EXPLORING CONTRIBUTIONS OF PUBLIC RESOURCES IN SOCIAL BOOKMARKING SYSTEMS

Reina Arakji
Department of Statistics and Computer Information Systems
Baruch College, City University of New York
55 Lexington Ave., Box B11-220, New York, NY 10010
Phone: (646)-312-3420; Fax: (646)-312-3351
reina_arakji@baruch.cuny.edu

Raquel Benbunan-Fich (Contact Author)
Department of Statistics and Computer Information Systems
Baruch College, City University of New York
55 Lexington Ave., Box B11-220, New York, NY 10010
Phone: (646)-312-3375; Fax: (646)-312-3351
rbfich@baruch.cuny.edu

Marios Koufaris
Department of Statistics and Computer Information Systems
Baruch College, City University of New York
55 Lexington Ave., Box B11-220, New York, NY 10010
Phone: (646)-312-3373; Fax: (646)-312-3351
marios_koufaris@baruch.cuny.edu

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Abstract

Our study examines whether users' contributions of public resources to social bookmarking sites are circumstantial (a side effect of bookmarking for oneself), or motivational (intentional bookmarking for others). We develop a research model based on these two explanations and test it using survey data from users of two bookmarking sites. Our results suggest that public contributions are mainly driven by intentional bookmarking of resources for other users. In addition, we found that users deliberately bookmark resources for others when they believe that their bookmarks are valuable to other users and when they perceive that other users are contributing as well.

Keywords

Social bookmarking, online public repositories, public goods, information sharing, tagging, social networks, social computing, Web 2.0.

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INTRODUCTION

The first decade of the twenty-first century has witnessed the emergence of Web 2.0 [35], a form of social computing which engages consumers at the grassroots level in systems that necessitate creative, collaborative or information sharing tasks. Web 2.0 encompasses social bookmarking (or folksonomies), blogging, wikis and online social networking among others. The popularity of social computing systems is raising numerous research questions including how such systems are formed, what are the motivations behind user participation and whether they are stable in the long-run [38]. We concentrate in this study on exploring user contribution in the context of social bookmarking systems.

Typical social bookmarking systems, such as Del.icio.us, Furl, Spurl, Simpy and Ma.gnolia, allow individual users to catalogue and index various webpage URLs using individually selected keywords known as tags. The bookmark collection is stored online for easy access from any computer and the tags make the collection searchable based on the users' classification efforts. While the bookmarks are publicly available to all users by default, many bookmarking systems give users the option to keep some or all of the resources private. The aggregation of publicly available bookmarked resources generates a social network effect. By allowing users to search the common pool of public bookmarks, positive externalities and public value are created [32, 15]. However, the ad-hoc and uncontrolled nature of this grassroots bookmarking process of online resources can pose significant sustainability challenges for social bookmarking systems [17].

Recent empirical evidence suggests that users participate and contribute to various types of online communities ranging from posting opinions for discussion groups [38], helping with software [26], posting ratings for collaborative recommendations [36], sharing digital files on peer-to-peer networks [51] and developing code for open source software projects [21, 47], despite the opportunity to free-ride on others' contributions. These are key findings, as all of these systems require public contributions from their members for their sustainability [4].

In social bookmarking systems, contribution to the public pool of bookmarks is either circumstantial or motivational. Circumstantial contribution takes place when a user bookmarks resources for his/her personal use but unintentionally makes these bookmarks public. If bookmarks are public by default, whenever users are unaware of the private bookmarking option or are unwilling to take the extra step of designating bookmarks as private, personal bookmarking automatically feeds into the public pool. Circumstantial public contribution is therefore a by-product of bookmarking for one's own benefit. Motivational contribution on the other hand occurs whenever a user intentionally bookmarks resources that are of no interest to him for the benefit of the bookmarking community.

In this study, we aim to understand the nature of user contributions in social bookmarking systems. We develop a research model combining the circumstantial and motivational approaches to user participation and report the results of a field study where we surveyed actual users of two popular bookmarking sites. In addition to its relevance to practitioners, our research adds to the literature on online communities by highlighting the difference in contribution mechanism between the users of social bookmarking systems and those of other online communities.

In the next section, we review the literature and develop the hypotheses and the research model with the variables of interest. We follow that with the description of the research methodology. Then, we present the data analysis and a discussion of our results. We conclude with the implications, contributions and future research directions.

BENEFITS AND CHALLENGES OF SOCIAL BOOKMARKING SYSTEMS

Bookmarking systems allow users to describe and organize content using individually selected keywords known as tags. The tags are considered metadata or data used to describe other data [49]. Tags are used by online repositories to collocate related information resources according to user categorizations [31]. Unlike formal taxonomies and classification schemes created by professionals, each tag is independent and in and of itself informative of the content of the resource it tags [15]. To distinguish this personal classification effort from more traditional taxonomies created by professionals, some authors use the term "folksonomy," a combination of "folk" and "taxonomy" [31, 57]. Bookmarking and tagging online resources is more similar to the natural human process of categorization because it allows the free association of tags and resources without the restriction of formal structures [22]. Therefore, this user-driven classification process takes much less time and effort than traditional hierarchical methods [45] or newer methods for generating Web taxonomies [8].

At the individual level, user-assigned tags can be highly useful for personal recall [45]. In a situation of information abundance, such as the web, assuring one's ability to find an important resource in the future is a clear benefit which far outweighs the low cost in terms of time and effort associated with bookmarking. For people using different computers and/or for those whose amount of saved bookmarks is large, the typical mechanism for storing bookmarks locally using their web browser has limitations. In contrast, online bookmarking systems enable

them to access their bookmarks from any computer connected online. In addition, the ability to tag those bookmarks with user defined tags allows easier retrieval by searching the tags instead of manually inspecting all bookmarks.

From a user's perspective, searching with tags is functionally equivalent to performing typical keyword searches in a search engine, with the only difference being that the tags are assigned by the users themselves [15]. Bookmarking systems also provide unique benefits over traditional search engines. For example, tags can be thought of as indicators of user awareness of – and potential interest in – a given resource. The result can be *allocation of attention*, which allows individuals to capitalize on the associations made by others who have assigned a similar tag to other resources [32]. This serendipity (or the pleasant discovery of the unexpected) effect, when users find collocated resources sharing the same tag, is a significant collective benefit of a bookmarking community [45].

