On the "How" and "Why" of Emergent Role Behaviors in Wikipedia

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ABSTRACT

Research on peer-production suggests that as participants choose what actions to perform, prototypical activity patterns emerge. Recent work characterized these patterns and demonstrated that informal emergent roles are highly stable. Nonetheless, we know little about the ways in which contributors take on and shed emergent roles. The objectives of this study are to: (a) delineate the temporal dynamics of participants' emergent role taking behaviors, and (b) identify the motivations driving role-transition behaviors. Our study links motivation to role-transition behaviors within Wikipedia. Our first sample covered eleven years and 222,119 contributors, and was used to identify four categories of temporal role-taking behaviors, that differ in their mobility between emergent roles and across Wikipedia articles. Our second examination linked the motivations of 175 new participants to their subsequent role-taking activity over 14 months. Together, the two analyses reveal that role-taking categories can be distinguished based on participants' motivational orientation (intrinsic/extrinsic and self/others-oriented).

Author Keywords

Online production communities, Wikipedia, emergent roles, role-taking, role mobility, motivation.

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION

One of the key guiding principles of open co-production knowledge communities is self-organizing, where participants themselves select how, when, and what to work on [11, 30, 45, 59]. Recent years have seen increased scholarly interest in the nature of emergent work and in

particular in the processes by which informal roles organically emerge in knowledge co-production [22, 29, 36, 39]. For example, a recent study has characterized emergent roles within Wikipedia in terms of prototypical activity patterns that emerge from individuals' knowledge production actions [2]. Throughout this paper, we use the term 'emergent role' (or simply 'role') to refer to these activity signatures.

While an understanding regarding the nature of emergent roles is beginning to form, less is known about the temporality and dynamics of participants' role-taking behavior [27, 34, 47]. In self-organizing knowledge co-production, the temporal perspective is particularly relevant, as the high level of fluidity in participation results in multiple tensions in the creation of a cumulative body of knowledge [22, 29]. Extant conceptualizations disagree on how individuals change their activity patterns over time [2, 13, 29, 48]. Particularly, little is known about the extent to which contributors switch roles and move between the knowledge-based products they are working on. Furthermore, our understanding of *why* contributors enact these role-transitions is quite limited. The objective of this study is, therefore, to unpack the black box of emergent role dynamics in knowledge co-production.

Our empirical investigation centers on co-production work (rather than coordination tasks or administrative duties) in Wikipedia, namely the co-authoring of encyclopedic entries. Wikipedia provides an excellent setting for our investigation of emergent roles, as co-production work is largely independent of formal access privileges and free from workflow constraints. Building on Arazy et al. [2] who identified seven emergent roles in Wikipedia, our study investigates how and why contributors transition between these emergent roles.

Our study included two samples. The analysis of the first large-scale sample aimed at delineating the temporal dynamics of emergent roles, recording how participants transition between emergent roles, as well as their mobility across knowledge-based products (i.e. Wikipedia articles) over time. By analyzing 689,514 co-production activities made by 222,119 contributors in 1,000 representative Wikipedia articles (from various topical domains and of varying maturity levels) over eleven years, we offer a first

characterization of contributors intense role-article mobility. In particular, our results illuminate four distinct categories of participants' role-taking temporal behaviors, which we label as: (I) *Role-Article Sampling* (enacting only a single role within one article); (II) *Article Embracing* (restricting activity to a single article, but switching between multiple roles); (III) *Role Embracing* (active on multiple articles, but always playing the same role); and (IV) *Role-Article Polymathing* (active across multiple articles and enacting several roles). A detailed analysis of the year-by-year activity for contributors in these four categories reveals that longevity in Wikipedia is more likely for contributors focusing on a single article (i.e. *Article Embracers*) compared to those who keep a single role over multiple articles (*Role Embracers*). An additional interesting finding is that contributors often "toy" with one article before settling their efforts on the second article they contributed to, sustaining activity in this second article for prolonged periods (this is particularly true for those in the categories of *Role Embracers* and *Role-Article Polymaths*).

Our second sample was used to investigate the motivations of 175 newcomers to Wikipedia, and their subsequent role-transition behaviors stretching over 14 months. Building on prior conceptualizations of motivation that distinguish between: (a) intrinsic versus extrinsic motives [21] and (b) self- versus others-orientation [41], we develop a 2 x 2 framework including four motivational drivers: *fun* (intrinsic, self-oriented), *friendship* (intrinsic, others-oriented), *reputation* (extrinsic, self-oriented), and *peer-approval* (extrinsic, others-oriented). An ANOVA shows statistically significant differences between role-transition categories across all of these motives. In particular, when referring to the *Role-Article Samplers* as an entry point to participation in Wikipedia and using its motivations level as a baseline, we notice that self-oriented motives (*fun*, *reputation*) are a major factor driving proliferation of both roles and articles, while the others-oriented motives have a one-dimensional effect: an increase in others/extrinsic (*peer-approval*) is associated with activity in more articles and an intensified levels of others/intrinsic (*friendship*) motivation is linked to playing multiple roles.

Together, findings from these two studies shed new light on the dynamic nature of emergent work in online co-production communities and inform the conceptualization of role mobility dynamics.

BACKGROUND AND RELATED WORK

Emergent Roles in Online Production Communities

Roles are an essential mechanism for coordinating work. In trying to explain how peer-production work is governed, the majority of studies of roles within online communities paid particular attention to the more "formal" aspects of roles, similar to those in traditional organizations. Prior studies in this area have investigated leadership roles [16], organizational roles that enable power, authority and status [4, 13, 55], and promotion processes from one formal role

to another [6, 14]. For example, formal roles in Wikipedia have been defined in terms of their access privileges, where each access privilege (e.g. *reviewer* or *sysop*) is associated with a set of responsibilities and access to community decision-making processes [6].

Notwithstanding the importance of formal roles, recent conceptualizations of self-organized co-production call to shift the focus to emergent roles – the "bundles" of activities that represent contributors' prototypical activity patterns [2] – and to ways in which they are enacted in the moment on a transient basis [1, 22, 29, 39]. For example, a recent study demonstrated that while individuals' activity patterns are turbulent, the nature of emergent roles in Wikipedia remains highly stable across time [2]. Whereas the traditional structural perspective of roles suggest that the activities performed while fulfilling a formal role are based on social expectations, norms, and status positions, the choices made by peer-production contributors are often free from such structural constraints [6]. In line with recent conceptualizations of emergent roles [22, 29], our study focuses on knowledge co-production activities (rather than non-production work, such as coordination tasks and community administration), and we operationalize emergent roles as prototypical activity patterns [2, 38, 61, 62].

While an understanding of the nature of emergent roles is beginning to form, much less is known about how and why individuals transition between emergent roles as they take part in the co-production of knowledge-based products. Delineating the temporal dynamics of emergent roles is essential for understanding the processes underlying, enabling and sustaining co-production work. A review of the literature reveals conflicting views regarding the ways in which participants enact and transition between emergent roles. Panciera et al. [48] argue that "Wikipedians are consistent. Wikipedians tend to maintain a high and constant level of participation for the majority of their lifespan". In contrast, Faraj et al [22] suggest that contributors' role taking behavior stems from a reaction to the state of the community and self-efficacy about the behavior's contribution, and does not follow a particular pattern. Other studies suggest that participants increase the breadth and depth of their activity as they move from the community's periphery to the core [13, 19, 49]. Yet another view is that although participants have much leeway in their role-enactment decisions, their activity patterns do show some regularities [2, 29].

These diverging views in previous research, coupled with insufficient empirical validation and the lack of focus on contributors' role enactment dynamics, stress the need for a a more nuanced understanding of the temporal dynamics that underlie emergent roles. A primary goal of our study is, therefore, to shed light on the process by which participants enact emergent roles and transition between roles and across articles over time.

