Stay on the Wikipedia Task:

when task-related disagreements slip into personal and procedural conflicts

Abstract

In Wikipedia, volunteers collaboratively author encyclopedic entries, and therefore managing conflict is a key factor in group success. Behavioral research describes three conflict types: task-related, affective, and process. Affective and process conflict have been consistently found to impede group performance; however, the effect of task conflict is inconsistent. We propose that these inconclusive results are due to under-specification of the task conflict construct, and focus on the transition phase where task-related disagreements escalate into affective and process conflict. We define these transitional phases as distinct constructs: task-affective and task-process conflict, and develop a theoretical model that explains how the various task-related conflict constructs, together with the composition of the wiki editor group, determine the quality of the collaboratively-authored wiki article. Our empirical study of 96 Wikipedia articles involved multiple data-collection methods, including the analysis of Wikipedia system logs, manual content analysis of article's discussion pages, and a comprehensive assessment of articles' quality using the Delphi method. Our results show that when group members' disagreements − originally task-related − escalate into personal attacks or hinge on procedure, these disagreements impede group performance. Implications for research and practice are discussed.

Introduction

Recent years have seen the emergence of a new community-based model for the production of knowledge-based goods; primary examples of this model include open source software and Wikipedia. With the rapid growth in peer-production initiatives, there is a need to better understand how self-organized communities work together to produce quality products (such as articles or software). Being the largest collaborative project online, Wikipedia (a peer-produced online encyclopedia) offers a unique opportunity to study the dynamics of IT-enabled collaborative production process. Theoretical frameworks developed in the context of traditional organizations may not be adequate for studying peer-production work processes (O. Arazy, Nov, Patterson, & Yeo, 2011; Von Krogh & Von Hippel, 2006).

Prior literature identifies team composition and conflict management as two central aspects in Wikipedia's collaborative authoring process. Team composition refers to the roles that group members play and the distribution of these roles within the group. One of the important characteristics of Wikipedia group members is their community[1]- vs. content-orientation. O. Arazy et al. (2011) describe content-oriented editors as having low commitment, identification and engagement with the Wikipedia community as a whole, with editors in this group usually contributing to a small number of articles. Community-oriented members, on the other hand, are characterized by high commitment, identification, and engagement; they distribute their contribution across a large number of articles and often volunteer to take on additional responsibilities. The characteristics are summarized in Table 1. Prior research has shown that the orientation of group members affects both the ability of the group to manage conflict and the quality of the peer-produced product (O. Arazy et al., 2011).

Insert Table 1 here

In large scale collaborations, conflict is inevitable (O'Neil, 2009). The organizational literature identifies three types of conflict – task-related, affective , and process-related conflict (Pamela J. Hinds & Bailey, 2003; Jehn & Mannix, 2001). Task-related conflict refers to differences in viewpoints and opinions regarding the subject of a group task; affective conflict (also referred to as relationship or emotional conflict) refers to team disagreements that are characterized by anger or hostility among group members; and finally, process conflict refers to controversies about aspects of how the task is to be accomplished. While process and affective conflict have been shown to have a negative impact on production, there is mixed evidence regarding the effect of task conflict on group performance for both collocated and virtual teams (Chidambaram & Carte, 2005). Extant literature on collocated and virtual teams reveals that task conflict inhibits performance, unless teams are able to effectively resolve conflict (Pamela J. Hinds & Mortensen, 2005; Jarvenpaa, Knoll, & Leidner, 1998; Ocker, Hiltz, Turoff, & Fjermestad, 1995). In distributed teams, coordination of conflict resolution is more difficult, and thus task conflict often hinders group performance (Mortensen & Hinds, 2001).

