and apply new knowledge in recombinative ways” (Yates *et al.*, 2010, p. 545).

3. Knowledge sharing, outcomes and mental model processing

3.1 Knowledge sharing

Throughout, we prefer the term knowledge to information, to include not just facts or explicit procedures, but also evaluation and interpretation of that information, and potential for enabling action (Chhim *et al.*, 2017). However, these terms are highly debated and overlap within and across disciplines (Rice *et al.*, 2001).

For a KSP to be useful, successful, and sustainable, there must be sufficient and valuable knowledge sharing (Malinen, 2015). Knowledge transfer is sometimes presented as more general than sharing, as it involves both prior and subsequent aspects, ranging from developing, searching and locating, through validation, application, and reuse (Chhim *et al.*, 2017). The term knowledge exchange is also often invoked: “Knowledge sharing is defined as the exchange between a contributor and a seeker” (Mirzaee and Ghaffari, 2018, p. 501). Chiu *et al.* (2017) however distinguish sharing from exchange; sharing is pro-active, without others explicitly seeking the knowledge, while exchange includes both sharing and seeking. A typical distinction within sharing is between seeking and sharing, or between seeking and contributing (Singh *et al.* (2018). Still, the term “seeking” implies a variety of preparatory processes beyond actually obtaining or collecting, such as browsing, seeking or searching for, or accessing that knowledge (Case and Given, 2016; Rice *et al.*, 2001).

While “mostly[,] sharing means contributing knowledge, but in some studies, KS contains both contributing and receiving knowledge” (Stennis *et al.*, 2016, p. 183). Law *et al.*, 2017, p. 1486) define knowledge sharing as “the provision and reception of know-what and know-how for performing tasks among organizational members.” Similarly, Razmerita *et al.* (2016, pp. 1225-1226) argue that “at the individual and group level, knowledge sharing comprises both knowledge ‘donation’ and knowledge ‘collection’”. Thus, we use the general term *knowledge sharing* to represent two distinct directions of knowledge flow via a KSP. One is *collecting*, whereby a user actively obtains knowledge via a KSP. The other is *contributing*, whereby a user actively makes knowledge accessible to others via a KSP. In spite of the tensions identified in the public goods approach, online communities nonetheless survive because people do in fact return to the site, and contribute and collect (Brake, 2014). Out of the 104 articles on organizational knowledge sharing reviewed by Cleveland (2014), 80 involved seeking (a precursor to collecting), and 71 involved contributing, but none

specifically referenced collecting. Not distinguishing collecting from contributing confounds their motivations, and their positive and negative outcomes (He and Wei, 2009).

3.2 Individual and collective costs and benefits

Individuals hope to reduce costs and obtain benefits through using a KSP (Phang *et al.*, 2014). Further, Serenko and Bontis (2016) noted that knowledge sharing can involve an exchange of benefits, but also of costs. However, an important aspect of public goods is the notion of both negative and positive network externalities, in which interdependent individual actions can affect both other individuals and the community in ways that are not captured by the costs or benefits accrued by any one individual (Shapiro and Varian, 1999). So, accumulated individual benefits and costs can generate collective benefits and costs, and vice versa. For example, owner-managers making decisions based on individual-level and organizational interests can affect collective-level and societal outcomes (Del Giudice *et al.*, 2017). Thus, costs and benefits of collecting and contributing knowledge can occur at the individual and the collective levels (Chiu *et al.*, 2017; He and Wei, 2009; Razmerita *et al.*, 2016).

3.2.1 Individual costs. *Collecting costs* include the time and effort expended to collect knowledge from a KSP, difficulty in finding or evaluating desired information from large amounts available, evaluating the credibility of the contributors, processing junk or otherwise non-useful information, specific costs for early adopters who do not find much relevant information and have few others to learn from, and decreases in either individual or organizational social trust (Cabrera and Cabrera, 2002; Markus, 1990; Monge *et al.*, 1998; Wasko and Faraj, 2000; Razmerita *et al.*, 2016).

Contributing costs are often conceptualized in terms of time and effort, both start-up and continuing (Monge *et al.*, 1998; Yuan *et al.*, 2005). These include learning to use the system, hard-to-use features or interfaces, slow response time, difficult or time-intensive procedures, giving up control over valuable content, losing competitive advantage, organizing information, learning the appropriate language and format of posts, concerns about privacy, security needs, and obligations, criticism and loss of face, loss of authority, damaged reputations from contributing low-quality or incorrect information, increased expendability, reduced job security, employee deskilling, etc. (Arazy and Gellatly, 2012; Cabrera and Cabrera, 2002; Chang and Chuang, 2011; Constant *et al.*, 1994; Cress and Kimmerle, 2008; Fulk *et al.*, 1996; Kim and Adler, 2015; Monge *et al.*, 1998; Taskin and Van Bunn, 2015; Yuan *et al.*, 2005).

H1a. Knowledge sharing (*H1a1* collecting and *H1a2* contributing) will be positively related to individual costs.

3.2.2 Collective costs. Collective outcomes are typically seen as positive (Constant *et al.*, 1994); thus, collective costs have received little research attention. Collecting knowledge that could threaten the reputation of a knowledge-intensive profession (e.g. consulting, law, health, financial services, etc.) or network of practice represents a collective cost to both participating and non-participating members. In addition, competing interpretations or perspectives about diverse KSP contributions can lead to confusion (Kraut *et al.*, 1998), and thus loss of credibility in the community or profession. Public consumption of knowledge resources can also lead to crowding and information overload (Fulk *et al.*, 1996).

Providing incentives to encourage contributing can paradoxically have the adverse effects of producing a high volume of low quality knowledge (Cabrera and Cabrera, 2002; Fulk *et al.*, 1996), generating redundant creation and storing of knowledge (Prusak and Cohen, 1998), or the unwanted or accidental sharing of knowledge (Ritala *et al.*, 2015).

H1b. Knowledge sharing (*H1b1* collecting and *H1b2* contributing) will be positively related to collective costs.

3.2.3 Individual benefits. Collecting knowledge via a KSP may include explicit benefits such as a reduction in time and energy to perform work tasks, an increase in competence, promotions, raises, or bonuses, the ability to compare across different sources and experts, searching at one's own pace during problem-solving, providing benefits to multiple other users, and not having to know the specific individual provider to obtain the knowledge (Fulk *et al.*, 2004; Vandenbosch and Higgins, 1996; Yuan *et al.*, 2011).

Contributing to a KSP would hardly be a worthwhile endeavor if individuals didn't receive at least some benefits in return. However, tangible benefits such as monetary rewards or a promotion may not be applicable for knowledge sharing communities that develop outside of formal organizational boundaries. Instead, individual benefits from contributing to self-organizing online communities may include satisfying a desire for psychological or intangible rewards such as an increase in status or reputation in a collective (if contributions and their authors are visible) and gaining a positive feeling from helping others (Huysman and De Wit, 2003; Wasko and Faraj, 2000; Wasko and Faraj, 2005). Benefits may be intrinsic (confirm ability to provide useful information) and extrinsic (such as reciprocity, social capital, reputation) (Hocevar *et al.*, 2019; Osatuyi, 2013).

H2a. Knowledge sharing (*H2a1* collecting and *H2a2* contributing) will be positively related to individual benefits.

3.2.4 Collective benefits. More contributions to online communities foster both community longevity and value over time (Bagozzi and Tsai, 2014; Chen and Hung, 2010). Members can observe others' contributions, emphasizing a social norm of sharing or improving a group or organization (Yates *et al.*, 2010). One primary public good that arises as a result of contributing to discretionary databases is *communality*, or the availability of a collective pool of knowledge to achieve both generalized (indirect reciprocity) and productive (information combined to produce new solution) exchanges (Fulk *et al.*, 1996; Monge *et al.*, 1998; van den Hooff *et al.*, 2003). KSP use may also be positively related to *connectivity*, the public good of being able to communicate and connect with others in a community, especially when it has achieved critical mass (Fulk *et al.*, 1996; Kraut *et al.*, 1998; Markus, 1990). Thus, as a critical mass of users and contributions develops, the benefits of positive network externalities of communality and connectivity quickly exceed the costs of individual participation (Markus, 1990; Shapiro and Varian, 1999).

H2b. Knowledge sharing (*H2b1* collecting and *H2b2* contributing) will be positively related to collective benefits.