Motivation for Contributing to Peer-Production

Sustained participation and the sharing of individuals' knowledge are critical to the viability of online communities [15, 18], and thus an understanding of contributors' motivations for participation is essential for successfully designing and managing community efforts [17, 37]. In recent years, a growing number of studies investigated volunteers' motivations for sharing information across a wide range of online communities, such as open source projects, Flickr, Twitter, and Wikipedia [49]. Some of the important factors that were studied include the improvement of skills and enhancement of status [31, 46], enjoyment [44], reciprocity [60], and identification with contributors' community [28, 54].

Many of the early studies on motivation in online production communities relied on participants' self-reported activity, treating the entire population as a uniform cohort [42, 54]. In recent years, research has moved to differentiating between participants groups based on their motivational make-up. Particularly relevant to our investigation are studies showing that participants' behavior within online production communities could be explained by their initial motivations [8]. Our investigation extends such studies by seeking to identify the motivations for *changes* in contributors' activity profiles.

Our conceptualization of motivation for participation integrates two theoretical frameworks. Self-Determination Theory (SDT; [21, 53]) is a well-established theory that places motives on a continuum between intrinsic and extrinsic motivations. Individuals are driven by intrinsic motivation when they freely and spontaneously engage in a task out of pure interest or enjoyment. In stark contrast, extrinsic motivation refers to motivation that is fundamentally compliance-based, whereby individuals engage a task in order to achieve a desired outcome. Often these countervailing motivational forces act in conjunction, such that a person performing a specific task may be driven by a combination of intrinsic and extrinsic factors. An alternative theoretical framework distinguishes between self- and others-oriented motivation [26, 41]. Self-oriented motivation is associated with the uncomplicated link between an actor and the object (i.e., task, product), whereas others-oriented motivation is concerned with an actor's social and emotional relationship around the object [9]. Based on these theoretical frameworks, a two (intrinsic vs. extrinsic) by two (self-oriented vs. others-oriented) motivation matrix was derived [12]. For this study, we selected four motivational factors that were shown to be relevant in prior studies: *fun* (intrinsic, self-oriented) [42, 56], *forming friendships* (intrinsic, others-oriented) [31], *gaining reputation* (extrinsic, self-oriented) [43, 60], and *peer-approval* (extrinsic, others-oriented) [54]. Our investigation seeks to create a linkage between a participant's motivational profile when joining the community and her subsequent role-transition behavior.

METHODOLOGY

The setting for our study is Wikipedia, which hosts many different projects, defined as the co-production of a particular article (i.e. authoring and editing of a particular encyclopedic article on a wiki page). Our starting point in this study is the approach to emergent roles in Wikipedia as characterized by Arazy et al. [2], where each role represents a prototypical activity pattern. While other studies characterized emergent roles in Wikipedia [38, 61, 62], the advantages of [2] are the reliability of the linguistic and machine learning techniques used [20], as well as their methods' ability to detect previously unobserved prototypical activity patterns (namely, "shaping" roles that correspond to recent conceptualizations of wiki-work [39]).

Set-Up: Sample, Activity Annotation, and Emergent Roles Delineation

We used the characterization of emergent roles and contributors' activity profiles from Arazy et al. [2]. The sample of 1000 articles from the January 2012 dump of the English Wikipedia was generated through a double-stratified sampling procedure. The strata were based on: (a) the maturity of articles (in terms of the number of revisions), and (b) the articles' topical domains. Altogether, this sample contained 721,806 activities (i.e. article revisions), authored by 222,119 contributors. [2] recorded data regarding the types of "production" activities (i.e. co-authoring encyclopedic entries; the Main namespace) and classified all activities (i.e. article revisions) from this sample (in each article in the sample, from its creation until the cut-off date January 4th, 2012) using a machine learning approach (with manual annotation of training data). The annotation of revisions was based on the taxonomy of wiki-work that lists 12 categories (e.g. "Create a New Article"; "Fix Typos or Grammatical Errors"; "Rephrase Existing Text"; "Add Substantive New Content"). The unit of analysis for the annotation was at the revision level, and each revision could contain multiple types of "editing work". An evaluation on a test set showed that this approach yielded good results [2]. Next, each of the contributors in the sample was represented through a vector listing the various wiki-work activities he has made. Assuming a contributor may enact different roles at different article co-authoring projects, several activity profiles were created for each contributor, one for each article he contributed to. A contributor's activity profile within a specific article has the form of [X% activity type a, Y% type b, Z% type c, etc.], where the types correspond to the wiki work taxonomy. In total, 325,417 activity vectors were created. Prototypical activity patterns were identified (as proxies for emergent roles) through a K-means clustering analysis. For example, referring to roles by letters (i.e. Role A, … Role F) and numbering the articles in our sample, contributor Joe could have played Role C in article#3 and Role E in article#17. Arazy et al. [2] found the optimal number of roles to be seven, and showed that the outcome of clustering was highly stable [32]. Please refer to

[2] for additional details regarding this initial set-up procedure.

Contributors' Dynamics across Articles and Roles

Having adopted the emergent role signatures from [2], we were ready to move to the primary goal of this study: delineating contributors' emergent role dynamics. Our analysis of individual-level dynamics identifies three key dimensions of the contributor's activity: emergent roles, articles, and years of contribution.

In order to perform this analysis, we employed a temporal bracketing strategy, recording a series of "snapshots" of the process over time [33]. We created yearly activity profiles for each contributor-article pair, starting with the time that the contributor began his activity (i.e. the Year 1 activity profile for a contributor in a particular article included all of her activity in that article over her first year of activity, and so on, until a maximum of Year 10 profile). Overall, we generated 344,360 such contributor-article-year vectors. Next, each yearly activity vector was associated with a particular emergent role (based on the proximity to cluster centroids from the global clustering solution). For example, assume that Joe's description above related to his activity in the first year of participation; and now we add that in his second year he played Role E in article#3; and in the third year: Role A in article#5 and Role B in article#17.

Using this data, we followed contributors' trajectories over time and recorded how they change the articles they are working on and transition between emergent roles. We then characterized each contributor in terms of the number of roles and distinct articles she was active in over the years, and divided the contributor population into four behavior classes: (A) active in one article enacting a single role; (B) active in multiple articles, enacting a single role; (C) active in a single article, but changing roles over time; and (D) active in multiple articles and enacting multiple roles. Continuing with the example of Joe, together across the three years of activity we record that he was active in 3 distinct articles (#3 (twice), #17 (twice), and #5) and played 4 distinct roles (C, E (twice), A, and B). Each contributor was assigned into one of the four role-transition categories (one/many roles x one/many articles). In our example, Joe would have been assigned into the [many articles, many roles] category. Finally, we performed a detailed analysis of the dynamics characterizing each category.

Linking Motivations to Role-Transition Behaviors

Employing a second smaller sample, we used a survey approach to identify individuals' motivation as they began contributing to Wikipedia. Adopting the approach from [8], we determined the distribution of participants from the 50th, 75th, 90th, 95th and 99th percentiles of Wikipedia's edit behavior (0-1 edits, 2-4 edits, 5-8 edits, 9-14 edits, and 15+ edits), and then used a stratified sampling technique to recruit approximately equal numbers of participants from each of these five strata. The first two weeks of editing

behavior were observed for all newly created accounts during a two month-long recruitment interval at May-June 2014. Potential participants with active email addresses were then randomly identified from each sampling strata, and emails containing links to the study were sent to these accounts after their first two weeks. Participants who reported having other Wikipedia accounts and those who reported being younger than 18 were removed from the sample, leaving 175 viable participants.

Measures of the four motivational factors were drawn from prior research, using one item to sample each motivational construct ["Consider how important the item is to you personally"]: *fun* ("have fun contributing to Wikipedia") [31], *forming friendships* ("developing friendships with other Wikipedia contributors") [54], *gaining reputation* ("Gaining a reputation as a valuable contributor among others who contribute to Wikipedia") [54], and *peer*-approval ("My colleagues think positively about my participation in Wikipedia") [54].