The Wikipedia collaborative-authoring process includes extensive discussions regarding the content that should be included in the encyclopedic entries and task conflict has been identified as a central part of this process (O. Arazy et al., 2011; A. Kittur, Suh, Pendleton, & Chi, 2007; Aniket Kittur, Suh, & Chi, 2009; Kriplean, Beschastnikh, McDonald, & Golder, 2007; Viegas, Wattenberg, Kriss, & Van Ham, 2007; Viégas, Wattenberg, & Dave, 2004). Prior studies investigating the effect of task conflict on the effectiveness of collaborative knowledge production have yielded mixed results. Our conjecture is that these mixed results are due – at

least in part – to under-specification of the conflict construct. In particular, we focus our investigation on hybrid conflict types that lie at the intersection between task, process, and affective conflicts, as illustrated in Figure 1. We refer to these situations where Wikipedia disagreements get off task and slip into personal and procedural conflicts as *task-affective* and *task-process* conflicts. In addition to investigating the effects of three task-related conflict types ("pure" task conflict, task-affective, and task-process conflict) on performance, we also examine how group members' orientation affects groups' ability to effectively manage these task-related conflicts.

Insert Figure 1 here

To better understand the dynamics of the different hybrid conflict types, we conduct an empirical study of the English version of Wikipedia with individual articles as the unit of analysis, using multiple data-collection methods. The authoring of each article represents a distinct group project, and the group is defined by the set of authors who contribute to the article. We estimate group composition by analyzing Wikipedia system logs. Our measures of the three task-related conflict types is based on content analysis of articles' discussion pages, and the measure of the group performance is the quality of the collaboratively-authored article (assessed through a Delphi process).

The primary contribution of our work is in developing a fine-grained conceptualization of conflict types, focusing on the areas of transition from task conflict to affective and process conflict. Through our analysis, we are able to shed light on the reason for the contradictory effects observed for task-related conflict in prior studies of online collaboration (Chidambaram & Carte, 2005). Although our investigation focuses on task-related conflict within the context of

large scale peer-production, we believe that the notion of hybrid conflict types is very much relevant to the study of conflict within organizational settings, and that the findings from this study could inform organizational research.

The paper proceeds as follows: the next section reviews work related to the study's constructs; the following section develops hypotheses regarding the relationships between these constructs; we then describe the research methodology and present the results of our empirical study; the last two sections discuss the implications of our findings.

Literature Review

Earlier, we identified two central themes in Wikipedia's collaborative authoring process: (I) the effect of task-related conflict on group performance and (II) the effect of group members' orientation on conflict, as well as its direct impact on the effectiveness of the peer-production process. Here we review studies related to these themes, as well as works related to the group's output: the quality of Wikipedia articles. We focus primarily on studies within the context of Wikipedia or in other types of peer-production (namely open source software development), as well as studies in the related areas of online communities and virtual teams.

Information Quality

The quality of the final product is an important aspect of determining the success of collaborative processes. Measuring information quality, however, is not a simple task; some scholars subscribe to an objective view and consider aspects such as factual correctness, while others take a more subjective view and look at how well the information meets the user's

expectations (Hilligoss & Rieh, 2008). Wang and Strong (1996) propose a more general definition – "fitness for use" – to embody both the objective and subjective aspects, and this definition has been adopted for our study[2]. Information quality is a multi-dimensional construct (Taylor & Voigt, 1986) with a wide body of research on its underlying dimensions (O. Arazy & Kopak, 2011; Hilligoss & Rieh, 2008; Y. W. Lee, Strong, Kahn, & Wang, 2002; Wang & Strong, 1996). We focus on a limited set of relevant information quality dimensions – accuracy, completeness, objectivity and representation – selected for their frequent use in prior studies of Wikipedia (O. Arazy & Kopak, 2011; O. Arazy et al., 2011; West & Williamson, 2009).

Group Members' Orientation

The role of individual Wikipedia contributors has been studied extensively (Beschastnikh, Kriplean, & McDonald, 2008; Bryant, Forte, & Bruckman, 2005; Aniket Kittur, Chi, Pendleton, Suh, & Mytkowicz, 2007; Stvilia, Twidale, Smith, & Gasser, 2008; Viegas et al., 2007). Group composition is often examined in terms of a core-periphery structure, particularly in peer production communities, where a small group of highly active core members are responsible for the bulk of production (Crowston, Wei, Li, & Howison, 2006; Kuk, 2006; Long & Siau, 2007; Mockus, Fielding, & Herbsleb, 2002). Here, we are interested in a related construct: group member orientation. There are two prototypical users in online communities such as Wikipedia: contributors who restrict their participation to content creation and administrators who have chosen to take on additional organizational responsibilities (Anthony, Smith, & Williamson, 2009; Beschastnikh et al., 2008; Bryant et al., 2005; Aniket Kittur et al., 2007; O'Neil, 2009). O. Arazy et al. (2011) characterize community-oriented users as those who identify with the community and take on additional responsibilities for infrastructure and social management