3.3 Knowledge sharing and mental model processing

As noted in Section 2.2, one contribution of this research is the inclusion of mental model processing into the online knowledge sharing process (Chen and Hung, 2010). Both contributing and collecting to KSPs can help develop better knowledge. Even contributors engage in some form of learning because they must organize, understand, conceptualize, and analyze the knowledge to share it (Chiu *et al.*, 2017). Collecting knowledge also requires common understandings to make sense of the knowledge, which in turn can reinforce and develop one's knowledge, and generate new knowledge. The KSP user must make sense of and interrelate the shared knowledge (Hecker, 2012; Phelps *et al.*, 2012) to internalize and create new information that can become part of a synergistic solution (Ghobadi, 2015). Knowledge transfer in general involves "evaluating, recognizing, absorbing, assimilating and adopting knowledge" (Tangaraja *et al.*, 2016, p. 663); "'information' is transformed into 'knowledge' only in an individual's mind based on one's interpretations, values, beliefs and experiences" (p. 657). For example, online innovation contest communities rely on users' willingness and ability to "recombine, modify, and integrate knowledge that others have provided" (Füller *et al.*, 2014, p. 275). Thus both kinds

of knowledge sharing should foster both kinds (i.e. maintenance and building) of mental model processing.

H3. Knowledge sharing (*H3a* collecting and *H3b* contributing) will be positively related to mental model processing (maintenance and building).

3.4 Mental model processing and costs and benefits

This study contributes to the literature on (online) knowledge sharing (both collecting and contributing) by including mental model processing as a partial mediator between knowledge sharing and outcomes of costs and benefits at individual and collective levels. As there is no prior research specifically on this relationship, we make the following tentative arguments. Mental model maintenance and building should influence the perception and extent of those costs and benefits of knowledge sharing. Concerning costs, engaging in model maintenance should lower the sense of risk or possible unsuitability of the shared knowledge, and reduce some of the perceived complexity of the knowledge. Thus, possibly maintenance is more relevant to reducing individual-level costs (compared to collective-level costs, because individual complexity reduction is more directly experienced) of both collecting and contributing. Concerning benefits, maintenance should reinforce one's understanding of and confidence in the shared and collective knowledge, making it easier and more satisfying to conduct one's work. Model building may require more time and effort to process and integrate new knowledge, perhaps more so for collecting than contributing, but also increases the risk for the sharing community by distributing novel perspectives and solutions. However, this same innovative building may generate positive benefits to both the individual and the collective, by solving those problems, saving future time and effort, and increasing the value of existing knowledge. Without much prior research in this area, we propose two sets of general hypotheses:

H4. Mental model processing (maintenance and building) will be negatively related to individual (*H4a*) and collective (*H4b*) costs.

H5. Mental model processing (maintenance and building) will be positively related to individual (*H5a*) and collective (*H5b*) benefits.

H3, *H4* and *H5* also imply several indirect effects:

H6. Knowledge sharing (contributing and collecting) will be positively related to mental model processing, which will in turn be negatively related to individual (*H6a*) and collective (*H6b*) costs.

H7. Knowledge sharing (contributing and collecting) will be positively related to mental model processing, which will in turn be positively related to individual (*H7a*) and collective (*H7b*) benefits.

4. Method

4.1 Research site

This study examines initial usage of TaxAlmanac, a voluntary, public online collaboration system created by Intuit for tax professionals. Intuit launched the system in May, 2005, modeling it after Wikipedia, an open online collaboration tool used as a reference source for a variety of topics (see, for example, Cress and Kimmerle, 2008). Wikis not only support the sharing of both explicit and tacit knowledge and the development of knowledge bases, but also conversations about that knowledge (Arazy and Gellatly, 2012). Eventually its content included the following categories: main page, forums, general, what's new, income, deductions, depreciation, credits, state, business, miscellaneous, forms and publications, code and regulations. It provided updated codes and forms only through 2007/2008, but continued to allow posting and discussions until it was closed to contributions in 2014 (it is

still available as an archived site at www.taxalmanac.org/index.php/Main_Page.html). By that time, there had been over 5.6 million accesses of the main page, and over 27,000 forum discussions. As with other professionals (such as health care or legal), tax professionals must update and evaluate their knowledge regularly to benefit from learning from their peers. Thus knowledge sharing platforms improve their ability to provide good client service (Singh *et al.*, 2018). Tax professionals could use TaxAlmanac in a number of ways, including posting and answering questions, creating, editing, and posting comments on articles (such as on new tax regulations, tax scenarios or tax preparation tips), browsing or searching articles and non-editable reference materials, creating, browsing and posting comments on user introduction pages and/or user pages and browsing the history of recent contributions. Individuals who wished to browse contributions on the website did not need to register or log in. However, making a contribution required an individual to have a registered user name (no other information was required) to log into the website. Registered members could add information to their user page on a voluntary basis which, in turn, became visible to other users, thus providing a mechanism for verifying some authors' credentials and offering opportunities for interaction.

4.2 Procedures

4.2.1 Access and background information. We gained access to Intuit through a personal introduction to TaxAlmanac's product manager, who became the primary contact for all subsequent communications (including weekly phone calls up through the survey administration). Contractual documents included a corporate proposal, a statement of participant anonymity, an organizational support statement (later to be sent to registered users in an email containing the survey link), human subjects' approval at the researcher's university, and an Intuit contractor agreement that was modified to fit an academic research context.

To better understand the context of TaxAlmanac and its users, and their relevant terms and concerns, we first sought background information from interviews and focus groups. One-hour stakeholder semi-structured interview sessions were conducted with 15 employees at Intuit's professional tax headquarters who were involved in the creation, design, development, and/or use of TaxAlmanac. Then two focus group sessions were conducted by a third party market research company with tax professionals who averaged around 425 clients. The stakeholder interviews and focus group discussions emphasized four themes: tax research resources, benefits of using Tax Almanac, costs of using TaxAlmanac, and motivations for either contributing or collecting knowledge through TaxAlmanac. These qualitative understandings were used to customize the survey for this particular KSP usage and user group.

4.2.2 Survey. Insight gained from the interviews and focus group sessions, as well as established scales in the literature, were used to develop a survey that integrated the language of tax professionals, and used conceptually meaningful measures of usage, subjective costs and benefits of contributing and collecting knowledge from TaxAlmanac. Four members of Intuit's 12-person Tax Advisory Board – a group of registered users who provided feedback and advice on TaxAlmanac – completed and critiqued a printed draft of the survey. To meet Intuit's criteria for a survey length acceptable to their users, the original survey of 164 items (reflecting a more complex model with more concepts and scales with more items) was iteratively reduced to a final version containing 79 items (including a range of individual and collective influences, not studied here). This iterative process took into account the conceptual relevance of each scale or item to the model, stakeholder and Advisory Board advice, reliabilities and factor analyses of previously established scales, and item face validity. Thus, due to the survey length constraint, nearly all scales are shortened versions, consisting of their two strongest and most indicative items of their original forms.

A half-year after the launch of Tax Almanac, in mid-November 2005, an email with a hyperlink to the final survey was sent to the 3,447 registered TaxAlmanac users who had valid email addresses. Two follow-up emails were sent between late November and mid-December 2005. All survey respondents had the option of entering a raffle drawing to receive one of five \$100 gift cards provided by Intuit. A third party research company administered the survey and collected the data (with raffle contact information stored separately from the survey data and not available to Intuit or the researchers), which was not available to Intuit. The electronic survey randomized the sequence of questions within sections for each respondent, thereby controlling for any scale-specific item order effects. Unfortunately system-monitored usage data was not available, due to Intuit's policies about protecting their professional clientele.

4.2.3 Sample. The total number of respondents was 1,238 (35.9 per cent response). However, only 602 provided responses to all of the 31 items used in testing this study's model. Little's MCAR test indicated no significant pattern of missing responses ($\chi^2 = 3,057.5$, $df = 3,219$, $p = 0.98$), thus justifying listwise deletion with no need for imputing missing values from the full sample. Of the final sample, 67.5 per cent were male. Most of the respondents were experienced professionals with an average of 20.3 years of experience ($SD = 10.9$). The mean number of tax returns their business prepared in the prior tax year was 7,500 ($SD = 617.5$; these did not include one outlier reporting 400,000), and the percent of time allocated to tax preparation vs. non-tax preparation work was 67.5 per cent. Concerning respondents' age, 30.5 per cent of the respondents were between 45-54 years old, and another 33.7 per cent were in the 55-64 age group; 7 per cent were under 25, 5.5 per cent were between 25 and 34, 12.5 per cent were between 35 and 44, and 16.9 per cent were 55 or older. 44.6 per cent of the respondents earned a MS/MA/CPA degree and 31.6 per cent earned a BS or BA degree, while 5.2 per cent had only a high school degree, 15.2 per cent had an enrolled agent degree, and 3.4 per cent a PhD. Their organizational types were primarily sole proprietor 54.3 per cent or corporation 28.2 per cent.