In order to create a linkage between a participant's motivational profile when joining the community and her subsequent role-transition behavior, we followed participants' activity trajectory over a fourteen month period. Similarly to the approach described above, we: automatically classified the editing activities; created a 2-month activity profile for each contributor in each of the articles he was active in; associated these activity profiles with the emergent roles from [2]; and categorized each contributor into one of the four role-transition categories (one article / one role; one article / many roles; many articles / one role; and many articles / many roles). After grouping contributors into these four categories, we used analysis of variance (ANOVA) and Fisher's Least Significant Difference (LSD) post-hoc tests to compare motivation means across categories of role-transition behavior.

FINDINGS

Having laid the methodological foundations, we now turn to the analysis of results. We start with the findings from the large-scale analysis of role-transitions of Wikipedia contributors over time, and then describe our findings from the limited scope analysis of the connections between contributors' motivation and role-transition behaviors.

Role-Transition Over Time

Our findings show that article variety per participant was characterized by a power law distribution, where the vast majority of contributors were active in only a single article (198,073; 89% of all contributors), another 10% (25,254) were active in 2-10 articles, and the remaining 1% were active in more than ten articles. A similar distribution was observed for the number of roles contributors enacted, where most of the contributors (204,755; 92%) enacted a single role, 5% (11,481) enacted two roles, and the remaining 3% enacted three or more different roles.

We identified four types of temporal behaviors, transitioning across articles and between roles (see Figure 1), which we label as: *Role-Article Sampling* [197,488 contributors; 89.1%]: contributors who tend to enact one particular role on a specific article (over 99% of which are active in a single year); *Role Embracing* contributors [7,267 contributors; 3.3%] keep to the same role, but enact it on multiple articles; *Article Embracing* contributors enacting multiple roles within a single article [585 contributors; 0.3%]; and *Role-Article Polymathing* contributors [16,362 contributors; 7.4%] exhibit the most dynamic behavior, contributing to multiple articles and playing multiple roles.

		1	2	3	4	5	6	7
7267 Role Embracers								16362 Role-Article
	3 (1000)	0	0	0	0	1	0	0
	2.75	0	2	0	0	0	2	0
	2.5	1	2	1	7	10	5	0
	2.25	0	6	0	8	20	5	1
	2 (100)	5	13	14	32	33	13	3
	1.75	7	38	61	84	72	34	3
	1.5	31	101	140	174	139	35	7
	1.25	124	242	349	369	149	32	0
	1 (10)	277	610	758	402	110	10	1
	0.75	568	1348	999	255	29	2	0
	0.5	6254	8560	1032	39	0	0	0
	0.25	197488	559	25	1	0	0	0
197488 Role-Article Samplers								585 Article Embracers

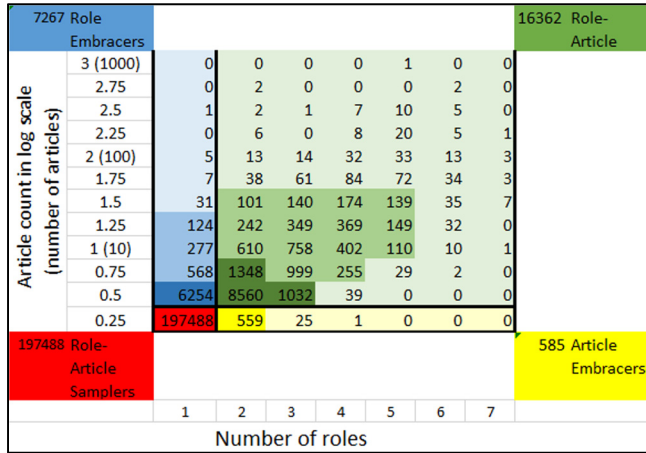(Article count in log scale (number of articles) — Y axis; Number of roles — X axis)

Figure 1. Contributors' dynamics based on year-by-year analysis: number of roles taken over the 10-year period (X axis) and number of distinct articles they have contributed to (Y axis, log scale). The colors represent the four role-article transition types.

Next, in order to provide a detailed picture of contributors' temporal role-taking dynamics, we analyzed the year-by-year patterns more closely. We "normalized" emergent role trajectories by replacing the particular articles and roles in each contributor's trajectory to generic ordered data (i.e. 1st role, 2nd role, etc.; 1st article, 2nd article, etc.). Going back to the example of contributor Joe, the first role he played

was Role C and the first article he worked on was article#3, thus his activity vectors for the 3 years would have been replaced by: first year [1st role in 1st article; 2nd role in 2nd article], second year [2nd role in 1st article]; and third year [3rd role in 3rd article; 4th role in 2nd article]. Figure 2 depicts the role-article temporal trajectories for four prototypical contributors from our sample, each representing one of the classes of dynamics identified. The aggregates of this analysis revealed the average role/article dynamics across the entire population, as well as the patterns of dynamics that are typical of each of the four contributor classes. For example, we observed that 24% of the Article Embracers worked on their focal (i.e. first) article in their third year of activity. Please refer to Figure 3 for details.

We see that *Role-Article Samplers* tend to enact one particular role in a specific article only for a single year (continuing to a second year in 0.3% of the cases, and less to additional years). *Role Embracers* keep to the same role, but enact it in multiple articles: in the first year of their activity they often contribute to a second article (76% of cases), a third (20%) and a forth (10%), and in rare cases more than ten articles; they tend to be active for shorter durations, and about 5% sustain their participation beyond three years. Interestingly, after Year 1, the focus of activity in the majority of cases moves from their first article to the second article they have worked on. Contributors working on a single article but enacting different roles (*Article Embracing*) show higher longevity: contributors remain active for multiple years (in 79%, 32%, 14%, 7%, 3% and 2% of the cases for Years 2-7 respectively). The *Role-Article Polymaths* exhibit the most dynamic behavior, contributing to many articles (in Year 1, 34% contributed to 10 or more articles) and sustaining participation over prolonged periods (in Year 4, 4% continued to contribute to their first article, and over 27% were active in additional articles; in Year 7 more than 4% are still active). As with the *Role Embracers*, we see a shift of focus to the second article after Year 1.
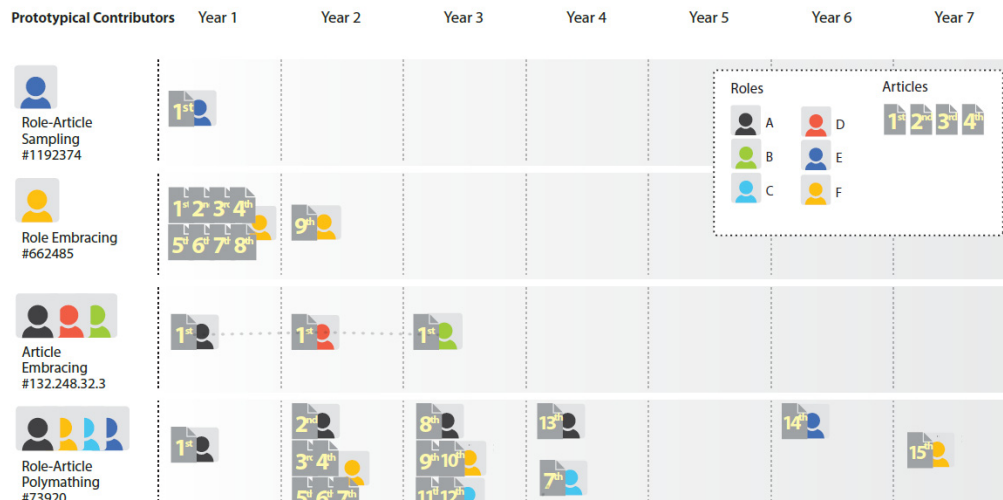