For example, a group of diverse users may be independently bookmarking online resources on linguistics using the tags "linguistics," "language," and so on. As they search the collective pool of resources using those tags, not only can they discover new resources that other users may have bookmarked, they can also discover the other users themselves and in that way form a group of members interested in the topic of linguistics. In a shared bookmarking system, the very act of finding resources classified by other users with a specific tag may yield more valuable information than a hit provided by a traditional search engine because of the unique human ability to make associations between the content and the tag. While search engine agents can work much faster than humans, they are unable to detect semantic differences or other nuances in the information resources that they index. For example, humans can easily identify and tag photographs, a task that is virtually impossible for software agents.

According to the theory of critical mass, a community or social network is sustainable only when it reaches a critical mass of members or resources [4, 29]. This is also true for bookmarking sites, where if only few individuals bookmark resources for others, it may not be sufficient for making enough resources available to the community. The theory of critical mass further suggests that a community will be favored by heterogeneity of interests [29]. In other words, the joint action of individual users with varied backgrounds, resources and interests will bring to the attention of the community more online sources than a homogeneous group of participants bookmarking the same sources. Like other "public virtual spaces" [24], bookmarking systems allow a potentially wide range of individuals to participate and contribute thereby increasing the heterogeneity of users and the variety of resources made available to the community. Since bookmarking systems are free to join and use, and the marginal cost in time and effort of contributing an additional public bookmark is relatively low, it would seem that achieving critical mass of users and resources to ensure their success is easy. However, the challenge of attracting and maintaining a large enough user population that is actively contributing to the site's pool of public bookmarked resources remains significant.

RESEARCH MODEL AND HYPOTHESES

Contributing to the public pool of bookmarked resources can create a *social dilemma* or a *public good problem*. According to economic theory [48], public goods are defined by two key characteristics: (1) non-rivalry, whereby individual consumption does not limit the availability of the good to everyone else [43] and (2) non-excludability, whereby people cannot be prevented from enjoying the good even if they have not contributed to its production [29, 42, 13]. Since those who do not share in the production of a public good cannot be prevented from consuming it, the theory of rational choice short-term maximization behavior predicts that users will tend to

free-ride [34]. Social bookmarking communities rely on privately produced bookmarks for public consumption. Due to their infinite nature, the simultaneous consumption of public bookmarks by a large number of individuals does not reduce the amount available to anyone else. Furthermore, unless designated as private, public bookmarks are non-excludable and hence available to all users of the system, regardless of their individual level of contribution. Social bookmarking systems may therefore fall prey to free riding behavior, which leads to under production of bookmarked resources, hence preventing the systems from reaching the critical mass of users and resources that would ensure their survival. A wealth of empirical research and public good experiments however prove that even though free-riding behavior is inevitable, contribution to the production of a public good is higher than theoretically predicted [37].

Our exploration of the nature of contribution to a public good in the context of social bookmarking systems is based on the private-collective model [52] of information sharing, which combines elements of both the private investment and the collective action models. The private-collective model of information sharing posits that contribution to a public repository of information retains a significant private component. Shared information therefore constitutes an *impure public good*, or a *hybrid good*. The main tenets of the private-collective model are that (1) sharing information does not necessarily lead to a loss of private benefit to the sharer, and/or (2) when contributing to the pool of public information, sharers obtain benefits that are not available to free-riders. In the context of social bookmarking, the absence of loss of private benefits stimulates circumstantial contribution, while social rewards not available to free-riders encourage motivational contribution. Our research model (Figure 1) combines both circumstantial and motivational contributions to the pool of public bookmarks and we use

empirical data to test which path is supported. We also test the social rewards that may accrue to motivational contributors.

The first path leading to a sustainable social bookmarking system indicates that individual contributions to the public pool of bookmarked resources are not intentional, but rather circumstantial and the byproducts of bookmarking for personal use. As Kollock [25] explains "while it may be the case that many people spend time and effort producing goods they intend to contribute to the group, another path to the production of public goods is as a simple side-effect of private behavior." In most bookmarking systems, since the default is to bookmark resources publicly, bookmarking for personal use unintentionally feeds into the pool of public bookmarks. This spillover is automatic, unless the user chooses to restrict accessibility to his/her personal bookmarks. Since keeping bookmarks public generally does not decrease the private benefit that users derives from them, the users do not have the incentive to make the bookmarks private except when they point to information that is valuable only if it is not widely disseminated. Furthermore, since public bookmarks are only associated with the username of their contributors and not their real name, there is diminished risk of loss of privacy, even when the bookmarks are of a controversial nature. Consequently, we expect that higher levels of production of bookmarked resources for personal use would produce a spillover effect where participants contribute at least some of these bookmarks and their tags to the common pool. Therefore, we hypothesize that:

H1: Bookmarking for self is positively related to the individual level of public contribution.

The second path leading to a sustainable social bookmarking system suggests that users intentionally contribute for others by creating public bookmarks that they have no interest in.

This is for example the case of bookmarking a website that a user already knows by heart and does not need to enter into the system for future personal recall. It would seem at first glance that users are contributing to the common pool of bookmarks without any benefits to themselves, and maybe even incurring costs by devoting additional time for bookmarking solely for others. However, motivational contributors derive social benefits that are not available to free-riders. These social benefits include positive feelings of solidarity, fairness and altruism [53]. Thus, we hypothesize:

H2: Bookmarking for others is positively related to the individual level of public contribution

In order to understand the positive feelings that drive motivational contribution of public bookmarks, we resort to social exchange theory and assume that people treat information sharing like other exchanges that are influenced by their social context [3, 9]. Social exchanges of information are similar to economic exchanges because there is an expectation of some future return for sharing. However, unlike economic exchanges, there is no clear understanding of the exact nature of future returns which are expected to materialize when other people share their own information [9, 23].

According to social exchange theory, individuals have a sense of obligation and believe that they should reciprocate the contribution offered by others [25]. For the most part, social exchange theory predicates a direct model in which A helps B and in return B helps A [55]. In online bookmarking communities, however, this kind of reciprocity follows a 'generalized' pattern [11]. In other words, reciprocity may come from others and not necessarily from the original beneficiaries of the information. Reciprocity mechanisms can also be activated when

individuals personally benefit from the use of public information, and thus decide to contribute to the common repository because of a duty to reciprocate [25]. Therefore, we expect that in a bookmarking community, users who feel that they have benefited from using some other users' input may elect to bookmark resources for the benefit of all others.

