Analysis of Participation in an Online Photo-Sharing Community: A Multidimensional Perspective

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In recent years we have witnessed a significant growth of social-computing communities—online services in which users share information in various forms. As content contributions from participants are critical to the viability of these communities, it is important to understand what drives users to participate and share information with others in such settings. We extend previous literature on user contribution by studying the factors that are associated with various forms of participation in a large online photo-sharing community. Using survey and system data, we examine four different forms of participation and consider the differences between these forms. We build on theories of motivation to examine the relationship between users' participation and their motivations with respect to their tenure in the community. Amongst our findings, we identify individual motivations (both extrinsic and intrinsic) that underpin user participation, and their effects on different forms of information sharing; we show that tenure in the community does affect participation, but that this effect depends on the type of participation activity. Finally, we demonstrate that tenure in the community has a weak moderating effect on a number of motivations with regard to their effect on participation. Directions for future research, as well as implications for theory and practice, are discussed.

Introduction

Social-computing systems designed to enable users to share information have demonstrated a dramatic rise in popularity in recent years. Such systems enable collective action and social interaction online and rich exchange of multimedia information (Parameswaran & Whinston, 2007), and are based on user participation and online community formation. These systems are characterized by different forms of participation, including the sharing of information artifacts (e.g., photos and videos), sharing of metainformation and pointers (e.g., tags, bookmarks), and participation in social structures, including one-to-one relationships and one-to-many relationships. Some of the best-known examples of social-computing communities are content sites such as Flickr and YouTube, social interaction platforms such as Facebook, and social bookmarking services such as del.icio.us.

Sustained participation and content contribution from individual members are critical for the viability and success of online communities (Burke et al. 2009; Butler, 2001; Chiu, Hsu, & Wang, 2006; Koh, Kim, Butler, & Bock, 2007). Reflecting this premise, the question of why people contribute information goods in information-sharing communities has been a subject of study for researchers in recent years (e.g., Ames & Naaman, 2007; Arakji, Benbunan-Fich, & Koufaris, in press; Cheshire & Antin, 2008; Kim & Han, 2009; Kuo & Young, 2008; Schroer & Hertel, 2009). However, little attention so far has been given to the similarities and differences between the different types of social-computing participation, and in particular, the interaction between motivations for participation and users' tenure in the community. In the present study we address this gap by examining the following research questions: What factors are associated with the sharing of information goods and participation in social structures of online communities? Are different forms of community participation affected by different factors? How do various forms of participation change with respect to tenure in the community?

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In addressing these questions we consider the effects of individual motivations, network properties, and tenure in the community, building on existing theories of motivation and participation.

To summarize, the contributions aimed at in this work, building on data from a highly popular online community, are:

- A comparison of different forms of community participation and the factors underpinning them.
- A study of participation with respect to the tenure in the community.

We begin by reviewing the theoretical aspects underlying this work, and the relevant literature. We then lay out the research model and hypotheses, describe the study method and results, and then discuss the implications of the study.

Related Work and Theoretical Background

This work builds on existing theories of motivation and contribution from various fields to examine the activity of users on Flickr, a photo-sharing community. The motivational factors we consider include both intrinsic and extrinsic motivations, a distinction made by scholars of motivation and self-determination theory (Deci & Ryan, 1985), and later applied by researchers of participation in online communities and open-source software projects (Lakhani & Wolf, 2005; Roberts, Hann, & Slaughter, 2006). Extrinsic motivations are instrumental and represent cases where an activity is carried out in order to achieve a separable outcome (Ryan & Deci, 2000). In a user-contribution context, extrinsic motivations represent cases where the expected benefits of contributing are perceived to exceed the contribution's costs (Lerner & Tirole, 2002). These include, for example, improvement of skills (Lakhani & von Hippel, 2003) and the enhancement of professional status (Lakhani & Wolf; Wasko & Faraj, 2005). In this work we consider two types of extrinsic motivations: first, the expected rewards to be gained from photographic self-development, which is directed at the self, and building reputation within the community, which is directed at others. Intrinsic motivations, on the other hand, emphasize inherent satisfaction from an activity rather than its consequences (Ryan & Deci). They include motivations such as enjoyment (Torvalds & Diamond, 2001), reciprocity (Wasko & Faraj, 2005), and a sense of obligation to contribute (Bryant, Forte, & Bruckman, 2005; Lakhani & Wolf). Reflecting the distinction between intrinsic and extrinsic motivations for participation in open-source software-development projects, Lakhani and Wolf (2005) divide the intrinsic motivations into enjoyment-based, and obligation/community-based motivations; the former is directed at the self, and the latter at others.

To summarize, in the present study we consider two types of intrinsic motivation: enjoyment, which is directed at the self, and commitment to the community, which is directed at others. We also consider two extrinsic motivations: self-development, which is directed at the self, and reputation, which is directed at the community. The motivations are outlined in Table 1.

TABLE 1. Motivational factors.

	Towards self	Towards others
Intrinsic	Enjoyment	Commitment
Extrinsic	Self-development	Reputation

These four types of motivations form the underlying framework for our investigation. All four motivations were examined in the context of various online services that are built on participation and contribution. The intrinsic motivation of enjoyment was shown to be related to information sharing of content in open-content and open-source software projects (Lakhani & Wolf, 2005; Nov, 2007). Similarly, commitment (or obligation to the community), was shown in prior research to motivate individuals to share in various settings, such as open-source software projects (Lakhani & Wolf), and open-content projects (Bryant et al., 2005). Gaining reputation among like-minded people has been shown to motivate sharing in online communities and open-source software projects (Parameswaran & Whinston, 2007; Raymond, 1999). Self-improvement (through learning from others in the community and receiving feedback) was shown to be associated with knowledge sharing (Lakhani & von Hippel, 2003) and with participation in open-content project communities such as Wikipedia (Oreg & Nov, 2008). We provide more details on the factors selected for our study in the next section.