4.3 Measures

4.3.1 Knowledge sharing portal use for knowledge sharing (collecting and contributing). Five items constituting *collecting knowledge* (two were deleted based on the measurement model analysis), and four for *contributing knowledge* (one was deleted), were derived from the stakeholder interviews, focus groups, prior literature, and an analysis of the TaxAlmanac website.

4.3.2 Mental model processing. For *mental model processing*, two items each of Vandenbosch and Higgins' (1996) seven-item mental model maintenance and eight-item mental model building scales were used. However, in their study, factor analysis did not distinguish between the two concepts and scale reliability was higher when the two concepts were combined, and our results were similar, so we used the one combined scale.

4.3.3 Individual and collective costs and benefits of knowledge sharing through a knowledge sharing portal. The survey explicitly instructed participants to consider the costs and benefits of using TaxAlmanac, based on their experience using it. At the individual level, costs and benefits were measured for collecting and for contributing, yielding four measures:

1. individual costs of collecting (four items);
2. individual costs of contributing (two items);
3. individual benefits of collecting (two items); and
4. individual benefits of contributing (two items; one was deleted based on the measurement model).

Some of the costs and benefits identified from the stakeholder interviews and focus group sessions shared much in common with previously developed and tested items, so three items at the individual level were adapted from prior research: two items from value and cost constructs (Fulk *et al.*, 2004), and one item from impact on reputation (Wasko and Faraj, 2005).

At the *collective level*, two separate *collective cost* items were developed, one that addressed effects on the credibility of tax professionals more generally (*harm to profession*), and another that captured the notion of cognitive limits in information processing (March and Simon, 1958) and the need for accuracy when doing tax-related work tasks (*too many interpretations*). However, this latter item was deleted from the model, leaving one indicator for collective costs (*harm*). *Collective benefits* consisted of a two-item scale for *communality* developed for this study, and a two-item scale for *connectivity* from four items of Van den Hooff *et al.*'s (2003) scale.

Table I presents descriptive statistics of the items and scales, and scale Cronbach alphas.

4.4 Analysis

To test the hypothesized model we used structural equation modeling in AMOS 24. Incremental indices (the Tucker–Lewis Index [TLI] and the comparative fit index [CFI]), and absolute indices (a standardized version of the root mean squared residual [SRMR] and the root mean square of approximation [RMSEA]) were used to gauge model fit. The χ^2 statistic primarily serves as a relative measure to evaluate model fit between the retained and alternative models or nested models using a $\Delta\chi^2$ test. The confidence intervals for parameter estimates were calculated by extracting 5,000 bootstrap samples. Before the analysis, multi-variate normality assumptions were examined and curve-estimations to determine whether the relationships in the model were sufficiently linear, with no problems indicated. Moreover, Harman's single factor test to extract a single factor indicated an explained variance of 31.83 per cent, suggesting the absence of common method bias (Malhotra *et al.*, 2006). This conclusion is substantiated by a latent variable approach we used known as a common latent factor analysis (Podsakoff, MacKenzie, Lee, and Podsakoff, 2003). Comparison between the factor loadings in the model with the common latent factor and the model without the common latent factor indicated no substantial differences (i.e. >0.20). As such we do not need to include common method bias corrected composites.

5. Results

5.1 Measurement model

The measurement model demonstrates good model fit: $\chi^2 (224) = 573.73$; CFI = 0.96; TLI = 0.96; SRMR = 0.05 and RMSEA = 0.051 (CI: 0.046, 0.056). Discriminant validity of the factors in the model was assessed through factor intercorrelations (table available from the authors). The model contains moderate to substantial factor correlations ranging from -0.36 to 0.65 , but none is as large as 0.70 or the alpha coefficients, which provides support for the discriminant validity of the constructs (Kline, 2011). Conversely, convergent validity was assessed by examining factor loadings and squared multiple correlations (see Table I). The factor loadings were significant and sizable, ranging from 0.60 to 0.98 on the intended constructs, exceeding the recommended cut-off point of 0.60 (Kline, 2011). One item was removed from the final model due to cross loadings on both collecting and contributing knowledge. This item referred to looking up answers in the system. Arguably, although seeking the answer to a question might be viewed as collecting knowledge, the manner in which this quest for answers is conducted might also involve specific contributing behaviors, such as first posting questions. Table I provides the squared multiple correlations, standardized

Table I Measurement model

Item	M	SD	α	AVE/R ^{2g}	St. loading	Unst. Loading ^{d, e}	SE
<i>Use – Collecting^a</i>	2.00	1.01	0.85	<i>0.61</i>			
Freq searched for articles, IRS codes or treasury regs	2.00	1.18		0.74	0.859	1.000	
Freq browsed the user introduction page	1.74	0.97		0.46	0.679	0.800	0.05
Freq use TaxAlmanac	2.26	1.35					
<i>Use – Contributing^a</i>	1.19	0.51	0.93	<i>0.43</i>			
Freq posted articles	1.15	0.55		0.46	0.678	1.000	
Freq edited articles	1.16	0.61		0.43	0.659	0.965	0.08
Freq answered questions that are posted on the Ask or Answer a Tax Question Page (Q&A page) or on the User Discussion Page	1.20	0.69		0.48	0.691	1.091	0.09
<i>Mental Model Maintenance and Building^b</i>	2.76	1.86	0.93	<i>0.91</i>			
Justify your decisions	2.68	1.89		0.90	0.947	1.000	
Verify your assumptions	2.77	1.95		0.95	0.976	1.063	0.02
Improve your insight into an issue	2.94	2.02		0.90	0.949	1.072	0.02
Test your assumptions	2.63	1.86		0.88	0.940	0.974	0.02
<i>Individual Costs – Collecting^c</i>				<i>0.46</i>			
Locating specific information is too time consuming	3.89	0.87	0.88	0.41	0.644	1.000	
I cannot trust the content that is available because I do not know who the author is	3.95	1.19		0.42	0.644	0.967	0.08
The articles do not provide enough interpretation of tax code to be useful	3.75	1.15		0.56	0.749	1.034	0.08
Not enough tax professionals contribute to make it valuable	3.81	1.05		0.46	0.681	1.023	0.08
<i>Individual Costs – Contributing^c</i>	3.97	0.94	0.93	<i>0.60</i>			
The process for posting content is confusing because it requires the use of special commands or code	3.90	1.01		0.53	0.728	1.000	
Posting content is too time consuming	4.04	1.10		0.67	0.820	1.232	0.14
<i>Collective Costs^{c, f}</i>							
The credibility of the tax professional community is harmed by using the content from TaxAlmanac in tax preparation	2.59	1.33		–	–	–	–
<i>Individual Benefits – Collecting and Contributing Combined^d</i>				<i>0.76</i>			
Reduced the amount of time you spend researching tax related questions	3.23	1.85		0.95	0.974	1.000	
Improved the accuracy of the tax returns that you do	3.16	1.87		0.90	0.946	0.980	0.02
Given you a positive feeling about helping other tax professionals	2.91	1.80		0.44	0.660	0.659	0.03
<i>Collective benefits – Communal^e</i>	4.98	1.29	0.89	<i>0.83</i>			
The more that users share information on TaxAlmanac, the more valuable that information is	4.92	1.32		0.75	0.868	1.000	
The more that users share information on TaxAlmanac, the more time & effort the tax professional community saves overall	5.04	1.40		0.90	0.948	1.029	0.06
<i>Collective benefits – Connectivity</i>	4.33	1.15	0.92	<i>0.67</i>			
It is easier for tax professionals to get in touch with each other	4.33	1.28		0.60	0.775	1.000	
Tax professionals obtain information from, and provide information to, other tax professionals faster	4.34	1.25		0.73	0.857	1.136	0.11

Notes : N = 602; ^a1 = never, 2 = only once or twice total, 3 = once a month, 4 = 2-3 times a month, 5 = once a week, 6 = 2-3 times a week, 7 = once a day or more; ^b1 = not at all, 4 = moderate, 7 = to a very great extent; ^c1 = strongly disagree, 4 = neutral, 7 = strongly agree; ^dall factor loadings are significant at $p < 0.05$; ^eunit loading indicators constrained to 1.000; ^fcollective costs was measured using a single observed indicator, so there are no factor loadings; ^gvalues in italic are average variance extracted (AVE)

and unstandardized factor loadings, and standard errors. These indicate that the measurement model adequately represents all latent constructs, allowing examination of the structural model.