Figure 2. The article/role-transitioning behavior for four prototypical contributors representing the four classes of dynamic behavior.
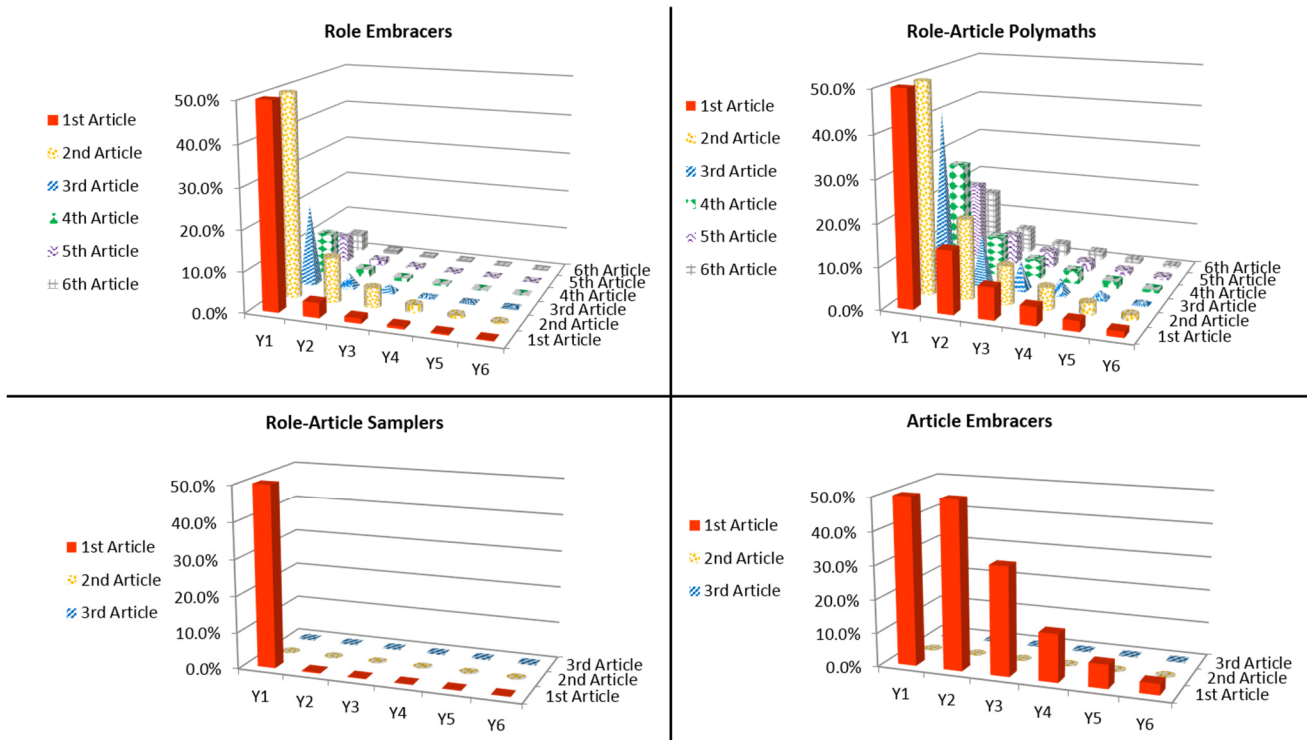
Figure 3. Contributors' temporal dynamics across articles for each of the four behavior types. The X axis represents contributors' years, beginning with their initial activity; the Y axis represents the order of articles that the contributor worked on; the Z axis represents the percentage of contributors working on their i^{th} article in a particular year of their Wikipedia career.

An analysis of contributors' activity longevity indicates that when considering only a single focal article, *Article Embracers* remain active longer than contributors belonging to different groups (see Figure 4). However, when analyzing a contributors' activity across all the articles, we find that *Role-Article Polymaths* sustain their participation over a longer horizon. Interestingly, *Article Embracers* exhibit higher longevity than *Role Embraces*, even when considering those contributors' activity across multiple articles. As expected, *Role-Article Samplers* rarely sustain their participation beyond a single year.
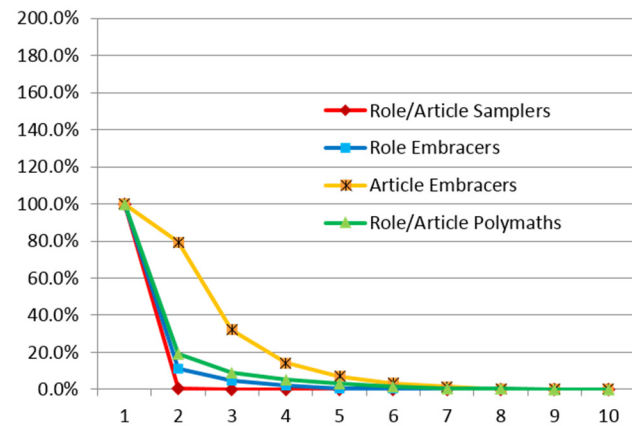

Figure 4. The longevity of Wikipedia career for each emergent role types. Percentage of contributors who were active in each year (considering any of the articles they have worked on).

Motivation Driving Emergent Role-Transition Behavior

Our analysis of the motivations for the smaller set of 175 participants revealed that contributors are primarily driven by two countervailing motivational forces: *peer-approval* (extrinsic / others-oriented; mean = 3.87; STD = 0.79) and *fun* (intrinsic / self-oriented; mean = 3.82; STD = 0.94), whereas the *reputation* motive showed moderate levels (extrinsic / self-oriented; mean = 3.04; STD = 1.41), and *friendship* was the weakest motivational factor (intrinsic / others-oriented; mean = 2.12; STD = 1.31).

The analysis of contributors' role-transition behaviors revealed that the majority of contributors fell into the *Role-Article Sampling* and *Role-Article Polymathing* categories (70 and 81 contributors; 40% and 46%; respectively), followed by *Role Embracing* (20, 11%), and the fewest number of contributors falling into the *Article Embracing* category (4, 2%).

Linking motivation to role-transition behaviors, we observe that each role-transition category is characterized by a distinct motivational profile, as illustrated in Figure 5. *Role-Article Samplers* are relatively weak in terms of all motivational drivers; *Article Embracers* are characterized by high motivation across all factors (noticeable, they are very high in terms of the intrinsic motives: fun and friendship, as well as in terms of reputation motive); *Role Embracers* could be distinguished by high peer-approval motives; and *Role-Article Polymaths* are characterized by very low friendship motive and relatively high fun motive.
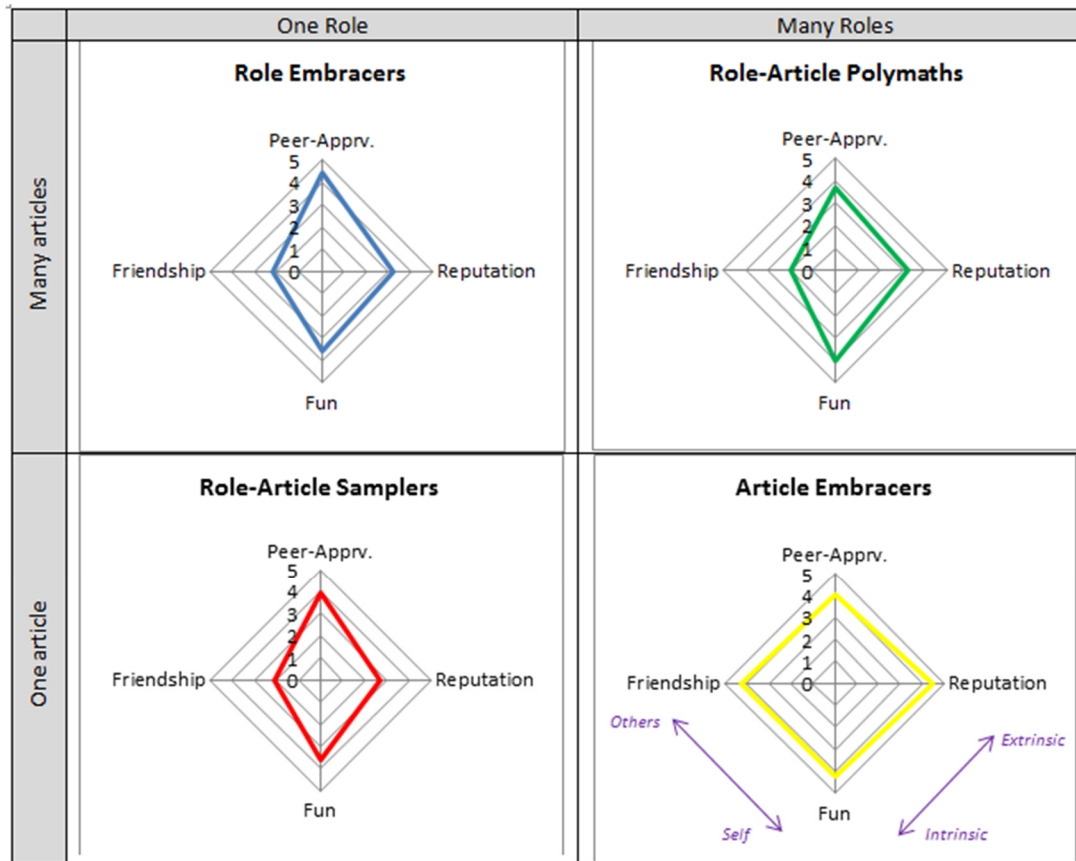
Figure 5. The motivational profiles of the four role-transition categories.