Finally, in this article we examine whether the length of membership in the community affects participation. Existing research is inconclusive on this point, as there is conflicting evidence regarding the effects of community tenure: On the one hand, evidence from small-scale qualitative research shows that over time, after the fading of the initial excitement, community members often become bored, disappointed, or otherwise less enthusiastic, and as a result decrease their level of community participation (Brandtzaeg & Heim, 2008; Nov, Naaman, & Ye, 2009). On the other hand, we expect that as users get used to the system, get feedback on their postings, create connections with others, and have their photos viewed by others, they increase their participation. Some evidence for this was provided by Huberman, Romero, and Wu (2008), who showed that views by others leads to an increase of video sharing on YouTube. This conflicting evidence calls for further research. However, no empirical study, to the best of our knowledge, has taken a comprehensive look at motivational factors, tenure, and users' participation. In this study we intend to address this research gap and conduct an exploratory study of the relations between these aspects of users' participation in an online community.

Social Media and Motivations

The research community has addressed the question of participant motivations, and how those affect activities and outcomes in online community and social media services.

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The positive effect of viewing and attention on production of content was demonstrated by Huberman et al. (2008) in the context of YouTube, and Huberman, Romero, and Wu (2009) in the context of Twitter. In their YouTube study, (which is relevant to the present study as YouTube, like Flickr, is an artifact-sharing service) the authors show that increased attention leads to heightened contribution of content. The findings suggest a connection between tenure, survivability, and attention (users who get no attention may drop off). Burke et al. (2009) have quantitatively examined photo contribution on Facebook, focusing on the factors that motivate contributions from newcomers. The authors only measured system data, and therefore their findings are indirectly tied to the motivations that we measure directly through a survey. For example, the authors hypothesize that distribution of the user's content by others, and direct feedback on content, are both related to attention and therefore reputation, and show that both contribute to content upload.

One of the key aspects of social-media services is the strong influence of motivations related to the users' social network. For example, creating social capital was shown to be a primary outcome of Facebook use (Ellison, Steinfield, & Lampe, 2007), although the authors did not show that social capital was a driving *motivation* for Facebook use. Ling et al. (2005) examined whether affiliation with groups enhances contribution of reviews on MovieLens, with mixed results. Joyce and Kraut (2006) demonstrated that responses to community members' postings by other members increased their likelihood of contribution, and Rashid, Ling, Kraut, and Riedl (2006) showed that displaying the value of contribution to community members led to increased contribution. An extrinsic incentive strategy (i.e., "points") was explored by Farzan et al. (2008) in a corporate information system, showing short-term effects on contribution levels.

Several studies addressed the motivation to contribute metainformation in social-media environments. Sen et al. (2006), for example, studied tagging in MovieLens, and showed that the content of tags is influenced by the community, perhaps as an artifact of social learning (Bandura, 1977); the authors, however, could not quantify the effect of the community aspects on contributors' tagging behavior.

Flickr and Related Research

In this work we focus on Flickr[1], a prominent social-media photo-sharing community that has received much research attention in recent years in various qualitative and quantitative studies. Flickr was established in 2004 and gained considerable popularity. The service now features over 35 million users who have shared over 3 billion photos as of March 2009 (Harrod, 2009). Flickr is a prominent example of an online community and artifact-sharing system in which content is created, shared, annotated, and viewed by users (Lerman & Jones, 2007; Parameswaran & Whinston, 2007). Every Flickr user can upload photos and short videos, and annotate them with a title and description, as well as tags—short text labels that often convey metainformation about the photo and can be used for search by anyone who can view the image. Flickr users can designate other users as "contacts," users whose photos they follow (contacts are often, but not always, reciprocal). A user can choose to share each photo with the public, with designated contacts marked as family or friends, or keep the photo completely private. Users can also join groups, which are commonly formed around a topic of interest for community members (Negoescu & Gatica-Perez 2008; Nov, Naaman, & Ye, 2008). Paying ("pro") users of Flickr can share an unlimited number of photos on the site; others can only show their latest 200 uploads.

Miller and Edwards (2007), in a qualitative study, informally identified two types of Flickr users: "Snaprs" (i.e., snappers, Flickr users who are engaged in explicit activities designed to capture media for the purpose of sharing) and "Kodak culture" (traditional amateur photographers who share their captures with others). The authors suggested that these and other groups of Flickr users exhibit differences in their habits and practice of capture and upload. Quantitatively, Prieur, Cardon, Beuscart, Pissard, and Pons (2009), using principal-component analysis (PCA) on key usage statistics, suggested that Flickr users could be clustered according to their actions on the site into three groups. The authors dubbed the groups "social media," "MySpace-like," and "photo stockpiling." The social-media group uploads photos and focuses on the interaction around the content; the MySpace-like group is more likely to use the social aspects of Flickr, perhaps independently from photo uploads; and the stockpiling group mostly uploads photos without using the social functions on Flickr. The motivations we examine here could be related to practices identified in these different subcommunities, although in this work we examine the general community and not specific subgroups. We focus on the general population as the association of users with specific subgroups is a difficult and imprecise task. Specifically, with the recent trends of social media and digital photography, there is a blurring of the traditional differences between groups such as professional and amateur photographers. These differences represent a continuum rather than distinct categories (Meyer, 2008). Further evidence for this blur can be found in a recent announcement by Getty Images that they will start paying Flickr amateur photographers for images it wants to distribute commercially (Tozzi, 2008).