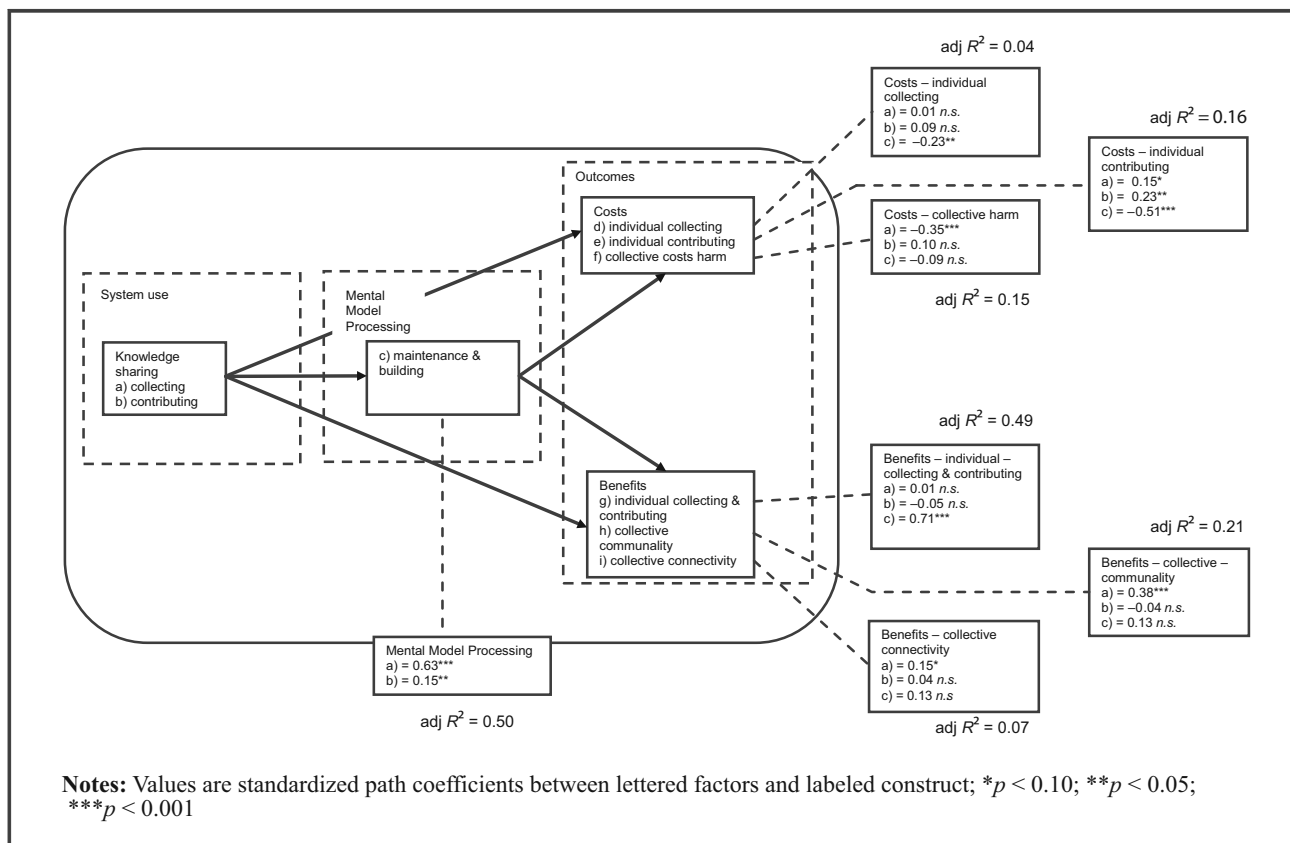
5.2 Structural model

Figure 1 presents the structural model with standardized regression coefficients, showing direct, but not indirect, effects. The structural model fits the data: $\chi^2(255) = 813.99$; CFI = 0.94; TLI = 0.93; SRMR = 0.07 and RMSEA = 0.060 (CI: 0.056, 0.065). Knowledge sharing explains 49.5 per cent of the variance in mental model processing. Knowledge sharing and mental model processing explain from 4 to 16 per cent of costs, and from 7 to 49 per cent of benefits.

5.2.1 Direct effects. All [bracketed intervals] reported below are bias-corrected, 95 per cent confidence intervals.

H1. Concerning *individual costs*, *collecting* knowledge was not significantly associated with individual costs of collecting ($b^* = 0.006 [-0.197; 0.178]$, $p = 0.981$), and was just barely not significantly associated with individual costs of contributing ($b^* = 0.154 [-0.011; 0.328]$, $p = 0.064$) (*H1a1*). *Contributing* knowledge was not associated with individual costs of collecting ($b^* = 0.093 [-0.100; 0.284]$, $p = 0.392$), but was with individual costs of contributing ($b^* = 0.231 [0.069; 0.399]$, $p = 0.005$) (*H1a2*). Concerning *collective costs*, *collecting* knowledge was negatively related to collective costs ($b^* = -0.353 [-0.509; -0.195]$, $p < 0.001$) (*H1b1*), but *contributing* knowledge was not significantly related to collective costs ($b^* = 0.103 [-0.030; 0.255]$, $p = 0.130$) (*H1b2*). These results only partially

Figure 1 Structural regression model with standardized parameter estimates



support the rationale reflected in *H1a* (but only for contributing and individual costs) and *H1b* (but only for collecting and collective costs).

H2. Concerning *benefits*, surprisingly, *collecting* knowledge is not associated with individual benefits ($b^* = 0.006 [-0.110; 0.132]$, $p = 0.910$). However, collecting is related to collective communality benefits ($b^* = 0.376 [0.211; 0.554]$, $p < 0.001$) but not to collective connectivity benefits ($b^* = 0.148 [-0.011; 0.332]$, $p = 0.068$) benefits (*H2a1*). Also surprisingly, *contributing* knowledge is not associated with individual ($b^* = -0.047 [-0.150; 0.046]$, $p = 0.318$), collective communality ($b^* = -0.053 [-0.233; 0.097]$, $p = 0.485$) or collective connectivity ($b^* = 0.038 [-0.121; 0.196]$, $p = 0.651$) benefits (*H2b2*). These results provide only limited support for *H2a*, but do not support *H2b*. Thus knowledge sharing by itself seems to directly foster some costs and few benefits.

H3. Both collecting ($b^* = 0.625 [0.546; 0.703]$, $p < 0.001$) (*H3a*) and contributing ($b^* = 0.147 [0.032; 0.259]$, $p = 0.017$) (*H3b*) knowledge were significantly positively associated with mental model processing, supporting *H3*.

H4. Mental model processing is indeed negatively related to individual *costs* of contributing ($b^* = -0.514 [-0.662; -0.370]$, $p < 0.001$), and to individual *costs* of collecting ($b^* = -0.229 [-0.424; -0.023]$, $p = 0.032$), but is not significantly related to collective costs ($b^* = -0.088 [-0.221; 0.046]$, $p = 0.188$).

H5. Mental model processing is positively related to individual *benefits* ($b^* = 0.713 [0.614; 0.804]$, $p < 0.001$), but not significantly related to collective communal benefits ($b^* = 0.131 [-0.032; 0.294]$, $p = 0.113$), or to collective connectivity benefits ($b^* = 0.126 [-0.049; 0.288]$, $p = 0.135$).

That is, mental model processing is associated with individual, but not collective, costs and benefits. Hence, these findings support *H4a* and *H5a*, but not *H4b* or *H5b*.

5.2.2 Indirect effects. Several hypotheses proposed indirect effects, with mental model processing as the mediator. Table II reports both the standardized and unstandardized indirect effects.