The results of the ANOVA reveal that each of the motivational constructs differs significantly across role-transition categories: *fun* (F = 3.08; p = 0.003), *forming friendships* (F = 3.98; p = 0.009), *gaining reputation* (F = 3.52; p = 0.002), and *peer-approval* (F = 4.02; p = 0.009). Please see details in Table 1 below.

Table of Motives Means (SD)	Role-Article Samplers	Article Embracers	Role Embracers	Role-Article Polymaths	F value	p value
Peer-Approval	3.90 (0.74)	4.00 (1.15)	4.41 (0.71)	3.70 (0.78)	4.02	0.009
Reputation	2.69 (1.41)	4.50 (0.58)	3.20 (1.28)	3.23 (1.40)	3.52	0.002
Fun	3.62 (0.98)	4.25 (0.50)	3.60 (1.09)	4.02 (0.83)	3.08	0.003
Friendship	2.10 (1.27)	4.25 (0.50)	2.20 (1.40)	2.00 (1.27)	3.98	0.009

Table 1. Means and standard deviation of motivation scores for the role-transition categories, and the results of the ANOVA comparing motivation scores between categories.

In order to better understand the effects of the various motivational forces, we first established the Role-Article Samplers category as the entry point to participation within Wikipedia, used that group's motivational profile as a baseline, and compared the profiles of each of the other role-transition categories against this baseline. We found that self-oriented motives (*fun*, *reputation*) are a major factor driving proliferation of both roles and articles. Namely, Role-Article Polymaths are higher than the baseline in terms of *reputation* (+20%; p < 0.05 using Fisher's Least Significant Difference; LSD) and *fun* (+11%, p < 0.01). Furthermore, the effects of these self-oriented motives are "projected" onto the article and role

dimensions, such that: (a) *reputation* motive is higher for both Article Embracers (+67%, p < 0.05) and Role Embracers (+19%); and (b) *fun* motive is higher for Article Embracers (+17%) when compared to the baseline. In contrast, others-oriented motives have a one-directional effect, whereas an increase in others/extrinsic (*peer-approval*) is associated with activity in more articles (Role Embracers +13%, p < 0.05, when compared to the baseline), and an intensified levels of others/intrinsic (*friendship*) motivation is linked to playing multiple roles (Article Embracers +102%, p < 0.001, when compared to the baseline). See Figure 6 for illustration.
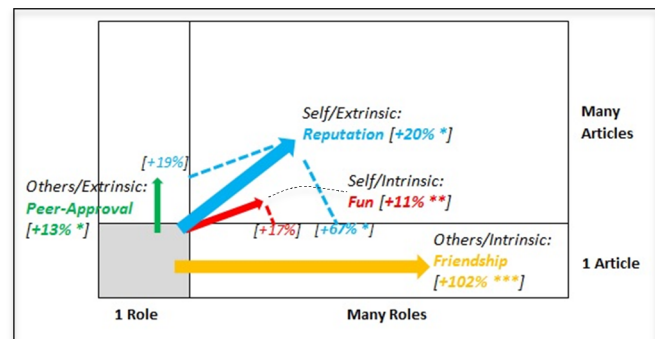

Figure 6. Motivations driving changes in role-transition behavior (compared to the baseline of Role-Article Samplers). Differences below 10% suppressed. '***' indicate differences in motivation at p < 0.001; '*' refers to p < 0.05.

DISCUSSION

Large-scale peer-production initiatives require extensive mechanisms for coordinating work. Extant explanation suggest that formal structural mechanisms are used to coordinate work activities in these settings, for example norms and policies [16, 23], quality control and conflict resolution mechanism [7, 55], and a formal role system [6]. Yet, when we look at the "production" space within Wikipedia (i.e. co-authoring of encyclopedic entries on the "Main" namespace), we notice that work is largely free from such structural constraints, such that most anybody can chose to make almost any type of activity (adding content, inserting a hyperlink, or restructuring a page's contents), without consulting the article's discussion space or looking up Wikipedia's policies. Accordingly, recently scholars have called for a shift in focus of research in this area towards a study of emergent work [22], and particularly emergent roles [2].

However, to date, the understanding of the temporal dynamics of emergent roles has been far from complete. Most of the literature on roles has focused on formal roles, where a role is a set of prescriptions defining what the behavior of a particular organizational position should be. Decades ago, role theorists alluded to the notion of emergent roles: for instance Turner [57] describes roles that are "put on and taken off like clothing" (p. 1) without lasting effect on personality; Faraj et al. [22] called for exploring "the enactment of temporary sets of behaviors that are volitionally engaged in, self-defined, and inductively created for the purposes of the online community" (p. 1231); and Welser et al [61] state that "we should aim for systems that can assess degree of role performance, and, ideally, to track assessment across time to monitor role change" (p. 128). Our study represents a first step toward this aim.

While research has long recognized that participants in peer-production differ in terms of their backgrounds, motivational make-up, and behaviors, here we propose an alternative categorization: one that is based on the temporal dynamics of participants' engagement. Through an empirical analysis of Wikipedia, we found intense levels of mobility across articles and between emergent roles, identifying four distinct behaviors: *Role-Article Sampling* (low mobility of role and articles), *Role Embracing* (low mobility of roles, high mobility of articles), *Article Embracing* (high mobility of roles, low mobility of articles) and *Role-Article Polymathing* (high mobility of both roles and articles).

Why is it important to distinguish between contributors based on their emergent role mobility? We propose that each of the four behaviors in our framework plays a distinct role in Wikipedia's co-production: some behaviors represent generalized and highly flexible behavior, while others denote a more specialized behavior (focusing on either a particular emergent role or a specific article). We maintain that generalized and specialized behavior contribute differently the communal co-creation process. Second, we show that role/article mobility behaviors are associated with participation sustainability in intricate ways (e.g. Role Embracers sustain participation over multiple years in the second article they have worked on). Third, we suggest that the motivational forces driving these distinct mobility behaviors differ significantly.