Both van Zwol (2007) and Lerman and Jones (2007) studied the consumption patterns on Flickr, showing that the contact network drives much of the viewing activity on Flickr (rather than being driven by groups or search activity, for example). While the implications for the activities of users are clear (adding more contacts is likely to result in more views for your photos), the authors do not discuss how different motivations affect the user's action in that respect.

In another study, Ahern et al. (2007) looked at privacy decisions in Flickr and identified (qualitatively) various factors that contribute to marking photos as private; these factors were linked to the magnitude of the user's participation as

[1] http://www.flickr.com

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measured by the number of public photos. The study demonstrated that users considered how they would be perceived by others when making privacy decisions about their Flickr photos, a factor that is linked to the self-development and reputation factors discussed in the present study. Van House (2007) presented qualitative findings on users' social actions and motivations in Flickr, identifying relationship maintenance (with known others) and photo exhibition (to the public) as two of the social factors that come into play in the community. Negoescu and Gatica-Perez (2008) later performed a descriptive statistical analysis of Flickr groups, hypothesizing that groups are mostly used by participants who are using Flickr for "self-expression," amongst the uses named by Van House (2007), but not expanding beyond descriptives to examine the motivations in depth. Finally, the work of Nov et al. (2009), showed the tenure effect on a single measure of activity, namely public sharing of photos on Flickr. The present study significantly extends and expands the analysis presented by Nov et al. (2009) to include other forms of contribution and new, comparative analysis.

Research Model

Our research model attempts to explain community participation using theories of motivation. By using a large-scale dataset of different users in different stages of their tenure in the community, we can gain insight to how tenure and motivations affect users' community participation.

Participation in online communities can be reflected in a number of forms, which we divide here into two main types: sharing information goods with others in the community, and joining social structures within the community. In the literature on online communities, two prominent examples of the first type are contribution of content or information to a common pool created by the community (e.g., Bryant et al., 2005; Cheshire & Antin, 2008; Koh et al., 2007), and contribution of metainformation (i.e. information about information), which is often done by adding tags to information goods such as photos or bookmarks (Lee, 2006; Marlow, Naaman, Boyd, & Davis, 2006). The second type of evidence for community participation is activity in social structures, for example the involvement of users in one-to-many relationships. On Flickr, we can look at participation in groups, which are commonly created around a topic of interest for community members, or reflect existing social structures and organizations (Negoescu & Gatica-Perez, 2008). In addition, the creation of one-to-one ties with other members of the community—by adding them as "friends" or "contacts"—is another type of activity that reflects participation in communities such as Facebook or Flickr. (Nov & Ye, 2008).

The dependent variables we measure, therefore, are indicators of information contribution and social participation, including:

1. The number of public photos uploaded by the user to a Flickr account per year of the user's Flickr activity (i.e., per community-membership year).
2. The number of unique tags applied by the user to Flickr photos per year of the user's Flickr activity.
3. The number of contacts (one-to-one relationships) the user has per year of the user's Flickr activity.
4. The number of groups (one-to-many relationships) the user is a member of per year of the user's Flickr activity.

For our research model, we follow Lakhani and Wolf's (2005) framework, and as noted above, focus on the following motivations for participation in communities:

Enjoyment. Enjoyment has been established as one of the prominent factors explaining volunteering activities (Clary et al., 1998). In the context of online communities, enjoying the act of sharing has been shown to be a prominent reason for contributing to open-source software projects (e.g., Lakhani & Wolf, 2005; Roberts et al., 2006) as well as open-content projects such as Wikipedia (e.g., Nov, 2007). We expect therefore that

H1: A higher level of enjoyment from the act of sharing photos will be associated with increased level of participation in the community.

Commitment to the community. The second motivation involves commitment, or the desire to help other members in the online community (e.g., Chiu et al., 2006; Hars & Ou, 2002; Lakhani & von Hippel, 2003). Prior research on motivations for sharing information goods online suggests that commitment to the community is related to increased tendency to share information in various settings, such as open-source software projects (Lakhani & Wolf, 2005), open-content projects (e.g., Bryant et al., 2005) and photo-sharing communities (Nov et al., 2009). In the case of sharing photos with others in the community, we expect that

H2: A higher level of commitment will be associated with increased level of participation in the community.

Self-development. A more instrumental motivation for sharing, for both professional and amateur photographers, involves expected rewards in the form of learning and improvement of skills achieved by learning from others in the field (e.g., Bonaccorsi & Rossi, 2003; von Hippel & von Krogh, 2003). The self-development motivation was shown to be associated with knowledge sharing (Lakhani & von Hippel 2003), and is one of the motivations for sharing in open-content projects communities such as Wikipedia (e.g., Oreg & Nov, 2008). Therefore, we expect that

H3: Higher levels of the self-development motivation will be associated with increased level of participation in the community.

Reputation gaining. An even more instrumental motivation for community information sharing is the enhancement of status in the community (Lakhani & Wolf, 2005; Roberts

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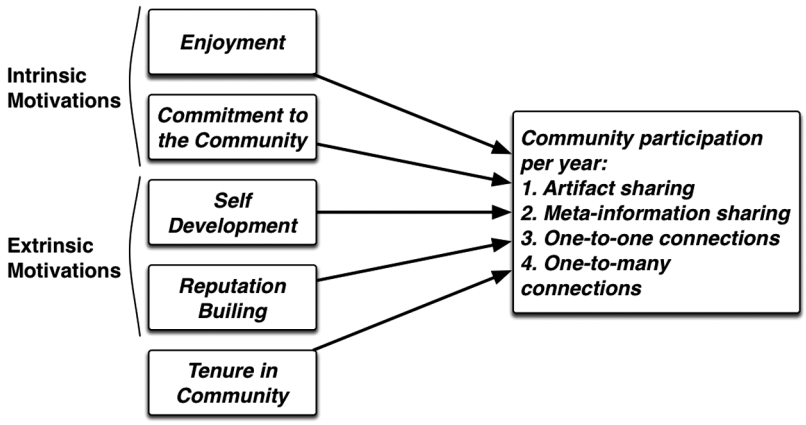

FIG. 1. Research model.