H3: Perceived use of bookmarks contributed by others is positively related to bookmarking for others

Since in bookmarking communities reciprocity is generalized rather than personalized, it is also possible that individual contributions to the public pool are motivated by a sense of fairness to the community of users. Constant et al.'s [9] extension of social exchange theory suggests that the context regulates information exchange by causing people to consider the long-term impact of their actions. This concern for the future leads people to rise above their own self-interests and exhibit pro-social behaviors aimed at maintaining the well-being of the community [23]. In this view, the decision to share information with others arises from a sense of public duty and concern for the community [25, 55]. This kind of contextual influence in technology use has also been documented in other types of computer-mediated settings [50]. Some users may also be *conditional cooperators*, contributing public bookmarks only when they perceive that others are contributing public bookmarks as well [37]. Therefore, we believe that in bookmarking systems, individuals may contribute to the supply of public goods because they perceive that other users are doing the same.

H4: Perceived contribution of bookmarks by others is positively related to bookmarking for others

In addition to contextual influences, a user's decision to contribute to the supply of public goods may arise out of pure altruism, in which people contribute to the public good out of a sense of unselfishness [25]. People may also contribute for impure altruistic motives, because the act of giving when bookmarking resources for others provides a "warm glow" feeling of being a good person [1], or because contributing for others makes the contributor "look good" by providing a positive reputation effect [28, 56]. In addition, a person who is an expert in a given field and believes s/he is the only source of the information may be more willing to share it [41]. Therefore, we hypothesize:

H5: Perceived value of own bookmarks for others is positively related to bookmarking for others

The complete research model can be seen in Figure 1.

<---------- Insert Figure 1 here ---------->

METHODOLOGY

In order to test our model, we conducted a survey-based field study of existing users of two popular bookmarking websites. The two sites allow users to bookmark web pages and tag them with keywords of their choice. The default option for tagged bookmarks is that they are public but users also have the option of making these bookmarks private. The two sites are similar in terms of focus (they are both general) as well as reach (based on their Alexa statistics). We selected two sites that are of similar focus and reach in order to have a more cohesive sample. We contacted the owners of the two websites and asked for their permission and help in recruiting users from their sites to take our survey. The sites advertised the online survey through emailed newsletters to the users and a link on either the home page of the site itself or the site

owner's blog. The survey was tailored for each site so that the questions referred to the site by name. No incentives were offered to the respondents for completing the survey.

The survey consisted of scales adapted from prior literature as well as some new scales developed specifically for this research. We measured perceived value of bookmarks with the perceived relevance scale adapted from [27]. We created new scales measuring the extent to which users created bookmarks for themselves or created bookmarks specifically for others, and new scales measuring their perceptions of whether other users contributed to the system and their own use of others' bookmarks. All were seven-point Likert scales. Before the study was run, we refined the new scales using a traditional sorting exercise with the assistance of judges [33]. We also measured each user's contribution of public bookmarks by asking them to tell us the percentage of bookmarks that they kept publicly available on a scale from 0% to 100% in 10% increments. Finally, we collected various demographics and asked users to tell us how long they had been members of the specific bookmarking system and how often they used it. All the scale items can be seen in Table 2.

RESULTS

The survey was available online through a commercial web hosting service and from the 381 users who accepted the invitation to complete the survey, we obtained a sample of 94 complete and usable responses (25% response rate). There were 66 responses from users of bookmarking system A and 28 from users from bookmarking system B. We ran an ANOVA on all demographic variables (age, gender, education, and income) as well as system membership length, frequency of system use, and percentage of bookmarks made public between the users of the two systems that completed the survey. Since none of them were significantly different, we were able to use the entire sample of 94 in testing our model.

As seen in Table 1 our sample is almost 77% male, with just over 69% in the age range of 26-45, over 88% having at least some college education, and an evenly distributed income. These characteristics are consistent with the demographics of people who engage in bookmarking reported by the Pew Internet and American Life Project [40]. Regarding frequency of usage, over 76% of the respondents to our survey had been users of the bookmarking systems for over a month, over 62% of them use the system at least once a day, and over 78% of respondents reported that at least 80% of their bookmarks were kept public.

<---------- Insert Table 1 here ---------->

We used Partial Least Squares (PLS) with *PLS-Graph v. 3.0* with the bootstrapping resampling procedure to test our model [5]. PLS requires a sample size of at least 10 times the largest number of formative indicators or structural paths directed at a construct in the path model [6]. In our case, the highest number of structural paths directed at a construct is three, which are pointing to bookmarking for others. Therefore, the minimum sample size is 30 (3*10), well below our sample size of 94.

We performed a confirmatory factor analysis according to the procedure outlined in [7, 18]. Using *PLS-Graph v. 3.0,* we tested the model with no relationships specified between the constructs. Using the resulting item-construct loadings, we computed single factor scores for all the constructs. Table 2 shows a correlation analysis between the single factor score constructs and all the original scale items. Since all constructs correlate highest with their reflective indicators, we were able to confirm convergent validity.

<---------- Insert Table 2 here ---------->

To test for discriminant validity, we ran a correlation analysis between the latent constructs, shown in Table 3 along with composite reliability (CR) and the square root of the average variance extracted (AVE) for each construct. CR values are well above the recommended 0.70, indicating good construct reliability. For good discriminant validity, the square root of AVE of a construct should be larger than that construct's correlations with the other constructs [7, 18]. This is true for all correlations in Table 3. Finally, the composite reliability values for the constructs, shown in the leftmost column of Table 3, are all above the recommended value of 0.70, suggesting good internal consistency for all of them [12].

Finally, we tested whether our data suffered from common method variance using Harmon's single factor test [20]. We ran a principal components analysis on all the scale items. No single factor accounted for the majority of variance, indicating that common method variance was not significant in our data.

<---------- Insert Table 3 here ---------->

We then tested the full structural model with *PLS-Graph v. 3.0.* The results of the model analysis are presented in Figure 2. The coefficient between creating bookmarks for self and public bookmark contributions was not significant, providing no support for the circumstantial contribution hypothesis (H1). In contrast, the coefficient between bookmarking for others and public bookmarks contribution is significant with a value of 0.283 ($p<0.01$). This indicates that motivational contribution (H2) is supported. The coefficient between use of others' bookmarks and creating bookmarks for others was not significant indicating that the reciprocity hypothesis (H3) was not supported. However, the coefficient between perceived contribution by others and creating bookmarks for others was significant with a value of 0.161 ($p<.05$). This provides support for the contextual influence hypothesis (H4). Also, the coefficient between value of own

bookmarks to others and creating bookmarks for others was significant and very large, with a value of 0.593 ($p<0.001$). This strongly supports H5. A summary of the hypotheses and findings is provided in Table 4.