Delineating the Temporal Dynamics of Emergent Roles

Interestingly, each of the divergent perspectives in the literature provides only a partial account of role-taking behaviors, which we were able to formalize and measure using empirical data. Role-Article Sampling represents a transient behavior and often very low level of activity. These participants are only making the preliminary step from the 'reader' group to becoming a 'contributor', but after sampling wiki editing in one particular article, choose to leave Wikipedia. Turner [57] refers to this behavior as role taking and shedding, and the transient behaviors described by Faraj et al. [22] resemble our role sampling behavior. Empirical evidence to this behavior is provided by studies that have documented the high attrition of newcomers to peer Wikipedia as well as other peer production efforts [40, 48]. Our second class of role-transition behaviors, Article-Embracers, describes participants who are committed to a particular article over a longer period of time, often because of particular interest or expertise related to that article's topic. This behavior corresponds to the notion of 'content-oriented' contributors [5]. The next class of behaviors, Role Embracers, refers to participants with a very narrow portfolio of activity (i.e. a single emergent role) that enact this same activity pattern across many articles. Thus, their primary focus is the task, rather than a specific topical domain within Wikipedia. This behavior has evidence in prior empirical studies (e.g. 'administrative-oriented' contributors [5, 10, 55]). Lastly, Role-Article Polymaths, are the most agile and responsive, changing their activity patterns and moving between articles as needed. Bryant et al. [13] suggested that participants shift over time from a local focus on individual articles to a concern for the overall quality of Wikipedia, and that pattern is linked to our Role-Article Polymathing behavior (as evident in the longevity of this group's activity). While prior studies have described core community members as those serving official roles (e.g. holding special access privileges in Wikipedia, see [6]), we perceive the highly responsive Role-Article Polymaths class of contributors to represent an essential segment of Wikipedia's collaborative production process.

In sum, we are not aware of prior studies that have recorded the portfolio of engagement patterns and quantitatively characterized their temporal dynamics across roles and articles. Our findings bring a more comprehensive understanding of emergent role dynamics, proposing a framework that integrates the various perspectives in the

literature, and highlight the importance of the temporal dimension for studying complex socio-technical systems.

In addition to identifying the four types of role-article behavior, the analysis points to two characteristics of contributor behavior over time: first, as Figures 3 and 4 show, longevity in Wikipedia was more likely for participants focusing on one article (i.e. Article Embracers). This finding suggests that affinity to a particular knowledge domain (represented by the article) is more 'sticky' than task specialization (i.e. embracing a particular emergent role), which is associated with a shorter editing career. This pattern of activity may be explained by job characteristic theory [24], which suggests that jobs with a higher variety yield higher motivation and consequently commitment (that is, the narrow scope of Role Embracer's job leads to attrition). Furthermore, our findings suggest that interest in a particular topical domain is a key driver of sustained participation, in line with findings in other domains, such as citizen science [50]. More research is warranted in order to better understand the personality profiles of those belonging to the different classes of role-taking behaviors.

A second finding is that among the groups active in multiple articles (namely, Role Embracers and Role-Article Polymaths), it is not the initial article where they first experience Wikipedia editing, but rather the second article they have edited, that attracts their sustained participation. Figure 3 illustrates that in later years the second article shows higher percentage of contributors compared to all other articles. This finding has not been documented in prior empirical studies, and suggests that complementing the groups of participants who stick to the first article they have encountered, there are contributors with both narrow (Role Embracers) and broad (Role-Article Polymaths) scope of activity which identify their primary topic of interest only after sampling a what seems to be a somewhat arbitrary first article. Interestingly, although contributors in these groups often go on to experience editing additional articles, it is the second article that they tend to return to over their career in editing Wikipedia. Here, too, we call for future research that would shed light on the rationale behind these temporal role dynamics.

Motivation Driving Emergent Role Dynamics

Why do contributors transition between articles and change the emergent roles they enact? To date, much of the literature has investigated the motivation for participation in peer-production [42-44] and more recently the motivational drivers associated with particular activity profiles [8]. However, very little is known about how the motivation drives *role mobility behaviors*. In this preliminary study we demonstrate distinct motivational orientations - both in the strength of motivation and its type - are linked with contributors' role-transition patterns.

Regarding the strength of motivation, we find that contributors which demonstrate high mobility across articles and roles are highly motivated (across all categories), as opposed to those who show little mobility and low motivation. Thus, in our subsequent analysis of motivation types, we used the motivation levels of the Role-Article Samplers category as a baseline to be compared against.

Regarding the type of motivation, this study reveals that some motives are linked to role-changing behavior, while others are associated with mobility across Wikipedia articles. We found that self-oriented motives (*reputation*, *fun*) are good predictors of generalized behavior: high mobility both across articles and between emergent roles. We note that it is surprising to find in a community-based project such as Wikipedia, where contributors are presumed to be primarily interested in the social aspects [25], that those who enact the most transient behavior [22] and that exhibit the richest activity portfolio (i.e. Role-Article Polymaths) are the individuals that are driven mostly by the desire to satisfy self-oriented needs.

In contrast, we find that others-oriented motives are linked with specialization: either mobilizing across articles while embracing the role (Role Embracers) or mobilizing across roles within the same articles (Article Embracers). In particular, an increase in *peer-approval* motive (others/extrinsic), when compared to the baseline level of motivation, is linked to the Role Embracing behavior. We believe that contributors enacting such behavior are less interested in a particular topical domain, and are primarily driven to establish themselves within the community (i.e. community-oriented, as opposed to content-oriented [5, 7]). Our earlier results indicated that this behavior category is less likely to sustain participation, in line with the results of [43] which showed that contributors to citizen science projects that are driven by peer-pressure (conceptualized as norm-oriented motives) do not remain active for prolonged periods.

Friendship motivation (others/intrinsic), on the other hand, seem to drive Article Embracing behavior (their *friendship* motivation is significantly higher than all other role-transition categories). Thus, it seems that intrinsic motives are linked to a specialization around a topical domain (i.e. content orientation [5]). Theories of motivation (in particular, self-determination theory; [53]) suggest that intrinsic motives (*friendship*, *fun*) have a lasting power; indeed, we saw earlier that Article Embracers sustain their participation over the longest period. We note that while prior surveys of motivation suggested that veteran Wikipedians are characterized by intrinsic motives [31, 42], here we make a somewhat different argument: namely, we claim that the reason that they sustained their participation to become veterans is because they were driven by intrinsic motives in the first place.

Implications for Design and Management of Co-Production Communities

Our findings have important practical implications for designers and administrators of co-production communities. Rather than simply encouraging participants to become more involved – which is implied by extant frameworks such as Legitimate Peripheral Participation [35] or Reader-to-Leader [49] – we propose that participants be offered much more specific and personalized guidance regarding the nature of tasks most relevant for them. Particularly, we proposed that community's efforts to cultivate contributors and channel their efforts pay special attention to role-transition behaviors. For example, those that enact the same emergent roles across multiple articles may be offered automation tools, whereas contributors who keep to the same article (or few articles) may be best served by tools that facilitate the formation of within-article sub-communities.

We also encourage custodians of online production communities seeking to channel participation to take note of the motivational forces driving each of the four role-transition behaviors. For example, peer-approval was found to be the primary factor driving proliferation across articles (while keeping to a single emergent role), thus encouraging such form of behavior calls for interventions that would allow contributors to receive (positive) feedback for their work. Along the same vein, facilitating the formation of friendships between contributors may be most effective means for cultivating proliferation across emergent roles (while keeping to a focal article), thus helping grow the small group of *Article Embracers*.

Moving beyond online communities, key principles from the community-based peer-production model have recently begun "spilling over" into traditional organizations. Many organizations use wiki technology as a knowledge management tool, and in particular for developing Wikipedia-like organizational encyclopedias and knowledge sharing tools [3], adopting (at least in part) the organic processes that typify wiki-based collaboration over the Internet. In a similar vein, some technology companies participate in open source software development, few have adopted the principles of peer production for their internal software development projects [52] and more broadly for their organizational design (e.g. "bossless organizations" [51] and Zappos's 'holacracy' paradigm [58]). A key issue for organizations looking to adopt peer-production principles is designing for and managing role-taking and role-transitions among participants, and creating avenues for their development for effective co-production efforts. Future research could investigate generalization of our findings to more traditional organizations that are not fully based on co-production principles.