TABLE 2. Questionnaire items.

Enjoyment	ENJ1: I find posting public photos on Flickr to be enjoyable. ENJ2: The process of posting public photos on Flickr is pleasant. ENJ3: I have fun posting public photos on Flickr.
Commitment	COM1: I would feel a loss if Flickr was no longer available. COM2: I really care about the fate of Flickr. COM3: I feel a great deal of loyalty to Flickr.
Self development	DEV1: Posting my photos publicly on Flickr provides me with a means of developing my skills. DEV2: Posting my photos publicly on Flickr gives me an opportunity to learn new things. DEV3: Posting my photos publicly on Flickr enables me to become more proficient and enhance my expertise.
Reputation	REP1: I earn respect for my photography by posting my photos publicly on Flickr. REP2: I feel that posting my photos publicly on Flickr improves my status as a photographer. REP3: I post my photos publicly on Flickr to improve my reputation as a photographer.

et al., 2006). In other information-sharing community contexts, the prospect of reputation—or the attainment of status in the community—was linked with increased contribution (e.g., Lakhani & Wolf). Similarly, we expect that

H4: Higher levels of the reputation motivation will be associated with increased level of participation in the community.

Overall, our study includes three parts: First, we explore the relationship between tenure in the community and different forms of users' community participation. Second, drawing on the motivational factors reviewed above, we examine the relationship between the individual motivations and the four community-participation forms. Finally, we present a more refined perspective on the findings by examining interaction effects, and in particular, the moderating effect of tenure in the community on the different motivations with regard to their effect on participation. The overall research model, relating the independent variables on the left, to the dependent variables on the right, is summarized in Figure 1.

Method

We collected data for this study using a combination of survey responses and independent system data about Flickr users. Among the independent variables, the four motivation factors were measured using responses to a Web-based survey, which included existing scales adapted to the Flickr context. Survey items, measured on a 7-point Likert scale, are presented in Table 2. Reputation building and commitment were measured by a scale used by Wasko and Faraj (2005) in their study of motivations for contributors to electronic networks of practice, and adapted to the Flickr context. For example, the item "I would feel a loss if the Message Boards were no longer available" was changed to "I would feel a loss if Flickr was no longer available." The self-development motivation was adapted from a study by Oreg and Nov (2008) who used it to compare the motivations of Wikipedia contributors and open-source software developers. Finally, the enjoyment motivation was adapted from Venkatesh (2000) who studied the intrinsic motivations of software users. All the scales were validated in the original studies, and were validated again in the present study (as we explain in Tables 3 and 4 below).

System data, such as number of users' photos, tags, contacts, groups, and tenure in the Flickr community, are available via Flickr's Application Programming Interface (API). The Flickr API allows third parties to communicate with Flickr and to get information about the user, often requiring the user's authorization. Respondents were asked, as part of the Web-based survey, to authorize the researchers

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TABLE 3. Item means, standard deviations, and factor loadings.

		Mean	*SD*	1	2	3	4
1.	DEV1	4.93	1.46	0.838			
	DEV2	5.00	1.32	0.837			
	DEV3	4.82	1.34	0.813			
2.	COM1	5.60	1.37		0.821		
	COM2	5.36	1.24		0.812		
	COM3	4.77	1.46		0.792		
3.	REP1	4.74	1.20			0.656	
	REP2	4.15	1.32			0.805	
	REP3	3.33	1.53			0.819	
4.	ENJ1	5.75	0.97				0.743
	ENJ2	5.49	0.96				0.764
	ENJ3	6.14	0.84				0.825

Note. Factor loadings below 0.4 were suppressed.

TABLE 4. Means, standard deviations, reliability, intercorrelations, and average variance extracted.

Construct	Mean	*SD*	α	1	2	3	4
1. Self Development	4.92	1.22	0.86	0.754			
2. Enjoyment	5.79	0.76	0.74	0.381**	**0.778**		
3. Commitment	5.24	1.13	0.78	0.207**	0.364**	**0.816**	
4. Reputation	4.07	1.12	0.77	0.561**	0.407**	0.341**	**0.802**

Note. The diagonals are the square root of the average variance extracted (AVE) of each factor

** Significant at the 0.01 level.

to access the respondent's Flickr account via the survey Web site. This way, key data about the respondents' activities were automatically extracted. We used the system data to measure the dependent variables and some of the independent variables (such as the users' tenure in the Flickr community). The data was recorded anonymously together with the responses to the questionnaires.

Our four dependent variables—the number of photos posted, unique tags assigned, contacts made, and groups joined per year—were measured using the user's total number of photos/tags/contacts/groups, divided by the number of years the user has been posting photos on Flickr.

One potential methodological issue in interpreting survey results is common-method bias (Straub, Boudreau, & Gefen, 2004) whereby all variables are measured using a single data source. In our study, the motivations were measured using survey responses, while other variables, including the dependent variables, were retrieved directly through the Flickr API, therefore mitigating the risk of common-method bias.