H6 (costs). *Collecting* is related through mental model processing to (*H6a*) *individual costs* (both collecting ($b^* = -0.143 [-0.273; -0.017]$, $p = 0.029$), contributing ($b^* = -0.321 [-0.434; -0.227]$, $p < 0.001$)), but not to (*H6b*) *collective costs* ($b^* = -0.055 [-0.136; 0.028]$, $p = 0.178$). Similarly *contributing* is related through mental model processing to (*H6a*) *individual costs* (both collecting ($b^* = -0.034 [-0.098; -0.004]$, $p = 0.020$),

Table II Standardized and unstandardized indirect effects

Indirect effect $x \rightarrow m \rightarrow y$	Standardized				Unstandardized				
	b^*	Low	Up	p	Bootstrap β	SE	Low	Up	p
<i>H6a</i> , Collecting \rightarrow mmp \rightarrow ind. costs collecting	-0.14	-0.27	-0.02	0.03	-0.25	0.12	-0.50	-0.04	0.03
<i>H6a</i> , Collecting \rightarrow mmp \rightarrow ind. costs contributing	-0.32	-0.43	-0.23	0.00	-0.56	0.11	-0.81	-0.36	0.00
<i>H6a</i> , Contributing \rightarrow mmp \rightarrow ind. costs collecting	-0.03	-0.10	-0.00	0.02	-0.12	0.09	-0.40	-0.02	0.02
<i>H6a</i> , Contributing \rightarrow mmp \rightarrow ind. costs contributing	-0.08	-0.15	-0.02	0.01	-0.27	0.14	-0.61	-0.07	0.01
<i>H6b</i> , Collecting \rightarrow mmp \rightarrow coll. costs	-0.06	-0.14	0.03	0.18	-0.17	0.14	-0.43	0.09	0.18
<i>H6b</i> , Contributing \rightarrow mmp \rightarrow coll. costs	-0.01	-0.05	0.00	0.12	-0.09	0.09	-0.37	0.02	0.13
<i>H7a</i> , Collecting \rightarrow mmp \rightarrow ind. benefits	0.45	0.38	0.53	0.00	1.89	0.17	1.58	2.25	0.00
<i>H7a</i> , Contributing \rightarrow mmp \rightarrow ind. benefits	0.10	0.02	0.19	0.02	0.93	0.45	0.19	1.98	0.02
<i>H7b</i> , Collecting \rightarrow mmp \rightarrow communal benefits	0.08	-0.02	0.18	0.11	0.24	0.16	-0.06	0.51	0.11
<i>H7b</i> , Collecting \rightarrow mmp \rightarrow connectivity benefits	0.08	-0.03	0.18	0.13	0.18	0.13	-0.06	0.43	0.12
<i>H7b</i> , Contributing \rightarrow mmp \rightarrow communal benefits	0.02	-0.00	0.07	0.07	0.12	0.10	-0.01	0.43	0.07
<i>H7b</i> , Contributing \rightarrow mmp \rightarrow connectivity benefits	0.02	-0.00	0.06	0.08	0.09	0.08	-0.01	0.34	0.07

Note: mmp = mental model processing

contributing ($b^* = -0.075 [-0.148; -0.020]$, $p = 0.012$)), but not to (*H6b*) *collective* costs ($b^* = -0.013 [-0.049; 0.003]$, $p = 0.123$). These results support *H6a*, but not *H6b*.

H7 (benefits). *Collecting* is positively related through mental model processing to (*H7a*) *individual* benefits ($b^* = 0.445 [0.375; 0.525]$, $p < 0.001$), but not to (*H7b*) *collective* benefits (communal ($b^* = 0.082 [-0.021; 0.180]$, $p = 0.111$), connectivity ($b^* = 0.079 [-0.030; 0.184]$, $p = 0.129$)). *Contributing* is also related through mental model processing to *individual* benefits (*H7a*) ($b^* = 0.104 [0.022; 0.192]$, $p = 0.016$) but not to *collective* (*H7b*) benefits (communal ($b^* = 0.019 [-0.001; 0.065]$, $p = 0.068$), connectivity ($b^* = 0.018 [-0.002; 0.061]$, $p = 0.077$)). These findings support *H7a* but not *H7b*. In both paths, we see that both collecting and contributing knowledge affect *individual* costs and benefits through mental model processing, but not *collective* costs and benefits.

6. Discussion

6.1 Contributions

This study has several strengths and makes several contributions. First, it involves a reasonable-sized sample of professionals using a public KSP. Second, it distinguishes between collecting and contributing knowledge, between costs and benefits, and between individual and collective levels, all consistent with a public goods approach. Both collectors and contributors of a KSP aim to reduce costs while obtaining benefits (Brake, 2014). But, based on a public goods perspective, it is insufficient to consider only individual costs and benefits. Indeed, the tension between individual and collective costs and benefits lies at the heart of the public goods perspective. Third, it assesses the influences of both kinds of knowledge sharing on both costs and benefits, at both individual and collective levels. Fourth, it includes and identifies the mediating role of mental model processing (here, maintenance and building combined). These distinctions unconfound a variety of concepts and measures in prior studies of online knowledge sharing, and emphasize the importance of including how users process shared knowledge to explain costs and benefits at various levels in online environments.

6.2 Individual and collective costs and benefits

Surprisingly, neither *collecting* nor *contributing* knowledge was much *directly* associated with *individual* costs or benefits, with the exception of both being related to contributing costs. Participation in the early stages of a KSP may not have yet generated individual perceived benefits, yet still involved costs associated with contributing, a crucial tension in the public goods approach. That is, an inherent challenge from a public goods perspective is to foster enough early contributions (at some cost) to generate enough individual and collective resources (a benefit) to encourage ongoing collection and contribution. Early collecting activities may have heightened awareness of the possible costs of contributing in the first place.

Collecting knowledge is directly related to all the *collective* costs and benefits. Individual collecting usage, even in this early stage of the KSP, can be associated with awareness of possible harm to the tax professional community, but also of possibilities for greater contact among professionals and positive network externalities (increasing value of information and time savings for the community). This again supports the public goods argument. Thus, promoters of KSPs should emphasize both individual and collective benefits to early users, even just collectors.

However, *contributing* knowledge was not significantly associated with either collective costs or benefits. One may discount the possibility of one's own contributions harming the community (as a cost). Further, as noted, this study was based on the beginning time period of the KSP use, so there would have been less time to perceive implications of

contributing on the community, as compared to the more immediate implications of one's own collecting. More generally, though, this again underscores the public goods tension between individual and collective actions and outcomes. The perceived benefits of contributing are somewhat heightened by the extent to which one believes others in the profession will be able to benefit from the knowledge. But that is somewhat more abstract and projective than implications of one's own knowledge collecting, here, to solve tax problems of benefit to the professionals and their clients. Thus posting on a KSP the positive evaluations by collectors of one's contributed knowledge would encourage more contributions, increasing the positive network externalities of such KSPs. Also, when other, already established, knowledge repositories exist (e.g. in this case IRS.gov), substituting a new KSP for individuals' already established ways of doing things can pose a cost that some might choose not to bear. Presenting the new system as a complementary medium that provides yet another source of knowledge, and especially the potential for contributing knowledge, rather than as a replacement to existing repositories designed just for collecting, could increase such systems' potential for success.

Further, both research models and practical KSP implementations should not only explicitly assess both costs and benefits, but also test and finds ways to reduce forms of costs at both individual and collective levels.

6.3 Mental model processing and individual and collective costs and benefits

Both collecting and contributing knowledge are related to *individual* costs and benefits indirectly through mental model processing. How users of a KSP process the knowledge they collect and contribute affects their perceptions of the outcomes of that use. Thus models of online knowledge sharing cannot simply assume direct effects (either positive or negative) on outcomes. Indeed, integrating ways in which users process shared knowledge may serve to decrease inconsistencies in results across knowledge sharing models.

In contrast, collecting and contributing knowledge were not related to *collective* costs and benefits when mediated by mental model processing. This suggests that when knowledge is used to maintain current frameworks, or build and develop new understandings, the perceived costs and benefits are internalized as an *individual* good rather than being interpreted at the collective level as a *public* good. This has significant implications for fostering the public goods aspect of online communities. As public goods and collective outcomes may be more abstract and less observable, KSP designers and managers may wish to find ways to emphasize and visualize the (esp. beneficial) collective aspects more explicitly. A focus on the learning potential of the system – through both mental model maintenance and building – could serve to draw in new users, and thus the number of subsequent contributors as well, heightening the perceptions of the collective, public goods dimension of a KSP. Moreover, the concepts involved in the fundamental mental models developed before the world of online knowledge sharing – that is, a more individual-level, direct reciprocation approach – may need to be transformed through mental model building (Chi, 2008) to heighten awareness of collective level, or public goods, aspects, such as generalized reciprocation and connectivity and communality benefits.