CONCLUSION

While scholars investigating online co-production communities are beginning to unravel the nature of emergent work, to date much is still unknown. Not only do existing conceptualization disagree on the extent to which emergent roles are fluid and transient, there has also been a scarcity of empirical investigations validating these conceptualizations [22, 29, 48, 49]. In particular, why and how participants transition between emergent roles and across articles is largely unknown.

Seeking to acquire a deeper understanding of participants' temporal dynamics, we identified four article-role-transition patterns, which differ in the extent to which they embrace a particular article or a specific activity pattern (i.e. emergent role). We elaborated on the logic behind these behaviors, and demonstrated how certain behaviors correspond to prior knowledge in the area, whereas other behaviors we have identified extend what was known to date about participation dynamics in online production communities. An analysis of participants' motivations revealed that distinct motives are associated with each of the four role-transition behaviors. For example, the desire to form friendships is a characteristic of Article Embracers.

Notwithstanding the novelty of our findings regarding the intricacies of participants' activity dynamics, our study provided only a preliminary investigation and much research is still warranted. First, the investigation of motivation could be enhanced to incorporate additional motivational factors, employ multi-item scales, and include more participants. Given the preliminary nature of our investigation of motivation (as well as the difficulty associated with surveying contributors and receiving their agreement to record subsequent activity) we sampled the domain of motivational constructs using single-item measures. We acknowledge that such measures suffer in their reliability. Nonetheless, we observed statistically significant effects for these constructs. Given the limited reliability of measures, in all likelihood, the observed effects serve as lower bounds for the true effects of our model's motivational drivers. Second, whereas this study investigates distinct role-transition behaviors, we propose that future research move to exploring ecologies of these behaviors, potentially shedding light on the contextual factors (e.g. article's topical domain or maturity level) that determine the optimal composition of role/article mobility behaviors. Third, the scope of the investigation could be broadened to other co-production communities and findings should be generalized. In particular, it would be interesting to explore the effects of structural (e.g. the underlying IT platform) and community (for example, governance modes) on contributors' motivation and activity trajectories. Furthermore, in order to provide a broader understanding of antecedents (e.g. participants' personality [31]) and consequences (e.g. product quality [5]) of participants' article-role-transition behaviors, future investigation is warranted.

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REFERENCES

[1] Judd Antin, Coye Cheshire, and Oded Nov, Technology-mediated contributions: editing behaviors among new wikipedians. *Proceedings of the 2010 ACM conference on Computer Supported Cooperative Work (CSCW)*, Seatttle, WA, 2012. 373-382.

[2] Ofer Arazy, Johannes Daxenberger, Hila Lifshitz-Assaf, Oded Nov, and Iryna Gurevych, "Turbulent Stability of Emergent Roles: The Dualistic Nature of Self-Organizing Knowledge Co-Production," *Information Systems Research,* In Press.

[3] Ofer Arazy, Ian Gellatly, Esther Brainin, and Oded Nov, "Motivation to share knowledge using wiki technology and the moderating effect of role perceptions," *Journal of the Association for Information Science and Technology,* 2015.

[4] Ofer Arazy, Oded Nov, and Felipe Ortega, The [Wikipedia] World is Not Flat: on the organizational structure of online production communities. *The 22nd European Conference on Information Systems (ECIS'2014)*, Tel-Aviv, Israel, 2014.

[5] Ofer Arazy, Oded Nov, Raymond Patterson, and Lisa Yeo, "Information quality in Wikipedia: The effects of group composition and task conflict," *Journal of Management Information Systems,* vol. 27, pp. 71 - 98, 2011.

[6] Ofer Arazy, Felipe Ortega, Oded Nov, Lisa Yeo, and Adam Balila, Functional roles and career paths in Wikipedia. *Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work & Social Computing*, 2015. 1092-1105.

[7] Ofer Arazy, Lisa Yeo, and Oded Nov, "Stay on the Wikipedia task: When task-related disagreements slip into personal and procedural conflicts," *Journal of the American Society for Information Science and Technology,* vol. 64, pp. 1634-1648, 2013.

[8] Martina Balestra, Oded Arazy, Coye Cheshire, and Nov Oded, Motivational determinants of participation trajectories in Wikipedia. *Proceedings of the 10th International Conference on Weblogs and Social Media (ICWSM 2016)*, Cologne, Germany, 2016.

[9] Mark A Barnett, Michael Klassen, Vera McMinimy, and Laurel Schwarz, "The role of self- and other-oriented motivation in the organ donation decision," *NA-Advances in Consumer Research Volume 14,* 1987.

[10] Patrick Bateman, Peter Gray, and Brian Butler, "Community commitment: How affect, obligation, and necessity drive online behaviors," *Proceedings of ICIS 2006* p. 63, 2006.

[11] Y Benkler, *The wealth of networks: How social production transforms markets and freedom*: Yale Univ Press, 2006.

[12] Elisabeth Brüggen, Martin Wetzels, Ko de Ruyter, and Niels Schillewaert, "Individual differences in motivation to participate in online panels: the effect on reponse rate and reponse quality perceptions," *International Journal of Market Research,* vol. 53, pp. 369-390, 2011.

[13] Susan Bryant, Andrea Forte, and Amy Bruckman, "Becoming Wikipedian: transformation of participation in a collaborative online encyclopedia," presented at the international ACM SIGGROUP conference on Supporting group work, Sanibel Island, FL, 2005.

[14] Moira Burke and Robert Kraut, Mopping up: modeling wikipedia promotion decisions. *Proceedings of the 2008 ACM conference on Computer supported cooperative work (CSCW)*, San Diego, California, USA, 2008. 27-36.

[15] Brian Butler, "Membership Size, Communication Activity, and Sustainability: A Resource-Based Model of Online Social Structures," *Information Systems Research,* vol. 12, pp. 346-362, 2001.

[16] Brian Butler, Elisabeth Joyce, and Jacqueline Pike, Don't look now, but we've created a bureaucracy: the nature and roles of policies and rules in wikipedia. *Proceedings of the CHI conference on human factors in computing systems*, Florence, Italy, 2008. 1101-1110.

[17] Coye Cheshire and Judd Antin, "The social psychological effects of feedback on the production of Internet information pools," *Journal of Computer Mediated Communication,* vol. 13, pp. 705-727, 2008.

[18] Chao-Min Chiu, Meng-Hsiang Hsu, and Eric T. G. Wang, "Understanding knowledge sharing in virtual communities: An integration of social capital and social cognitive theories," *Decision Support Systems,* vol. 42, pp. 1872-1888, 2006.

[19] Kevin Crowston, Kangning Wei, Qing Li, and James Howison, "Core and Periphery in Free/Libre and Open Source Software Team Communications," presented at the Proceedings of the 39th Annual Hawaii International Conference on System Sciences - Volume 06, 2006.

[20] Johannes Daxenberger and Iryna Gurevych, "Automatically Classifying Edit Categories in Wikipedia Revisions," in *Proceedings of the Conference on Empirical Methods in Natural Language Processing*, ed. Seattle, WA, USA, 2013, pp. 578-589.

[21]   Edward L Deci and Richard M Ryan, "The "what" and" why" of goal pursuits: Human needs and the self-determination of behavior," *Psychological inquiry,* vol. 11, pp. 227-268, 2000.

[22]   Samer Faraj, Sirkka L Jarvenpaa, and Ann Majchrzak, "Knowledge collaboration in online communities," *Organization science,* vol. 22, pp. 1224-1239, 2011.

[23]   A. Forte, V. Larco, and A. Bruckman, "Decentralization in Wikipedia governance," *Journal of Management Information Systems,* vol. 26, pp. 49-72, 2009.

[24]   J Richard Hackman and Greg R Oldham, "Work redesign," 1980.