A randomly chosen sample of 1840 Flickr users who were mined from a Flickr page displaying a list of recently uploaded photos, and who had at least one publicly viewable photo, were e-mailed an invitation to participate in our Web-based survey. To eliminate any effect of posting restrictions by the Flickr system, we limited our analysis to Flickr "Pro" users, who pay a yearly fee and can upload unlimited number of photos (among other restrictions, non-Pro users are limited to sharing the 200 most recent photos uploaded to their account). In addition, we limited the analysis to users with at least three months of tenure, to make sure we considered members of the community with established motivations and habits. In particular, we aimed to eliminate the effect of the very initial intensive participation that is associated with joining a new service. A total of 276 usable responses were received. This represents a 15.0% response rate, which is typical of similar studies (e.g., Goode, 2005; Wu, Gerlach, & Young, 2007). Respondents' average age was 36.8 (median = 33, $SD = 10.8$). Female users comprised 49.9% of our sample.

The number of public photos posted, tags assigned, contacts made and groups joined per year varied greatly across users. On average, the respondents in the dataset used had posted 2821 public photos on Flickr (median = 1194, $SD = 7308.6$) per year, assigned 401 unique tags (median = 176, $SD = 608.8$), had 48.9 contacts (median = 12, $SD = 150.4$), and joined 33.5 groups (median = 4, $SD = 68.6$). The respondents' tenure on Flickr was 1.7 years on average (median = 1.6, $SD = 0.95$). We compared these descriptive statistics with the statistics of an independent random sample of 210 Flickr Pro users with more than 3 months tenure. We found similar characteristics between the two groups (e.g., 46.5 contacts and 1.8 tenure years on average), suggesting that our sample is representative of the population.

Results

Instrument Validation

Prior to testing the hypotheses, we validated the survey instrument used in order to enhance the results' validity and reliability. First, to confirm the reliability of survey items, we conducted a principle component analysis (PCA) with varimax rotation using SPSS. Four factors emerged in the PCA, corresponding directly to our framework of four motivation factors, with 71.4% total variance explained. Each item had factor loading higher than 0.6 on the intended construct and less than 0.4 cross-loadings. Table 3 presents the mean, standard deviation, and factor loadings of each measurement item.

Further, to confirm convergent and discriminant validity, we calculated the average variance extracted (AVE) for each construct (Fornell & Larcker, 1981). For each construct, AVE is expected to exceed 0.5 to display convergent validity, and the square root of AVE (RAVE) is expected to exceed the correlation with other constructs in order to display discriminant validity (Chin, 1998; Fornell & Larcker). As illustrated in Table 4, all constructs satisfy these requirements. In addition, all constructs have Cronbach's alpha values that satisfy the generally acceptable level of 0.70 for confirmatory research (Straub et al., 2004), indicating that all measures are reliable. Table 4 also presents the intercorrelations among the four motivational constructs.

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Finally, before proceeding with the statistical analysis of the motivations and their role in community participation, we checked whether the differences observed relative to users' tenure in the community can be attributed to some inherent differences between early and late community members and not the effect of the community membership tenure. For example, early users might tend to be "early adopters" that might exhibit different characteristics; or motivations to join Flickr might have shifted due to the sites functionality. To do that, we compared the populations of early and late community members using analysis of variance (ANOVA): we divided the sample of users into a subsample of users whose tenure in the community is below the median tenure, and a subsample of users whose tenure in the community is above the median. We compared these two subsamples on a number of variables, including self-rated computer expertise and the four motivations examined. No significant differences were found between the two subsamples on any of the factors compared, thus lending support to our assumption that the differences in community participation activities can be attributed to the effect of tenure in the community, rather than to any other differences between these populations.

Analysis

We first provide a descriptive analysis of the distribution of the different participation activities that are our dependent variables. Despite the differences between the four forms of participation, and despite the diversity in participation patterns *within* each of them, all forms of participation exhibited similar distribution patterns, characterized by a power-law distribution, where most users' participation level is relatively low, but a few users' participation level is disproportionately high. This pattern is common in social-computing participation data (e.g., Cosley, Frankowski, Terveen, & Riedl, 2006; Kumar, Novak, & Tomkins, 2006). In Figure 2 we present the distribution of the participation per year in our sample. We normalized all four participation forms such that the number of participation acts per year (photos posted, tags assigned, contacts made, and groups joined) is divided by the average corresponding variable found in the sample population. This way, for example, if a user posted 1000 photos per year and the average user posted 500 photos per year, the normalized number of photos per year in Figure 2 is 2 (1000/500).

We analyzed the correlations between the different types of participation level per tenure year, and found that the highest of them was 0.397 (between tags and photos), and that in some cases (photos-contacts and photos-groups) no significant correlation existed. In other words, high participation level in one activity is indicative of high participation level in other activities only to a limited extent.

Following the observation of a power-law distribution pattern for the four types of community participation, we set out to examine the relationship between community participation and tenure in the community. Figure 3 presents the scale of the users' participation activities per year (number of photos posted, tags assigned, contacts designated, and

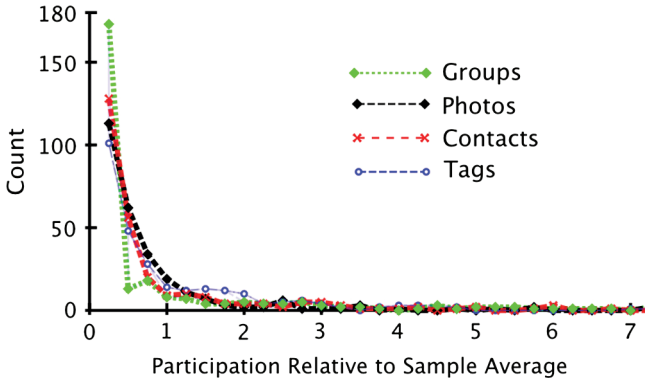

FIG. 2. Distribution of users' participation per year (normalized).

groups joined) as a function of the users' tenure in the community. As Figure 3a demonstrates, participation per tenure year tends to decrease with tenure in the community in the case of sharing of information artifacts (i.e., photos). As Figures 3b–3d demonstrate, participation per tenure year tends to increase with tenure in the case of metainformation sharing and participation in social structures (both one-to-one and one-to-many). In the next section, we use regression analysis to estimate the magnitude of the effect of tenure on participation as part of the overall model, including these factors.