<---------- Insert Figure 2 and Table 4 here ---------->

DISCUSSION

In our study, we have investigated the mechanisms explaining users' contributions to the public pool of resources in bookmarking systems. Specifically, we have proposed a private-collective model with two explanations for why users contribute bookmarks for public use. The first explanation is circumstantial contribution of public bookmarks where contribution is not intentional but is the byproduct of bookmarking resources for personal use. The second explanation is motivational contribution where adding to the common pool of bookmarks is the product of deliberate and voluntary bookmarking of resources specifically intended for other users. We conducted a survey of actual users of two popular bookmarking systems and found that only the second explanation was supported.

In other words, when comparing spillover of private bookmarking with intentional bookmarking for others as the source of public contributions, we found that only the latter is significant. Although circumstantial contributions are insignificant, we can not conclude that users of social bookmarking sites are not contributing resources for themselves, as this is the primary purpose of bookmarking sites (i.e. to allow people to store and classify their own bookmarks). It is possible that a large number of users are contributing for themselves and keeping their contributions private or contributing them to the public pool but not in large numbers. Our results indicate that public contributions mostly originate from the intentional provision of tagged bookmarks for other users.

We also found that bookmarking resources specifically for other users was not driven by generalized reciprocity, but is determined by two other factors. The first one is the contextual influence of the site: the more a conditional cooperator perceives that others contribute public bookmarks to the community, the more likely he is to bookmark resources specifically for other users. The second factor is a user's belief that he has resources that are valuable to others. Consequently, users evaluate their potential contributions for others before they make them publicly available. The nature of the content (or topic of the tagged resource) is likely to play an important role in the assessment of whether that resource is valuable for others. Accordingly, a web resource deemed potentially important or helpful for others is more likely to be contributed to the public pool than another resource whose significance or value is more personal.

The combination of these two factors for bookmarking for others (contextual influence and value of resources) has important implications for the sustainability of social bookmarking sites. If contribution to the public pool of bookmarks was due solely to conditional cooperation, the social aspect of bookmarking systems may not survive in the long run. In fact whenever conditional cooperators are disappointed by what others contribute, they start reducing their own involvement, which in turn discourages other conditional cooperators. This creates a downward cascade [37] which may lead to the eventual demise of social bookmarking. In that respect, the presence of individuals who contribute to the public pool of bookmarks because they believe that they have something valuable to share, regardless of the level of contribution of others, encourages conditional cooperators to continue adding to the pool of public bookmarks, hence promoting the sustainability of social bookmarking systems.

Implications for Theory and Research

Based on the theoretical approach of private-collective sharing of information, we tested two explanations of user contribution in the context of social bookmarking systems. Our results suggest that the level of contribution of bookmarked resources for others does not appear to be simply a side-effect of the creation of personal bookmarks, but a significant predictor is actually the intentional and voluntary bookmarking of resources specifically for other users.

Unlike other types of online communities, such as communities of practice, where generalized reciprocity has been shown to be a dominant force for user contribution [55], we found that bookmarking system users deliberately weighed the importance of their contribution, and only when that importance was significant did they intentionally bookmark resources for others. In addition, we found that contextual influence was a significant predictor of contributing bookmarks for others. In other words, users may have also bookmarked resources for other users simply because they believed that other users were doing the same (regardless of whether they benefited from the other users' contributions or not).

More research is needed to investigate why users create public bookmarked resources for other users when they believe their bookmarks are valuable to those users. The significance of the contextual influence in the model may signal the existence of a shared social norm that states that a user must contribute to the pool of public resources if others are doing the same. This would mean that users are using a different type of mechanism which is not necessarily based on their use of resources contributed by others. Other possible reasons include goodwill and pure altruism, the warm glow effect of personal emotional satisfaction when doing something good [1], the desire to signal one's wealth of knowledge in a specific subject [14] or to enhance one's reputation [28, 56].

Our theoretical model and results also highlight the difference in the nature and contribution mechanisms of online social networks. We can in fact now separate social computing systems into two broad categories. The first category of social computing systems includes systems that do not incorporate the circumstantial component and rely only on the motivational component for contribution to the shared pool of resources. Examples of systems belonging to this category are peer-to-peer networks, online recommendation or help and assistance systems. Since in no instances do users directly gain from sharing digital files [16] and posting helpful tips or comments, and since the marginal cost in bandwidth of sharing digital files and in time and effort of writing helpful passages may be significant, such systems have a critical free-rider problem. It is therefore important for this first category of systems to devise a structure that directly rewards contributors, especially if the marginal cost of contribution is high. This is already becoming evident for example in the second generation of peer-to-peer music and video sharing systems where users who contribute the most get the fastest download rate.

The second category of social computing systems encompasses structures that include both the circumstantial and motivational components of contribution to a public repository of information. Developing code for open source projects [21, 47], social bookmarking and wikis [43] belong to this second category. Circumstantial contribution is present whenever a software developer writes code for use personally or at his/her organization, or a researcher studies a particular topic, but chooses to make the code or the results of the study freely available to the public. Motivational contribution in contrast takes place when a software developer volunteers for the writing and debugging of open source software that he has no direct use for or when a person edits public wiki entries to supplement the text or correct any errors.

A possible difference, however, between open source software and wikis on one hand and social bookmarking on the other, is the fact that bookmarking existing resources such as URLs is a much lower marginal cost activity than providing original code or research in open-source or wiki communities. Another possible difference is that the marginal benefits of writing open source code and editing entries on wiki sites are higher than those of contributing a tagged public bookmark. In fact, open source developers and wiki editors select the modules or topics that interest them the most when publicly contributing [2], even if the marginal cost of that contribution is high. Their sense of enjoyment and learning and potential reputation effects while contributing to the public repository of information may therefore be higher than those obtained when bookmarking URLs. Only additional research can show whether the magnitude of marginal costs and benefits of contribution to others affects the underlying motives of contributors. Social bookmarking systems further stand out from open source software development and wikis in that they may exist solely as private tools for storing and organizing personal resources, with bookmarks constituting a private good, without any communal or social benefits. Contributing to the public pool of bookmarked resources is therefore entirely optional both for the users and for the continued existence of the bookmarking system. Social bookmarking systems also differ from open source in that contributors are anonymous and do not share the strong ties prevalent in the open source community. In fact, users of social bookmarking interact with the system only, rather than interacting with other users *through* the system [39]. Social bookmarking systems are therefore *im*personal repositories of information and do not rely on *inter*personal interaction, communication and coordination that normally facilitate contribution to open-source projects [30]

Our findings also have important implications for understanding knowledge creation and sharing in networked environments. While much research has focused on rational utility-based models to explain the creation, sustainability, and growth of knowledge sharing networks, our results indicate that there may be a need for a deeper understanding of the psychological drivers of information sharing. Users may contribute to the information pool simply because they believe that it is what everyone else is doing (i.e. acting out of a sense of fairness or compliance with social norms). It is also possible that individuals who possess valuable information/content are more likely to share it in order to help others. In this case, further research should examine why people exhibit pro-social behaviors in impersonal repositories such as bookmarking systems where social cues are absent. Future research can also test whether these motivations also apply to knowledge sharing networks within an organizational context.