6.4 Limitations

As with many information and communication technology studies, the data were gathered at a single research site, involving one specific KSP, at one time period, making it impossible to generalize the findings to other KSP systems and user populations, or to assert causality. However, the study does involve individuals engaged in professional jobs participating in a self-organizing online knowledge sharing community, making these results at least somewhat relevant to similar public KSP communities. Much of the prior research has focused on knowledge sharing activities in traditional organizations, in which the costs/

benefits might be quite different (and more obvious) from those involved in more public and online forms of organizing. The data come from very early adopters (in the first six months of TaxAlmanac), so only represent initial impressions. The relationships would likely change with the vastly more expansive involvement of the later adopters. For example, with more time, users, and knowledge sharing, there would be a critical mass of users and content, leading to more reinforcement between contributing and collecting, and more positive network externalities, generating a more obvious public good nature of the online content and user network. Extensive usage would also likely make the costs and benefits more perceptible and pervasive. Most of the scales were limited to two items to maintain an acceptable survey length, although they were derived from the high-loading items in existing validated scales, and nearly all had good reliability.

6.5 Directions for future research

A central characteristic of knowledge is the extent to which it is explicit or tacit. Tax information would seem to be primarily explicit rather than tacit, as it must satisfy formally stated federal and state tax regulations, and involves explicit calculations. Further, Polanyi (1966) argues that exchanging or codifying tacit knowledge requires extended social interaction. Thus, we might expect more influence of tax knowledge sharing on mental model *maintenance* rather than on *building* (though we cannot distinguish those outcomes here as both processes loaded on the same factor). Nonetheless, many regulations and contexts are open to interpretation, requiring sharing more tacit information (Marchant and Robinson, 1999), and stimulating more mental model building. Thus future research would include measures of the tacitness/explicitness of the knowledge collected or contributed.

While this study considers mental model maintenance and building as the mediating process between online knowledge sharing and various outcomes, future research could look much more deeply at the cognitive processes involved in making sense of and decisions based on that shared knowledge. As just one example, Grégoire *et al.* (2010) content-analyzed verbal protocols of managers discussing whether and how they might recognize opportunities for development of two new technologies (made up by the researchers). "Different kinds of mental connections play[ed] different roles in the process of recognizing opportunities, with different consequences" (p. 413). Processing superficial features was somewhat similar to mental model maintenance, as features of the new product were compared to similar features of relevant sources in memory. However, processing structural relationships, somewhat similar to mental model building, required understanding the underlying causal linkages and engaging in learning and problem solving. So a similar approach would expand our understanding of the roles of mental model maintenance and building in the context of online knowledge sharing.

In the context of online value co-creation in consumer tribes, Dominici *et al.* (2017, p. 93) concluded that "consumers process, transfer, and share information that is directed to attempt the emergence of an accepted and shared self-image." This seems similar to mental model maintenance as it reaffirms and assimilates existing mental modes, but possibly also requires some building to establish that share image. Hence, future research may investigate the mental model processing in the context of consumers sharing knowledge with each other about a common product, service, company, or interests. It might also be interesting for future research to examine the ways in which emotion regulation processes (Gross and John, 2003) affect mental model processing in the context of knowledge sharing and how this is related to habitual behaviors and authentic decisions (Calabrese *et al.*, 2018).

More rigorous testing of causal relations in general, the mutual influence both of usage and outcomes (such as including expectations about outcomes measured separately from post-user outcomes), and among system usage, sharing and mental model processing, would result from a longitudinal study. Future research might also expand the range of positive

and negative outcomes, such as social capital, psychological well-being, brand loyalty, and greater social connectedness (Malinen, 2015). From a public goods theory perspective, future work should include collective-level measures of collective costs and benefits to complement the current study's individual-level perceptions of collective outcomes.

Finally, a more complete model of online knowledge sharing would of course include motivations and other influences on online knowledge sharing (Heinz and Rice, 2009; Hocevar *et al.*, 2019), the relevance of prior knowledge (Grégoire *et al.*, 2010), the initial processes of seeking and searching, other intervening processes (such as validation), and other aspects of sharing, both potentially positive, such as re-use, and potentially negative, such as hoarding, hiding, withholding, hostility, ignorance, and disengagement (Chhim *et al.*, 2017; Chiu *et al.*, 2017; Serenko and Bontis, 2016; Trusson *et al.*, 2017). More generally, it would include other distinctions about and measures of online participation, such as the simple dichotomy of active (e.g. posting) vs passive (e.g. viewing or reading, including lurking) uses, consuming vs creating, asking vs. answering, general posting vs directing content to specific others (e.g. threads, replies), and sharing vs joining online social structures or interacting with others on the site (Malinen, 2015).

References

- Alavi, M. and Leidner, D.E. (2001), "Review: knowledge management and knowledge management systems: conceptual foundations and research issues", *MIS Quarterly*, Vol. 25 No. 1, pp. 107-136.
- Arazy, O. and Gellatly, I.R. (2012), "Corporate wikis: the effects of owners' motivation and behavior on group members' engagement", *Journal of Management Information Systems*, Vol. 29 No. 3, pp. 87-116.
- Bagozzi, R.P. and Tsai, H.T. (2014), "Contribution behavior in virtual communities: cognitive, emotional, and social influences", *MIS Quarterly*, Vol. 38 No. 1, pp. 143-164.
- Baker, W.E. and Bulkley, N. (2014), "Paying it forward vs rewarding reputation: mechanisms of generalized reciprocity", *Organization Science*, Vol. 25 No. 5, pp. 1493-1510.
- Bandura, A. (1989), "Regulation of cognitive processes through perceived self-efficacy", *Developmental Psychology*, Vol. 25 No. 5, pp. 729-735.
- Barry, B. and Hardin, R. (Eds) (1982), *Rational Man and Irrational Society*, Sage, Beverly Hills, CA.
- Benkler, Y. and Nissenbaum, H. (2006), "Commons-based peer production and virtue", *Journal of Political Philosophy*, Vol. 14 No. 4, pp. 394-419.
- Brake, D.R. (2014), "Are we all online content creators now? Web 2.0 and digital divides", *Journal of Computer-Mediated Communication*, Vol. 19 No. 3, pp. 591-609.
- Brewer, W.F. (1987), "Schemas versus mental models in human memory", in Morris, P. (Ed.), *Modelling Cognition*, Wiley, New York, NY, pp. 187-197.
- Cabrera, A. and Cabrera, E.G. (2002), "Knowledge-sharing dilemmas", *Organization Studies*, Vol. 23 No. 5, pp. 687-710.
- Calabrese, M., Iandolo, F., Caputo, F. and Sarno, D. (2018), "From mechanical to cognitive view: the changes of decision making in business environment", in Barile, S., Pellicano M. and Polese, F. (Eds), *Social Dynamics in a Systems Perspective*, Springer International, New York, NY, pp. 223-240.
- Caputo, F. and Evangelista, F. (2017), "Information sharing and cognitive involvement for sustainable workplaces", in Leon, R.D. (Ed.), *Managerial Strategies for Business Sustainability during Turbulent Times*, IGI Global, New York, NY, pp. 122-139.
- Case, D.O. and Given, L.M. (2016), *Looking for Information: A Survey of Research on Information Seeking, Needs, and Behavior*, Emerald Group Publishing, Bingley.
- Chang, H.H. and Chuang, S.S. (2011), "Social capital and individual motivations on knowledge sharing: participant involvement as a moderator", *Information and Management*, Vol. 48 No. 1, pp. 9-18.
- Chen, C.J. and Hung, S.W. (2010), "To give or to receive? Factors influencing members' knowledge sharing and community promotion in professional virtual communities", *Information and Management*, Vol. 47 No. 4, pp. 226-236.