To test the hypotheses, we performed regression analyses using the mean score of the constructs as extracted from the survey's responses to the questionnaire items, and the logarithms of the system-derived variables. In the case of tags per year, we also controlled for the number of photos, since tags are directly attached to photos, and therefore the more photos a user has, the more overall tags they are likely to have attached (as we show above, tags and photos are indeed correlated in our sample). As is common in studies of social-computing activities, we used logarithms because of the highly skewed distribution of the latter three variables. The results of the regression are summarized in Table 5.

Let us briefly summarize the results by the type of participation and their contributing factors. We attempt to provide some more insight and discussion in the next section. The *tenure* factor is correlated to increased participation in terms of tags, contacts and groups, but is negatively correlated to the number of photos shared, according to our model. The *self-development* factor exhibits the same characteristics, related positively to all forms of participation other than photos, which are negatively correlated to this factor. Similarly, the *reputation building* motivation has a positive correlation with tags, groups, and contacts; reputation was not found to be related to the number of photos in a statistically significant manner. The contribution of the intrinsic *commitment* motivation is positively related to information artifact sharing (photos), but negatively related to both metainformation sharing and participation in one-to-many social structures (tags and groups). Finally, the factor is found to be positively related to relationship creation (contacts and groups) but not

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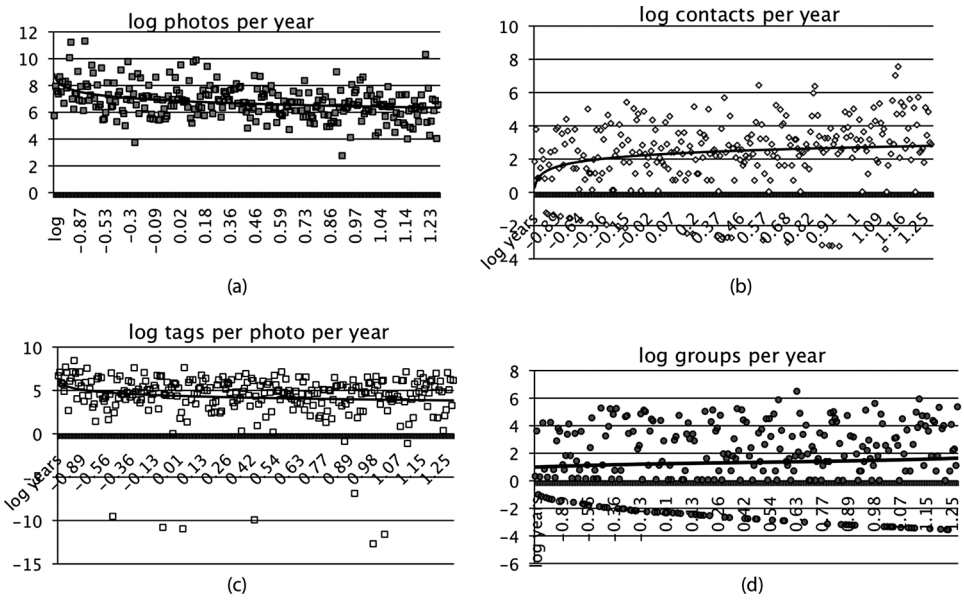

FIG. 3. Participation per year over users' tenure.

TABLE 5. Summary of the models for all four types of community participation.

	Independent variables / dependent variables	Information artifacts per year (photos)	Metainformation per year (tags)	One-to-one social relationship per year (contacts)	One-to-many social relationship per year (groups)
	Tenure: log(years)	**−0.416*****	**0.242****	**0.247*****	**0.114***
	Intrinsic motivation: Enjoyment	0.050	0.083	**0.135***	**0.153***
	Intrinsic motivation: Commitment	**0.172****	**−0.131***	−0.020	−0.230***
	Extrinsic motivations: Self-development	**−0.159***	**0.258*****	**0.151***	**0.319*****
	Extrinsic motivations: reputation building	0.049	**0.144***	**0.135**†	**0.187****
Control	Public photos per year		0.165**		
Overall model	R^2	0.182	0.177	0.169	0.257
	Adjusted R^2	0.167	0.159	0.153	0.244
	F	12.077***	9.674***	11.008***	18.784***

$^{\dagger}p < 0.1$. $*p < 0.05$. $**p < 0.01$. $***p < 0.001$.

TABLE 6. Hypotheses testing summary. Y: Hypothesis supported; N: Hypothesis not supported; R: Relation found in opposite direction.

	Hypothesis	Information artifacts	Metainformation	One-to-one social relationship	One-to-many social relationship
Hypothesis supported?	H1: Enjoyment participation	N	N	Y	Y
	H2: Commitment participation	Y	R	N	R
	H3: Self-development participation	R	Y	Y	Y
	H4: Reputation - participation	N	Y	Y	Y

to photos or tags. The results of the hypothesis testing are presented in Table 6.

Interaction Effects

After identifying the direct relationship between participation, motivations, and tenure in the community, we examine the interaction effects between these two types of influences on participation. In other words, we want to find out whether tenure in the community has a moderating effect on some of the motivations. The results of the interaction effect analyses are presented in Figures 4–6.