Implications for practice

For administrators and owners of bookmarking sites, our study is also valuable. Our findings suggest that allowing users to create private bookmarked resources does not lead to the collapse of the social bookmarking network, as users would still contribute to the public pool of tags. We also recommend enabling users to organize themselves in public (open) groups around specific tags or topics by equipping the system with communication functionality. This would increase trust between group members and foster the development of social norms that encourage public contribution [36] and would also guide users to contribute bookmarks that are more valuable to their group members. In fact, allowing communication between users (through posting feedback for example), is a main factor that enables members of an online community group to understand the needs of other members and hence incites them to contribute to the public pool of resources [25].

In addition, it may be important to both encourage users to contribute bookmarked resources *and* make the system transparent enough for a user to be able to see the level of other users' contributions. According to our results, in such a system, as users perceive the level of contributions of others, they may be more inclined to contribute to the public pool of resources.

Limitations

Our findings must be interpreted in light of the study's limitations. First, our respondents were recruited from two popular bookmarking websites and the results may not be generalizable to other contexts lacking the private option for bookmarking or any other types of social networks. Second, since the data comes from a cross-sectional survey, as opposed to a longitudinal study, the causal relations posited in the model and substantiated with our statistical analyses can only be inferred based on our theoretical analysis. Third, the size of our sample, while theoretically appropriate for analyzing our model with PLS, may have prevented us from detecting other significant relationships. Fourth, it is possible that due to its voluntary nature, our survey attracted mostly users who intentionally contribute bookmarks for others, while other self-interested users were not well represented in the pool of respondents. Notwithstanding these limitations, the main strength of our study is that by gathering data from real users of actual bookmarking sites, we are able to investigate the mechanisms of contribution for others.

CONCLUSION

Bookmarking systems are one of many different types of social computing applications that exist in an online networked environment. While there has been a lot of excitement about them in the mainstream press, little academic research has been devoted to explain how they work and grow. Our study showed that even when allowed the option to bookmark privately, users of bookmarking systems still contribute public resources to these systems ensuring their

sustainability and growth. Our results indicate that users are indeed valuable members of the community who contribute relevant resources for public use. These are very encouraging signs for the growth of not only bookmarking systems, but other online social networks as well, such as wikis and community blogs. We hope that future research will continue to enhance our understanding of the ways that networked environments and online social communities successfully interact.

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REFERENCES

[1] J. Andreoni, Giving with Impure Altruism: Applications to Charity and Ricardian Equivalence, *Journal of Political Economy* 97(6) (1989) 1447-1458.

[2] Y. Benkler, *The Wealth of Networks: How Social Production Transforms Markets and Freedom*, Yale University Press, New Haven, CT 2006.

[3] P.M. Blau, *Exchange and Power in Social Life*, Wiley, New York, NY 1964.

[4] B.S. Butler, Membership size, communication activity and sustainability: A resource-based model of online social structures, *Information Systems Research* 12(4) (2001) 346-362.

[5] W.W. Chin, The partial least squares approach for structural equation modeling, in: George A. Marcoulides (Ed.), *Modern Methods for Business Research*, Lawrence Erlbaum Associates, Mahwah, NJ, 1998.

[6] W. W. Chin, Frequently Asked Questions – Partial Least Squares & PLS-Graph, 2000, http://disc-nt.cba.uh.edu/chin/plsfaq.htm

[7] P. Chwelos, I. Benbasat, A. S. Dexter, Research Report: Empirical test of an EDI adoption model, *Information Systems Research* 12(3) (2001) 304-321.

[8] S.-L. Chuang, L-F. Chien, Enriching Web taxonomies through subject categorization of query terms from search engine logs, *Decision Support Systems* 35(1) (2003) 113-127.

[9] D. Constant, S. Keisler, L. Sproull, What's mine is ours, or is it? A study of attitudes about information sharing, *Information Systems Research* 5(4) (1994) 400-421.

[10] D. Constant, S. Keisler, L. Sproull, The kindness of strangers: The usefulness of electronic weak ties for technical advice, *Organization Science* 7(2) (1996) 119-135.

[11] P.P. Ekeh, *Social Exchange Theory: The Two Traditions*, Harvard University Press, Cambridge, MA, 1974.

[12] C. Fornell, D.F. Larcker, Evaluating Structural Equation Models with Unobservable Variables and Measurement Error, *Journal of Marketing Research* 18 (1) (1981) 39-50.

[13] J. Fulk, A. Flanagin, M.E. Kalman, P.R. Monge, and T. Ryan, Connective and communal public goods in interactive communication systems. *Communication Theory* 6 (1996) 60-87.

[14] A. Glazer, K.A. Konrad, A Signaling Explanation for Charity. *American Economic Review* 86(4) (1996) 1,019-28.

[15] S.A. Golder, B.A. Huberman, Usage patterns of collaborative tagging systems, *Journal of Information Science* 32(2) (2006) 198–208.

[16] P. Golle, K. Leyton-Brown, I. Mironov, and M. Lillibridge, Incentives for Sharing in Peer-to-Peer Networks, *Microsoft Research* November (2001).

[17] H. Green, R.D. Hof, Picking up where search leaves off, *BusinessWeekOnline* April 11 (2005) http://www.businessweek.com/magazine/content/05_15/b3928112_mz063.htm

[18] W. Hampton-Sosa, M. Koufaris, The Effect of Website Perceptions on Initial Trust in the Owner Company, *International Journal of Electronic Commerce* 10(1) (2005) 55-87.

[19] D. Harhoff, J. Henkel, and E. von Hippel, Profiting from voluntary spillovers: How users benefit from freely revealing their innovations, *Research Policy* 32 (10) (2003) 1753-1769.

[20] H.H. Harmon, *Modern factor analysis*, (2nd ed.), University of Chicago Press, Chicago, IL, 1967.