[25]   Aaron Halfaker, Aniket Kittur, and John Riedl, Don't bite the newbies: how reverts affect the quantity and quality of Wikipedia work. *Proceedings of the 7th International Symposium on Wikis and Open Collaboration (WikiSym'2011),* Mountain View, CA, USA, 2011. 163-172.

[26]   Andrea Hemetsberger, "Fostering cooperation on the Internet: social exchange processes in innovative virtual consumer communities," *NA-Advances in Consumer Research Volume 29,* 2002.

[27]   Tor Hernes, *A process theory of organization*: OUP Oxford, 2014.

[28]   Guido Hertel, Sven Niedner, and Stefanie Herrmann, "Motivation of software developers in Open Source projects: an Internet-based survey of contributors to the Linux kernel," *Research Policy,* vol. 32, pp. 1159-1177, 2003.

[29]   Gerald C Kane, Jeremiah Johnson, and Ann Majchrzak, "Emergent life cycle: The tension between knowledge change and knowledge retention in open online coproduction communities," *Management Science,* vol. 60, pp. 3026-3048, 2014.

[30]   Karim R Lakhani and Jill A Panetta, "The principles of distributed innovation," *innovations,* vol. 2, pp. 97-112, 2007.

[31]   Karim R Lakhani and Robert Wolf, "Why hackers do what they do: Understanding Motivation Effort in Free," in *Perspectives in Free and Open-Source Software*, B. Fitzgerald J. Feller, S. Hissam, & K. Lakhani Ed., ed: MIT Press, 2005.

[32]   Tilman Lange, Volker Roth, Mikio L Braun, and Joachim M Buhmann, "Stability-based validation of clustering solutions," *Neural computation,* vol. 16, pp. 1299-1323, 2004.

[33]   Ann Langley, "Strategies for theorizing from process data," *Academy of Management review,* vol. 24, pp. 691-710, 1999.

[34]   Ann Langley, Clive Smallman, Haridimos Tsoukas, and Andrew H Van de Ven, "Process studies of change in organization and management: unveiling temporality, activity, and flow," *Academy of Management Journal,* vol. 56, pp. 1-13, 2013.

[35]   J Lave and E Wenger, *Situated Learning: Legitimate Peripheral Participation*. Cambridge, UK: Cambridge University Press, 1991.

[36]   Hila Lifshitz-Assaf, "From problem solvers to solution seekers: dismantling knowledge boundaries at NASA," *Available at SSRN,* 2014.

[37]   K Ling, G Beenen, P Ludford, X Wang, K Chang*, et al.*, "Using Social Psychology to Motivate Contributions to Online Communities," *Journal of Computer-Mediated Communication,* vol. 10, 2005.

[38]   Jun Liu and Sudha Ram, "Who does what: Collaboration patterns in the Wikipedia and their impact on article quality," *ACM Trans. Manage. Inf. Syst.,* vol. 2, pp. 1-23, 2011.

[39]   Ann Majchrzak, Christian Wagner, and Dave Yates, "The Impact of Shaping on Knowledge Reuse for Organizational Improvement with Wikis," *MIS Quarterly,* vol. 37, pp. 455-469, 2013.

[40]   Brian James McInnis, Elizabeth Lindley Murnane, Dmitry Epstein, Dan Cosley, and Gilly Leshed, One and Done: Factors affecting one-time contributors to ad-hoc online communities. *Proceedings of the 19th ACM Conference on Computer-Supported Cooperative Work & Social Computing*, 2016. 609-623.

[41]   Mark Mendenhall and Gary Oddou, "The dimensions of expatriate acculturation: A review," *Academy of management review,* vol. 10, pp. 39-47, 1985.

[42]   Oded Nov, "What motivates wikipedians?," *Communications of the ACM,* vol. 50, pp. 60-64, 2007.

[43]   Oded Nov, Ofer Arazy, and David Anderson, "Scientists@ Home: what drives the quantity and quality of online citizen science participation?," *PLoS ONE,* vol. 9, p. e90375, 2014.

[44]   Oded Nov, Mor Naaman, and Chen Ye, "Analysis of participation in an online photo sharing community: A multi-dimension perspective," *Journal of the American Society for Information Science and Technology,* vol. 61, pp. 555-566, 2010.

[45]   Siobhan O'Mahony and Karim R Lakhani, "Organizations in the shadow of communities," *Research in the Sociology of Organizations,* vol. 33, pp. 3-36, 2011.

[46]   Shaul Oreg and Oded Nov, "Exploring motivations for contributing to open source initiatives: The roles of contribution context and personal values," *Computers in Human Behavior,* vol. 24, pp. 2055-2073, 2008.

[47]   Wanda J Orlikowski and JoAnne Yates, "It's about time: Temporal structuring in organizations," *Organization science,* vol. 13, pp. 684-700, 2002.

[48] Katherine Panciera, Aaron Halfaker, and Loren Terveen, Wikipedians are born, not made: a study of power editors on Wikipedia. *Proceedings of the ACM 2009 international conference on Supporting group work*, 2009. 51-60.

[49] Jennifer Preece and Ben Shneiderman, "The Reader-to-Leader Framework: Motivating technology-mediated social participation," *AIS Transactions on Human-Computer Interaction,* vol. 1, pp. 13-32, 2009.

[50] Nathan R Prestopnik and Kevin Crowston, Gaming for (citizen) science: exploring motivation and data quality in the context of crowdsourced science through the design and evaluation of a social-computational system. *e-Science Workshops (eScienceW), 2011 IEEE Seventh International Conference on*, 2011. 28-33.

[51] Phanish Puranam and Dorthe Døjbak Håkonsson, "Valve's Way," *Journal of Organization Design,* vol. 4, pp. 2-4, 2015.

[52] Dirk Riehle, John Ellenberger, Tamir Menahem, Boris Mikhailovski, Yuri Natchetoi*, et al.*, "Open collaboration within corporations using software forges," *IEEE Software,* vol. 26, pp. 52-58, 2009.

[53] Richard M Ryan and Edward L Deci, "Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being," *American Psychologist,* vol. 55, pp. 68-78, 2000.

[54] Joachim Schroer and Guido Hertel, "Voluntary engagement in an open web-based encyclopedia: Wikipedians and why they do it," *Media Psychology,* vol. 12, pp. 96-120, 2009.

[55] Besiki Stvilia, Michael Twidale, Linda Smith, and Less Gasser, "Information quality work organization in Wikipedia," *Journal of the American Society for Information Science and Technology,* vol. 59, pp. 983-1001, 2008.

[56] L Torvalds and D Diamond, *Just for fun: The story of an accidental revolutionary*: Harper Business, 2002.

[57] Ralph H. Turner, "The Role and the Person," *American Journal of Sociology,* vol. 84, pp. 1-23, 1978.

[58] Pepijn van de Kamp, "Holacracy - A Radical Approach to Organizational Design - *Elements of the Software Development Process- Influences on Project Success and Failure.*," *University of Amsterdam,* pp. 13-26, 2014.

[59] Georg Von Krogh and Eric Von Hippel, "The Promise of Research on Open Source Software," *Management Science,* vol. 52, pp. 975-983, 2006.

[60] Molly Wasko and Samer Faraj, "Why should I share? Examining social capital and knowledge contribution in electronic networks of practice," *MIS Quarterly,* vol. 29, pp. 35-57, 2005.

[61] Howard T. Welser, Dan Cosley, Gueorgi Kossinets, Austin Lin, Fedor Dokshin*, et al.*, "Finding social roles in Wikipedia," presented at the Proceedings of the 2011 iConference, Seattle, Washington, 2011.

[62] Diyi Yang, Aaron Halfaker, Robert Kraut, and Eduard Hovy, Who Did What: Editor Role Identification in Wikipedia. *International Conference on Web and Social Media (ICWSM-16). Cologne, Germany*, 2016.