As Figure 4 demonstrates, while newer community members share metainformation less intensively than older members in general, the motivation of enjoyment has opposite effects on newer and older members: For newer

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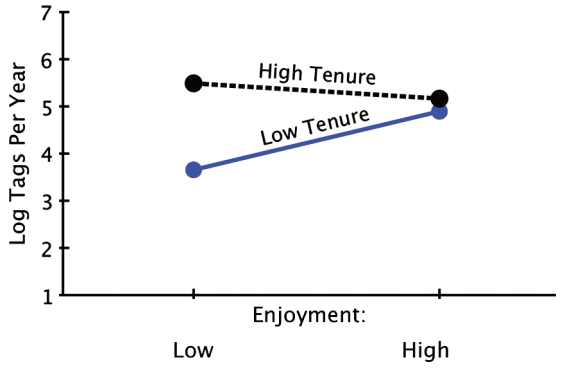

FIG. 4. Tenure moderates the effect of enjoyment on tags per year (weak moderation, $p < 0.1$).

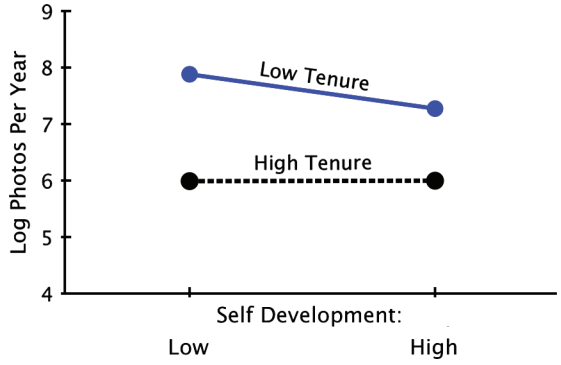

FIG. 5. Tenure moderates the effect of self development on photo posting per year (weak moderation, $p < 0.1$).

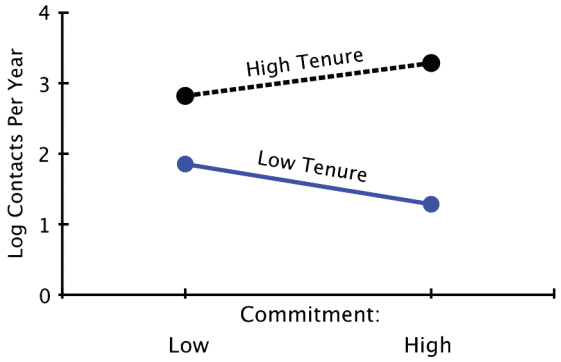

FIG. 6. Tenure moderates the effect of commitment on contacts per year (weak moderation, $p < 0.1$).

community members, increased enjoyment is associated with increased metainformation sharing, while for older members, increased enjoyment is associated with decreased metainformation sharing.

As Figure 5 shows, tenure in the community moderates the effect of the self-development motivation on artifact sharing: Overall, newer community members share more intensively than older members, however, newer community members share less intensively the more they are motivated by self-development, but this phenomenon does not take place in the case of older community members.

As Figure 6 demonstrates, while in general newer community members form one-to-one contacts less intensively than older members, the motivation of commitment to the community has opposite effects on newer and older members: For newer community members, increased commitment is associated with decreased contact formation, but for older members, increased commitment is associated with increased contact formation.

Discussion and Conclusions

With the substantial growth of information-sharing online communities and the importance of user participation for the sustainability of these communities, the information-science community may benefit from a better understanding of what factors enhance or moderate user participation in communities at various stages of the users' tenure in the community. Such understanding may generate better opportunities and guidelines for design and architecture of online communities and services, and eventually, greater sharing of information goods. A user-centric understanding of the dynamics of information-good contribution in these environments is important to researchers and practitioners alike. In this study we have extended the body of literature on user participation in information-sharing community environments by developing a framework to help understand users' participation in such a community, examining four different forms of participation.

Our data demonstrates that the level of information-artifact sharing decreases among users who have longer tenure in the community, but that other forms of community participation, namely metainformation sharing, and the two types of social structures participation, increase with the user's tenure in the community. How can this discrepancy be explained? The causality of the relationship between tenure and the measured factors is unclear. One way to explain the increase in joining social structures may be the effect of greater embeddedness in the community: As people form relationships with others (both one-one and one-to-many), they become more comfortable with activity and exposure on Flickr, they get to know new people, and through them, even more people. Thus, the social aspect of the community has a positive effect on continued participation. The construct of feedback (Burke et al., 2009) could help explain this relationship: People stick around because they are involved with more contacts and groups, which is likely to lead to more feedback. However, positive effects of feedback would also suggest a correlation between number of photos to contacts and groups, which was not found in our study. A longitudinal study such as the one by carried out by Huberman et al. (2008) on YouTube can help explore the causality of tenure and other variables in future work.

Metainformation contribution was also positively correlated with tenure. As was shown by previous research, metainformation contribution is in part a personal act (e.g., for collection organization purposes) and in part social activity aimed at others (Ames & Naaman, 2007). Adding metainformation can therefore be driven by self-targeted motivations. The longer the user is active, and the more information they

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have, the greater the need for metainformation for personal, organizational reasons. However, social motivations were shown to have the most direct influence on the magnitude of metainformation contribution on Flickr (Nov et al., 2008). Therefore, metainformation contribution may be more in line with other social activities such as joining social structures, explaining its mutual growth with tenure. Finally, as implied by Burke et al. (2009) and Sen et al. (2006), the idea of social learning (Bandura, 1977) could also play a role in metainformation contribution. Users who are active for a longer time, and connected to other users via groups or contacts, are more likely to be influenced by and follow the practices of others (in this case, tagging photos).