[21] A. Hars, S. Ou, Working for free? Motivations for participating in open-source projects, *International Journal of Electronic Commerce* 6(3) (2002) 25-39.
[22] E.K. Jacob, Classification and categorization: A difference that makes a difference, *Library Trends* 52(3) (2004) 515-540.
[23] S.L. Jarvenpaa, D.S. Staples, The use of collaborative electronic media for information sharing: an exploratory study of determinants, *Journal of Strategic Information Systems* 9(2-3) (2000) 129-154.
[24] Q. Jones, G. Ravid, S. Rafaeli, Information Overload and the Message Dynamics of Online Interaction Spaces, *Information Systems Research* 15(2) (2004) 194–210.
[25] P. Kollock, The economies of online cooperation: gifts and public goods in cyberspace, in: Smith, M.A., Kollock, P. (Eds.), *Communities in Cyberspace*, Routledge, London, UK, 1999.
[26] K.R. Lakhani, E. von Hippel, How open source software works: "free" user to user assistance, *Research Policy* 32 (6) (2003) 923-943.
[27] Y.W. Lee, D.M. Strong, B.K. Kahn, and R.Y. Wang, AIMQ: A Methodology for Information Quality Assessment, *Information & Management* 40(2) (2002) 133-146
[28] J. Lerner, J. Tirole, Some Simple Economics of Open Source, *Journal of Industrial Economics* 52 (2002) 197-234
[29] L. Markus, Towards a critical mass theory of interactive media: Universal access, interdependence and diffusion, *Communication Research* 14 (1987) 491-511.
[30] G. Marwell, P.E. Oliver, and R. Prahl, Social networks and collective action: A theory of the critical mass. III, *The American Journal of Sociology* 94(3) November (1988) 502-534.
[31] A. Mathes, Folksonomies – cooperative classification and communication through shared metadata, 2004. http://www.adammathes.com/academic/computer-mediated-communication/folksonomies.html
[32] U. Mejias, Tag Literacy, http://ideant.typepad.com/ideant/2005/04/tag_literacy.html
[33] G.C. Moore, I. Benbasat, Development of an Instrument to Measure the Perceptions of Adopting and Information Technology Innovation, *Information Systems Research* 2(3) (1991) 192-222.
[34] M. Olson, *The Logic of Collective Action*, Harvard University Press, Cambridge, MA, 1965.
[35] T. O'Reilly, What is Web 2.0: Design patterns and business models for the next generation of software. *O'Reilly*, September 30, 2005. http://www.oreillynet.com/pub/a/oreilly/tim/news/2005/09/30/what-is-web-20.html.
[36] E. Ostrom, A behavioral approach to the rational choice theory of collective action, *American Political Science Review* 92(1) March (1998) 1-22.
[37] E. Ostrom, Collective action and the evolution of social norms, *Journal of Economic Perspectives* 14(3) Summer (2000) 137-158.
[38] M. Parameswaran, A.B. Whinston, Research issues in social computing, *Journal of the Association for Information Systems* 8(6) (2007) 336-350.
[39] N.B. Peddibhotla, M.R. Subramani, Contributing to public document repositories: A critical mass theory perspective, *Organization Studies* 28(3) (2007) 327-346.
[40] Pew Internet and American Life Project. Tagging Play. *Pew Research Center Publications*, January 31st, 2007. http://pewresearch.org.

[41] D.R. Raban, S. Rafaeli, Investigating ownership and the willingness to share information online, *Computers in Human Behavior* 23 (2007) 2367–2382.
[42] Rafaeli, S., R.J. LaRose. 1993. Electronic Bulletin boards and 'public goods' explanations of collaborative mass media. *Communication Research* **20**(2) 177-197.
[43] Rapoport, A. 1987. Research paradigms and expected utility models for public goods. *Psychological Review* **94** 74-83.
[44] A. Rashid, K. Ling, R. Kraut, and J. Riedl, Motivating participations by displaying the value of contribution, in *CHI 2006*: *Proceedings of the ACM conference on human-factors in Computing systems*. ACM Press, New York, NY, 2006.
[45] P. Riddle, Tags: What are they good for? *Working paper. University of Texas at Austin*, 2005. www.ischool.utexas.edu/~i385q/ archive/riddle_p/riddle-2005-tags.pdf
[46] C.M. Ridings, D. Gefen, Virtual community attraction: Why people hang out online, *Journal of Computer Mediated Communication* 10(1) 2004.
[47] J. Roberts, I.H. Hann, and S. Slaughter, Understanding the motivations, participation and performance of open source software developers: A longitudinal study of the apache projects*, Management Science* 52(7) (2006) 984-999.
[48] Samuelson, P.A. 1954. The pure theory of public expenditure. *Review of Economics and Statistics* **36** 387-390.
[49] A. Sen, Metadata management: past, present and future, *Decision Support Systems* 37 (1) (2004) 151-173
[50] R. Spears, M. Lea, Social influence and the influence of the "social" in computer-mediated communication, in M. Lea (Ed.), *Contexts of Computer-Mediated Communication,* Harvester Wheatsheaf, England,1992, 30–65.
[51] L.J. Strahilevitz, Charismatic code, social norms, and the emergence of cooperation on the file-swapping networks, *Virginia Law Review* 89 May (2002) 505-596.
[52] E. von Hippel, G. von Krogh, Open source software and the "Private-Collective" innovation model: Issues for organization science, *Organization Science* 14(2) March-April (2003), 209-223.
[53] E. von Hippel, G. von Krogh, Free revealing and the private-collective model for innovation incentives, *R&D Management* 36(3) (2006), 295-306.
[54] C. Wagner, A. Majchrzak, Enabling Customer-Centricity Using Wikis and the Wiki Way, *Journal of Management Information Systems* 23(3) Winter (2006/2007), 17-43.
[55] M.M. Wasko, S. Faraj, "It is what one does": Why people participate and help others in electronic communities of practice, *Journal of Strategic Information Systems* 9(2-3) (2000) 155-173.
[56] M.M. Wasko, S. Faraj, Why should I share? Examining social capital and knowledge contribution in electronic networks of practice, *Management Information Systems Quarterly* 29 (1) (2005) 35-57.
[57] D. Weinberger, Everything is miscellaneous: The power of the new digital disorder, Henry Holt and Company, New York, NY, 2007.
[58] Y. Yuan, J. Fulk, M. Shumate, P.R. Monge, J.A. Bryant, and M. Matsaganis, Individual Participation in Organizational Information Commons, *Human Communication Research* 31(2) (2005) 212-240.