- Cheung, C.M.K., Lee, M.K.O. and Lee, Z.W.Y. (2013), "Understanding the continuance intention of knowledge sharing in online communities of practice through the post-knowledge-sharing evaluation process", *Journal of the American Society for Information Science and Technology*, Vol. 64 No. 7, pp. 1357-1374.
- Chhim, P.P., Somers, T.M. and Chinnam, R.B. (2017), "Knowledge reuse through electronic knowledge repositories: a multi theoretical study", *Journal of Knowledge Management*, Vol. 21 No. 4, pp. 741-764.
- Chi, M.T.H. (2008), "Three types of conceptual change: belief revision, mental model transformation, and categorical shift", in Vosniadou, S. (Ed.), *Handbook of Research on Conceptual Change*, Erlbaum, Hillsdale, NJ, pp. 61-82.
- Chiu, H., Zhu, Y.Q. and Holguin-Veras, E.J. (2017), "It is more blessed to give than to receive: examining the impact of knowledge sharing on sharers and recipients", *Journal of Knowledge Management*, Vol. 22 No. 1, pp. 76-91.
- Cleveland, S. (2014), "A causal model to predict organizational knowledge sharing via information and communication technologies", unpublished PhD dissertation, Nova Southeastern University, Graduate School of Computer and Information Sciences, Davis, FLA.
- Constant, D., Kiesler, S. and Sproull, L. (1994), "What's mine is ours, or is it? A study of attitudes about information sharing", *Information Systems Research*, Vol. 5 No. 4, pp. 400-421.
- Cress, U. and Kimmerle, J. (2008), "A systemic and cognitive view on collaborative knowledge building with wikis", *International Journal of Computer-Supported Collaborative Learning*, Vol. 3 No. 2, pp. 105-122.
- Dawes, R.M. (1980), "Social dilemmas", *Annual Review of Psychology*, Vol. 31 No. 1, pp. 169-193.
- Del Giudice, M., Khan, Z., De Silva, M., Scuotto, V., Caputo, F. and Carayannis, E. (2017), "The microlevel actions undertaken by owner-managers in improving the sustainability practices of cultural and creative small and medium enterprises: a United Kingdom-Italy comparison", *Journal of Organizational Behavior*, Vol. 38 No. 9, pp. 1396-1414.
- Deng, L. and Poole, M.S. (2011), "Knowledge utilization in electronic networks of practice", in Canary, H. E. and McPhee, R.D. (Eds), *Communication and Organizational Knowledge: Contemporary Issues for Theory and Practice*, Routledge, New York, NY, pp. 209-220.
- Dominici, G., Yolles, M. and Caputo, F. (2017), "Decoding the dynamics of value cocreation in consumer tribes: an agency theory approach", *Cybernetics and Systems*, Vol. 48 No. 2, pp. 84-101.
- Ellison, N.B., Gibbs, J.L. and Weber, M.S. (2015), "The use of enterprise social network sites for knowledge sharing in distributed organizations: the role of organizational affordances", *American Behavioral Scientist*, Vol. 59 No. 1, pp. 103-123.
- Fulk, J., Flanagin, A.J., Kalman, M.E., Monge, P.R. and Ryan, T. (1996), "Connective and communal public goods in interactive communication systems", *Communication Theory*, Vol. 6 No. 1, pp. 60-87.
- Fulk, J., Heino, R., Flanagin, A.J., Monge, P.R. and Bar, F. (2004), "A test of the individual action model for organizational information commons", *Organization Science*, Vol. 15 No. 5, pp. 569-585.
- Füller, J., Hutter, K., Hautz, J. and Matzler, K. (2014), "User roles and contributions in innovation-contest communities", *Journal of Management Information Systems*, Vol. 31 No. 1, pp. 273-308.
- Ghobadi, S. (2015), "What drives knowledge sharing in software project teams: a review and classification framework", *Information and Management*, Vol. 51 No. 1, pp. 82-97.
- Grégoire, D.A., Barr, P.S. and Shepherd, D.A. (2010), "Cognitive processes of opportunity recognition: the role of structural alignment", *Organization Science*, Vol. 21 No. 2, pp. 413-431.
- Gross, J.J. and John, O.P. (2003), "Individual differences in two emotion regulation processes: implications for affect, relationships, and well-being", *Journal of Personality and Social Psychology*, Vol. 85 No. 2, pp. 348-362.
- Gupta, A.K., Smith, K.G. and Shalley, C.E. (2006), "The interplay between exploration and exploitation", *Academy of Management Journal*, Vol. 49 No. 4, pp. 693-706.
- Hardin, G. (1968), "The tragedy of the commons", *Science*, Vol. 162, pp. 1243-1248.
- He, W. and Wei, K.K. (2009), "What drives continued knowledge sharing? An investigation of knowledge-contribution and-seeking beliefs", *Decision Support Systems*, Vol. 46 No. 4, pp. 826-838.

- Hecker, A. (2012), "Knowledge beyond the individual? Making sense of a notion of collective knowledge in organization theory", *Organization Studies*, Vol. 33 No. 3, pp. 423-445.
- Heinz, M. and Rice, R.E. (2009), "An integrated model of knowledge sharing in contemporary communication environments", in Beck, C. (Ed.), *Communication Yearbook*, Vol. 33, Routledge, London, pp. 172-195.
- Hislop, D. (2013), *Knowledge Management in Organizations: A Critical Introduction*, Oxford University Press, Oxford.
- Hocevar, K.P., Abeyta, A.N. and Rice, R.E. (2019), "Motivations for online knowledge sharing", in Yates, S. and Rice, R.E. (Eds), *Oxford Handbook of Digital Technology and Society*, Chapter 20, Oxford University Press, New York, NY.
- Huysman, M. and De Wit, D. (2003), "A critical evaluation of knowledge management practices", in Ackerman, M., Pipek, V. and Wulf, V. (Eds), *Beyond Knowledge Management: Sharing Expertise*, MIT Press, Cambridge, MA, pp. 3-26.
- Jarvenpaa, S.L. and Staples, D.S. (2000), "The use of collaborative electronic media for information sharing: an exploratory study of determinants", *Journal of Strategic Information Systems*, Vol. 9 No. 2-3, pp. 129-154.
- Kalman, M.E., Monge, P.R., Fulk, J. and Heino, R. (2002), "Motivations to resolve communication dilemmas in database-mediated collaboration", *Communication Research*, Vol. 29 No. 2, pp. 125-154.
- Katona, G. (1964), *L' "Uomo Consumatore"*, Etas Kompass, Milano, Italia.
- Khansa, L., Ma, X., Liginlal, D. and Kim, S.S. (2015), "Understanding members' active participation in online question-and-answer communities: a theory and empirical analysis", *Journal of Management Information Systems*, Vol. 32 No. 2, pp. 162-203.
- Kim, Y. and Adler, M. (2015), "Social scientists' data sharing behaviors: investigating the roles of individual motivations, institutional pressures, and data repositories", *International Journal of Information Management*, Vol. 35 No. 4, pp. 408-418.
- Kline, R.B. (2011), *Principles and Practice of Structural Equation Modeling*, 3rd ed., Guilford Press, New York, NY.
- Kollock, P. (1999), "The economies of online cooperation: gifts and public goods in cyberspace", in Smith, M. and Kollock, P. (Eds), *Communities in Cyberspace*, Routledge, New York, NY, pp. 220-239.
- Kraut, R.E. and Resnick, P. (Eds) (2011), *Building Successful Online Communities: Evidence-Based Social Design*, MIT Press, Cambridge, MA.
- Kraut, R.E., Rice, R.E., Cool, C. and Fish, R. (1998), "Varieties of social influence: the role of utility and norms in the success of a communication medium", *Organizational Science*, Vol. 9 No. 4, pp. 437-453.
- Law, K.K., Chan, A. and Ozer, M. (2017), "Towards an integrated framework of intrinsic motivators, extrinsic motivators and knowledge sharing", *Journal of Knowledge Management*, Vol. 21 No. 6, pp. 1486-1502.
- Malhotra, N.K., Kim, S.S. and Patil, A. (2006), "Common method variance in IS research: a comparison of alternative approaches and a reanalysis of past research", *Management Science*, Vol. 52 No. 12, pp. 1865-1883.
- Malinen, S. (2015), "Understanding user participation in online communities: a systematic literature review of empirical studies", *Computers in Human Behavior*, Vol. 46, pp. 228-238.
- March, J.G. (1991), "Exploration and exploitation in organizational learning", *Organization Science*, Vol. 2 No. 1, pp. 71-87.
- March, J.G. and Simon, H.A. (1958), "Cognitive limits on rationality", in March, J.G. and Simon, H.A. (Eds), *Organizations*, John Wiley and Sons, New York, NY, pp. 136-171.
- Marchant, G. and Robinson, J. (1999), "Is knowing the tax code all it takes to be a tax expert?", in Sternberg, R.J. and Horvath, J.A. (Eds), *Tacit Knowledge in Professional Practice: Researcher and Practitioner Perspectives*, Lawrence Erlbaum Associates, Mahwah, NJ, pp. 3-20.
- Markus, M.L. (1990), "Toward a critical mass theory of interactive media", in Fulk J. and Steinfield, C.W. (Eds), *Organizations and Communication Technology*, Sage, Newbury Park, CA, pp. 194-218.