Interestingly, a discrepancy between information-artifact-sharing and the other forms of community participation was also observed with regard to individual motivations (see Table 5): We found a negative relation between the self-development motivation and the amount of artifacts contributed per year, but a positive correlation between self-development and the other three forms of community participation. A possible explanation for the former the may be rooted in the tradeoff between the quality and quantity of artifact contribution: The more a user is motivated by self-development, the more the user will focus their efforts on the quality (rather than the quantity) of the photos shared. Presumably, those who are motivated by learning might be more cautious about posting, and elect to post only their best photos in order to get feedback. At the same time, the more users are motivated by improving their skills, the more they might want to attract feedback for the artifacts they *do* decide to share (even if the number of those shared artifacts is small), and therefore they will provide greater amount of metainformation related to their artifacts. Similarly, the more users are motivated by improving their skills through feedback and observation of others, the more likely they will be to join social structures that will provide such potential for observation and feedback. This hypothesis is somewhat supported by the (weak) interaction between tenure and self-development motivations with respect to the number of photos, showing that newer community members are affected more by self-development motivations when it comes to sharing photos. Members with longer tenure, on the other hand, are not affected by self-development motivations in terms of their photo contributions.

Similar to the self-development motivation, those motivated by gaining reputation in the community may not focus on the quantity of the photos they post, but will attempt to draw attention to their shared artifacts by providing metainformation, as well as by joining social structures.

Enjoyment showed no correlation with the magnitude of either photos or tag sharing. It is important to note, however, that artifact sharing on Flickr involves two separate acts of artifact creation and artifact contribution (Nov & Ye, 2008). People may enjoy the act of taking photos, and those photos might have uses and benefits even when not shared online in photo-sharing communities. Conversely, it is not common for us to edit an encyclopedia entry unless we intend to publish it on Wikipedia or a similar venue; or to write a product review to leave it in a drawer. This separation of creation and sharing of artifacts may have implications related to motivations for contribution. On the one hand, the "second act" of contributing online is a completely optional action separated from the "first act" of artifact creation; on the other hand, once the artifact has been created, sharing can often become a fairly easy step that requires little additional mental effort. The lack of correlation between enjoyment and sharing may be attributed to this peculiar two-step characteristic of artifact sharing: Users may be motivated more by the enjoyment in the content-creation part of the process (taking pictures), and the enjoyment of posting or tagging them become less salient. Note that an interaction effect was found between tenure and enjoyment with respect to tags, or metainformation (Figure 4). While newer community members tend to share metainformation less intensively than older members in general—possibly because of lack of familiarity with such form of sharing—newer members who enjoy the act of artifact sharing may be more inclined to add metainformation to their artifacts, whereas older members who enjoy sharing artifacts do not show the same effect.

The motivation of commitment to the community poses an interesting case: As expected, users characterized by higher commitment to the community contribute more information artifacts. However, in the case of metainformation and one-to-many relationship formation, the opposite was observed. This finding warrants further research. In particular, the interaction between commitment and tenure with respect to the number of one-to-one relationships calls for examining whether newer community members might be more likely to form such relationships with people they already know.

Limitations and Future Research

The findings presented here show correlation, but not necessarily causality. While the motivational factors are more likely to influence user activity metrics, rather than being influenced by user activity, the direction of causality between the tenure factor and user activity is one that calls for exploration. A longitudinal analysis could shed more light on the correlation between activity and tenure, by comparing changes in activity levels of the same users, rather than comparing different users with different tenure levels. Nevertheless, we think our analysis of tenure above, and the discussion below, provide some initial insights and interesting findings regarding tenure.

Another limitation of our study is the fact that it was not possible to identify in our sample the different groupings of users in terms of their Flickr activity. As we discussed above, different uses of Flickr by members of the community include self-expression, relationship maintenance, life recording, and so forth (Van House, 2007); other tentative classifications for the Flickr community members exist (Miller & Edwards, 2007; Prieur et al., 2009). We would expect different motivational characteristics for users of each mode or group, but it was not possible to extract these groups from our data.

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A future study will identify users who belong to different activity groups on Flickr and further analyze the motivations to contribute that exist in users of each group.

Overall, our model results in a relatively low adjusted R^2, thereby not accounting for a large portion of the variance in our data. The low value might reflect the fact that we did not perform analysis by groups and types of Flickr usage, as noted above, but rather considered all Flickr users in concert. Alternatively, other factors may be in play that we did not identify in this work.

Finally, this study was conducted on a specific social-computing service: the Flickr online community. Further studies, of other types of information-sharing communities—such as YouTube, or blogging communities—can help verify the generalizability of the findings.

Summary

The findings from our study have implications for both theory and practice: We identified the differences between different modes of community participation, thereby contributing to the literature on online communities and social computing, which often focuses on a single type of activity, information sharing. Communities such as Flickr, Facebook, and YouTube enable millions of individuals to share and use information. The negative relation identified between the self-development motivation and the amount of information artifacts shared calls for further research on the trade-off between quantity and quality of contribution in an information-sharing-communities context. Designers and community managers may need to consider the trade-off and, perhaps, encourage "tentative" contributions that are clearly marked, say, as "work in progress." More broadly, perhaps, such services may want to try to identify the underlying motivations for individual users. If identifying those motivations proves possible (for example, by mapping behaviors to known motivation factors), designers can use different tactics for different individuals to further encourage participation. Our results also indicate that there are differences between new and experienced members in how they are motivated to contribute in a social-computing system. For example, while self-development motivates experienced users to contribute more, it has an opposite effect on new users. It is possible that new users who are attracted to join the community to gain knowledge and skills tend to be more cautious in contributing compared to those who joined because of other reasons. For those aiming at self-development, for instance, emphasis should be placed on easing the apprehension they might have over contributing contents that do not represent their best work.

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