Figure 1: Research Model

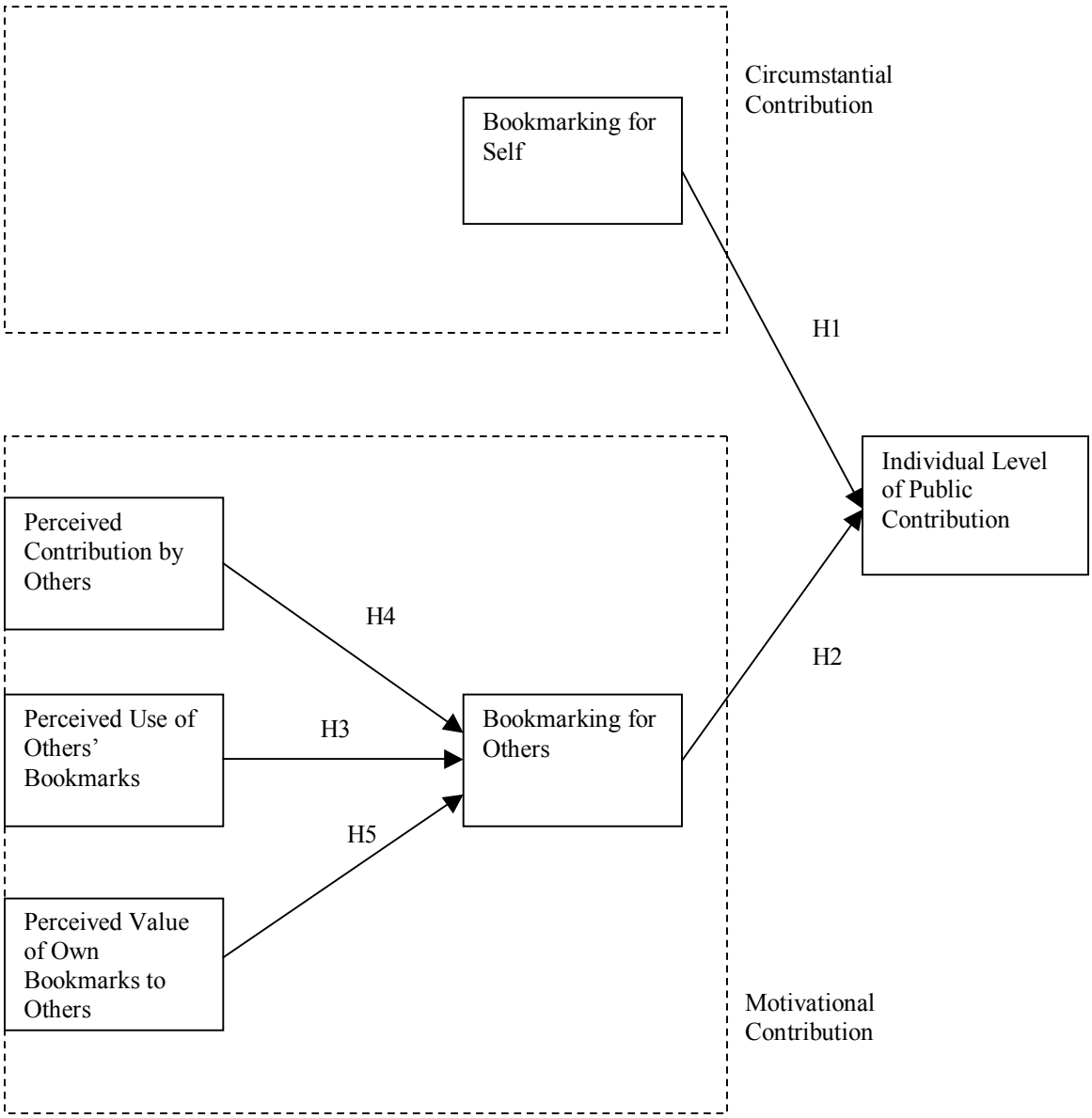
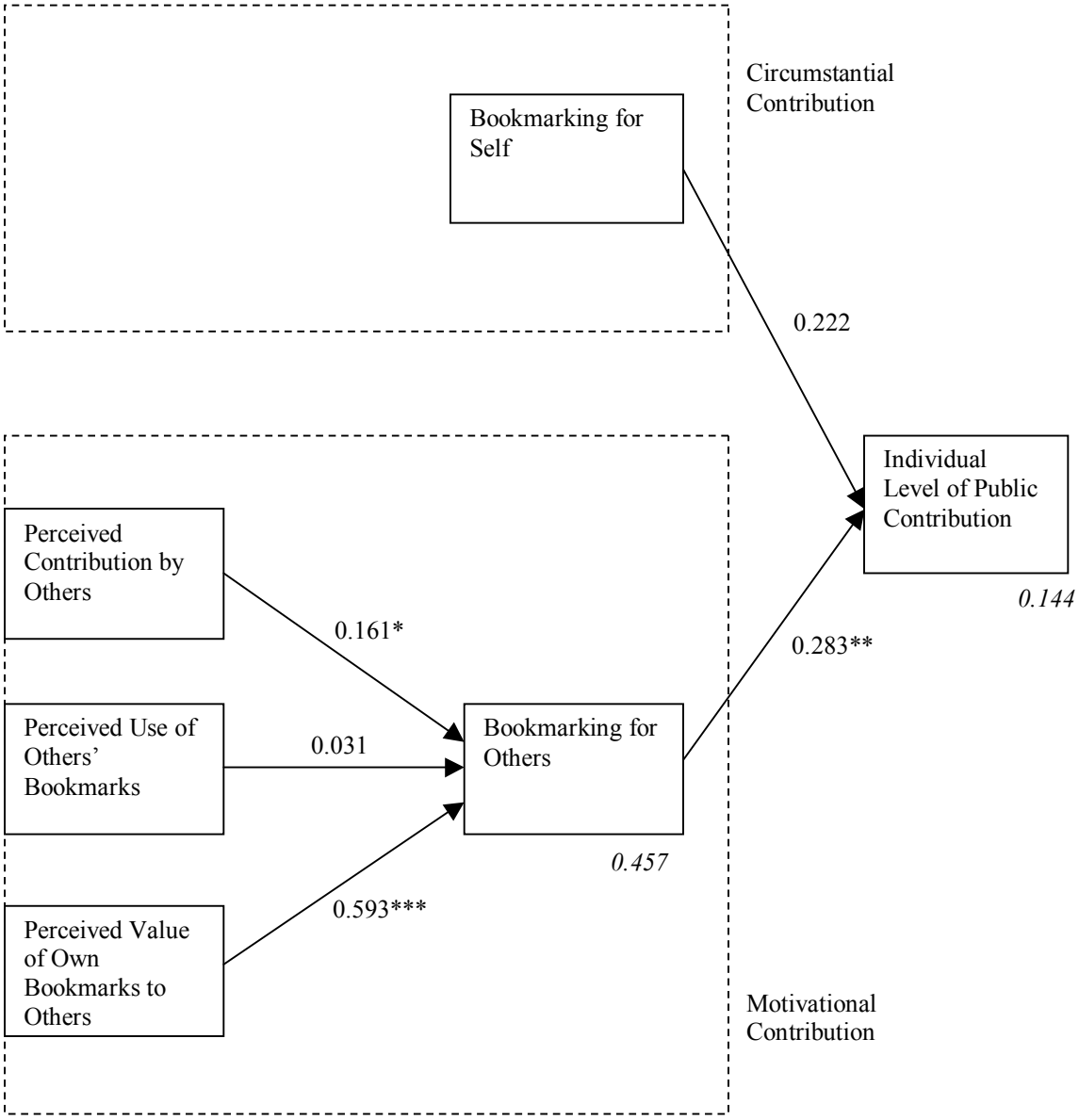