- Martin, B. (2008), "Knowledge management", in Cronin, B. (Ed.), *Annual Review of Information Science and Technology*, Vol. 42, Information Today, Medford, NJ, pp. 371-424.
- Mirzaee, S. and Ghaffari, A. (2018), "Investigating the impact of information systems on knowledge sharing", *Journal of Knowledge Management*, Vol. 22 No. 3, pp. 501-520.
- Mom, T.J.M., van den Bosch, F.A.J. and Volberda, H.W. (2009), "Understanding variation in managers' ambidexterity: investigating direct and interaction effects of formal structural and personal coordination mechanisms", *Organization Science*, Vol. 20 No. 4, pp. 812-828.
- Monge, P.R., Fulk, J., Kalman, M., Flanagin, A.J., Parnassa, C. and Rumsey, S. (1998), "Production of collective action in alliance-based interorganizational communication and information systems", *Organization Science*, Vol. 9 No. 3, pp. 411-433.
- Nonaka, I. and Takeuchi, H. (1995), *The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation*, Oxford University Press, New York, NY.
- Osatuyi, B. (2013), "Information sharing on social media sites", *Computers in Human Behavior*, Vol. 29 No. 6, pp. 2622-2631.
- Phang, C.W., Kankanhalli, A. and Huang, L. (2014), "Drivers of quantity and quality of participation in online policy deliberation forums", *Journal of Management Information Systems*, Vol. 31 No. 3, pp. 172-212.
- Phelps, C., Heidl, R. and Wadhwa, A. (2012), "Knowledge, networks, and knowledge networks: a review and research agenda annual review", *Journal of Management*, Vol. 38 No. 4, pp. 1115-1166. Issue,
- Podsakoff, P.M., MacKenzie, S.B., Lee, J.Y. and Podsakoff, N.P. (2003), "Common method biases in behavioral research: a critical review of the literature and recommended remedies", *Journal of Applied Psychology*, Vol. 88 No. 5, pp. 879-903.
- Polanyi, M. (1966), *The Tacit Dimension*, Routledge and Kegan Paul, London.
- Prusak, L. and Cohen, D. (1998), "Knowledge buyers, sellers, and brokers: the political economy of knowledge", in Neef, D., Siesfeld, G.A. and Cefola J. (Eds), *The Economic Impact of Knowledge*, Butterworth Heineman, Boston, MA, pp. 137-159.
- Razmerita, L., Kirchner, K. and Nielsen, P. (2016), "What factors influence knowledge sharing in organizations? A social dilemma perspective of social media communication", *Journal of Knowledge Management*, Vol. 20 No. 6, pp. 1225-1246.
- Rice, R.E., McCreddie, M. and Chang, S.J. (2001), *Accessing and Browsing Information and Communication*, The MIT Press, Cambridge, MA.
- Ritala, P., Olander, H., Michailova, S. and Husted, K. (2015), "Knowledge sharing, knowledge leaking and relative innovation performance: an empirical study", *Technovation*, Vol. 35, pp. 22-31.
- Sedighi, M., van Splunter, S., Brazier, F., van Beers, C. and Lukosch, S. (2016), "Exploration of multi-layered knowledge sharing participation: the roles of perceived benefits and costs", *Journal of Knowledge Management*, Vol. 20 No. 6, pp. 1247-1267.
- Serenko, A. and Bontis, N. (2016), "Understanding counterproductive knowledge behavior: antecedents and consequences of intra-organizational knowledge hiding", *Journal of Knowledge Management*, Vol. 20 No. 6, pp. 1199-1224.
- Shapiro, C. and Varian, H. (1999), *Information Rules: A Strategic Guide to the Network Economy*, Harvard Business School Press, Boston, MA.
- Shirky, C. (2008), *Here Comes Everybody: The Power of Organizing without Organizations*, The Penguin Press, New York, NY.
- Simard, C. and Rice, R.E. (2006), "Managerial information behavior: relationships among total quality management orientation, information use environments, and managerial roles", *Total Quality Management and Business Excellence*, Vol. 17 No. 1, pp. 79-95.
- Singh, J.B., Chindwin, R. and Kumar, M. (2018), "Factors affecting web 2.0 adoption: exploring the knowledge sharing and knowledge seeking aspects in healthcare professionals", *Journal of Knowledge Management*, Vol. 22 No. 1, pp. 21-43.
- Stennis, M., Hankonen, N., Ravaja, N. and Haukkala, A. (2016), "Why share expertise? A closer look at the quality of motivation to share or withhold knowledge", *Journal of Knowledge Management*, Vol. 20 No. 2, pp. 181-198.

- Tangaraja, G., Mohd Rasdi, R., Abu Samah, B. and Ismail, M. (2016), "Knowledge sharing is knowledge transfer: a misconception in the literature", *Journal of Knowledge Management*, Vol. 20 No. 4, pp. 653-670.
- Taskin, L. and Van Bunnem, G. (2015), "Knowledge management through the development of knowledge repositories: towards work degradation", *New Technology, Work and Employment*, Vol. 30 No. 2, pp. 158-172.
- Trusson, C., Hislop, D. and Doherty, N.F. (2017), "The rhetoric of 'knowledge hoarding': a research-based critique", *Journal of Knowledge Management*, Vol. 21 No. 6, pp. 1540-1558.
- van den Hooff, B., Elving, W., Meeuwssen, J. and Dumoulini, C. (2003), "Knowledge sharing in knowledge communities", in Huysman, M., Wenger, E. and Wulf, V. (Eds), *Communities and Technologies*, Kluwer Academic Publishers, Dordrecht, NL, pp. 119-141.
- van Doorn, G.S. and Taborsky, M. (2012), "The evolution of generalized reciprocity on social interaction networks", *Evolution*, Vol. 66 No. 3, pp. 651-664.
- Vandenbosch, B. and Higgins, D. (1996), "Information acquisition and mental models: an investigation into the relationship between behavior and learning", *Information Systems Research*, Vol. 7 No. 2, pp. 198-214.
- Wasko, M.M. and Faraj, S. (2000), "It is what one does': why people participate and help others in electronic communities of practice", *Journal of Strategic Information Systems*, Vol. 9 No. 2, pp. 155-173.
- Wasko, M.M. and Faraj, S. (2005), "Why should I share? Examining social capital and knowledge contribution in electronic networks of practice", *MIS Quarterly*, Vol. 29 No. 1, pp. 35-37.
- Yates, D., Wagner, C. and Majchrzak, A. (2010), "Factors affecting shapers of organizational wikis", *Journal of the Association for Information Science and Technology*, Vol. 61 No. 3, pp. 543-554.
- Yuan, Y.C., Fulk, J., Shumate, M., Monge, P.R., Bryant, J.A. and Matsaganis, M. (2005), "Individual participation in organizational information commons: the impact of team level social influence and technology-specific competence", *Human Communication Research*, Vol. 31 No. 2, pp. 1-29.
- Yuan, Y.C., Rickard, L.N., Xia, L. and Scherer, C. (2011), "The interplay between interpersonal and electronic resources in knowledge seeking among co-located and distributed employees", *Journal of the Association for Information Science and Technology*, Vol. 62 No. 3, pp. 535-549.
- Zhang, X. and Wang, C. (2012), "Network positions and contributions to online public goods: the case of Chinese wikipedia", *Journal of Management Information Systems*, Vol. 29 No. 2, pp. 11-40.

Further reading

- Good, D. and Michel, E.J. (2013), "Individual ambidexterity: exploring and exploiting in dynamic contexts", *The Journal of Psychology*, Vol. 147 No. 5, pp. 435-453.
- Nerkar, A. (2003), "Old is gold? The value of temporal exploration in the creation of new knowledge", *Management Science*, Vol. 49 No. 2, pp. 211-229.

About the authors

Ronald E. Rice (PhD, Stanford University) is Arthur N. Rupe Chair in the Social Effects of Mass Communication in the Department of Communication, University of California, Santa Barbara. He has published 13 books and over 125 refereed journal articles and 70 book chapters in areas such as environmental communication, public communication campaigns, methodology, organizational and management theory, information science and bibliometrics, social uses and effects of new media and information systems and social networks. Ronald E. Rice is the corresponding author and can be contacted at: rrice@comm.ucsb.edu

Marni Heinz (MA, University of California, Santa Barbara) is a Senior Account Executive at Salesforce.com. She currently advises large enterprise companies on the potential use of

online knowledge management portals as a channel to support call centers. She has over 18 years of experience working in the high tech industry, covering a range of different clients, from Google to the US Department of Defense. She has been published in *Communication Yearbook*.

Ward van Zoonen (PhD, University of Amsterdam) is an Assistant Professor of Corporate Communication at the Amsterdam School of Communication Research (ASCoR), University of Amsterdam. His research interests include the relationship between information and communication technology use and work outcomes. His work explores how technological innovations shape the future workplace.

For instructions on how to order reprints of this article, please visit our website:
www.emeraldgroupublishing.com/licensing/reprints.htm
Or contact us for further details: permissions@emeraldinsight.com