Figure 2: PLS Test of Research Model



* - p<0.05, ** - p<0.01, *** - p<0.001

Notes:

Numbers in italics indicate variance explained by independent variables.

Table 1: Demographics

VARIABLE	FREQUENCY (%)		VARIABLE	FREQUENCY (%)
Age			**Gender**	
Under 18	2 (2.1%)		Male	72 (76.6%)
18-25	16 (17%)		Female	22 (23.4%)
26-35	36 (38.3%)			
36-45	29 (30.9%)		**Household Income**	
46-55	8 (8.5%)		Under $10,000	12 (12.8%)
Over 55	3 (3.2%)		$10,000-$19,999	3 (3.2%)
			$20,000-$29,999	6 (6.4%)
Education			$30,000-$39,999	12 (12.8%)
High School or Equivalent	5 (5.3%)		$40,000-$49,999	12 (12.8%)
Vocational/Technical School (2 yr)	1 (1.1%)		$50,000-$74,999	14 (14.9%)
Some College or University	19 (20.2%)		$75,000-$99,999	8 (8.5%)
Bachelor's Degree (4 year)	29 (30.9%)		Over $100,000	7 (7.4%)
Master's Degree	24 (25.5%)		Rather not say	20 (21.3%)
Professional Degree (MD, JD, etc.)	3 (3.2%)			
Doctoral Degree	8 (8.5%)		**Frequency of use**	
Other	1 (1.1%)		Rarely	6 (6.4%)
Rather not say	4 (4.3%)		About once a month	4 (4.3%)
			About once a week	9 (9.6%)
Membership			2-3 times a week	16 (17%)
A week or less	12 (12.8%)		About once a day	15 (16%)
A month or less	10 (10.6%)		Multiple times a day	44 (46.8%)
Three months or less	30 (31.9%)			
Six months or less	16 (17%)			
Nine months or less	10 (10.6%)			
A year or less	6 (6.4%)			
Over a year	10 (10.6%)			

Table 2: Factor analysis for all constructs and their items

	Bookmarking for self	Bookmarking for others	Perceived value of own tags to others	Perceived contribution by others	Perceived use of others' tags
Bookmarking for self					
I create tags for websites because I want to be able to find those websites later if I need to	**0.815**	0.040	0.105	0.133	-0.143
I create tags for websites that I need to have in my list of bookmarks	**0.772**	0.051	0.140	-0.015	-0.030
I create tags for websites because I will not be able to remember how to find those websites	**0.730**	0.194	-0.018	-0.072	-0.159
Bookmarking for others					
I create public tags for websites because I think other users will find those websites useful	0.101	**0.941**	0.606	0.299	0.288
I create public tags for websites because I think those websites should be discovered by other users	0.116	**0.934**	0.647	0.341	0.210
I create public tags for websites because I think those websites should be included in Site A	0.127	**0.821**	0.409	0.332	0.248
I create public tags for websites so that other users will be able to find those websites	0.106	**0.906**	0.658	0.332	0.288
Perceived value of own tags to others					
My public tags are useful for other users' tasks	-0.008	0.602	**0.921**	0.305	0.294
My public tags are appropriate for other users' tasks	0.084	0.584	**0.937**	0.269	0.309
I create public tags that are applicable to other users' tasks	0.196	0.602	**0.911**	0.286	0.326
Perceived contribution by others					
Users of Site A contribute public tags to the site	0.009	0.354	0.322	**0.956**	0.320
Users of Site A share their tags on the site	-0.025	0.315	0.272	**0.932**	0.371
Users of Site A add public tagged bookmarks to the site	0.054	0.350	0.284	**0.934**	0.324
Perceived use of others' tags					
I frequently use other users' public tags to find information on Site A	-0.171	0.288	0.344	0.369	**0.916**
I rarely use public tags from other users of Site A (*reversed*)	-0.077	0.120	0.118	0.177	**0.825**
I frequently find websites I need through the use of other users' public tags on Site A	-0.112	0.344	0.413	0.390	**0.865**

Table 3: Correlations between constructs.

	CR[a]	(1)	(2)	(3)	(4)	(5)	(6)
Bookmarking for self (1)	**0.817**	**0.775**					
Bookmarking for others (2)	**0.946**	0.117	**0.902**				
Perceived value of own bookmarks to others (3)	**0.945**	0.100	0.648	**0.922**			
Perceived contribution by others (4)	**0.958**	0.028	0.361	0.311	**0.941**		
Perceived use of others' bookmarks (5)	**0.903**	-0.144	0.290	0.340	0.363	**0.869**	
Individual level of public contribution (6)	**N/A[b]**	0.135	0.311	0.368	0.180	0.127	**N/A[b]**

[a] The first column is the Composite Reliability (CR) for each construct. The values in the diagonal are the squared root of the Average Variance Extracted (AVE).
[b] Individual level of public contribution was measured by asking users the percentage of their tags that they made publicly available, using a scale from 0% to 100%, in 10% increments.

Table 4: Hypotheses and summary of findings.

Hypothesis	**Finding**
H1: Bookmarking for self is positively related to individual level of public contribution.	Not Supported
H2: Bookmarking for others is positively related to individual level of public contribution.	Supported
H3: Perceived use of bookmarks contributed by others is positively related to bookmarking for others.	Not Supported
H4: Perceived contribution of bookmarks by others is positively related to bookmarking for others.	Supported
H5: Perceived value of own bookmarks for others is positively related to bookmarking for others.	Supported