tasks, while content-oriented contributors tend to be attracted to the specific topic with less interest in the broader project or community. Both types of group members can contribute to the collaborative production process: content-oriented members often contribute unique domain-specific expertise (Anthony et al., 2009; G. K. Lee & Cole, 2003), while community-oriented people play an essential role in managing conflict. Thus, the optimal group composition includes a balance of content- and community-oriented members (O. Arazy et al., 2011).

Conflict

Conflict – within and between groups – is a central theme in modern sociology (Boulding, 1962; Coleman, 1957; Collins, 1975; Coser, 1956; Kriesberg, 1973; Schelling, 1960). Hoffman, Harburg, and Maier (1962) argued that conflict is the central construct that mediates the relationship between group composition and performance, and this assertion has been supported by later studies (e.g. (Damon, 1991; Gruenfeld, Mannix, Williams, & Neale, 1996; Jehn, Northcraft, & Neale, 1999; Levine, Resnick, & Higgins, 1993; Mannix & Jehn, 2004; Neale & Bazerman, 1991). Recent organizational studies have proposed three conflict categories: task, affective, and process (e.g. (Pamela J. Hinds & Bailey, 2003; Jehn & Mannix, 2001) which we describe below.

Task Conflict

Task conflict refers to differences in viewpoints and opinions pertaining to a group task. Conflicts of opinions are inherent to the Wikipedia collaborative authoring process (Kane & Fichman, 2009; A. Kittur et al., 2007; Kriplean et al., 2007; Viégas et al., 2004). Decisions about whether a piece of text, link, or image should be included, reordered, or rephrased are all

grounds for heated discussion, and resolving these disputes through consensus is the most fundamental discursive work that Wikipedians perform (Kriplean et al., 2007). Even within the bounds of Wikipedia policies, there are often contentions, conflicts, and power plays, where an editor or a group tries to influence the content and claim legitimate control over the article (Kriplean et al., 2007). Conflicts may be observed in the evolution of the article by studying the comments editors append to it (Viégas et al., 2004). In addition, a 'talk page' is associated with each article and provides a place for editors to argue their positions, negotiate disagreements in opinions, and try to reach a consensus (Bryant et al., 2005; Kriplean et al., 2007; Viégas et al., 2004). An analysis of some 4,200 comments in 625 distinct discussion pages revealed that changes appeared and disappeared repeatedly as the community wrestled for control of content; the most common issues in the discussion pages were task-related conflicts: what content should be added or removed and how information should be structured (Kane & Fichman, 2009).

In organizational settings, task conflict has been shown to have mixed effect on group performance. While in some studies task conflict is associated with negative outcomes (Jehn, 1997), other studies demonstrate its positive effects (Eisenhardt, Kahwajy, & Bourgeois, 1997; Jehn & Shah, 1997; Jehn, 1995; Shah & Jehn, 1993). Task conflict enhances group performance in complex tasks that require significant cognitive effort (the type of task that is the focus of our research), because teams benefit from differences of opinion about the work being done (Bourgeois, 1985; Eisenhardt & Schoonhoven, 1990; Jehn, 1995; Shah & Jehn, 1993). Task conflict, in the absence of pressure to conform to a dominant viewpoint, often leads members to revise fundamental assumptions, engage in cognitive restructuring, and generate novel insights, thus avoiding "groupthink" (Janis, 1972) and leading to enhanced problem solving (Damon, 1991; Pelled, Eisenhardt, & Xin, 1999; Perret-Clermont, Perret, & Bell, 1991). The synthesis that

emerges from the task conflict is generally superior to the individual perspectives themselves (Schweiger & Sandberg, 1989; Schwenk, 1990).

In distributed teams, task conflict is expected to have negative outcomes (Pamela J. Hinds & Bailey, 2003; Mortensen & Hinds, 2001), since conflict is only beneficial to the extent that it is expressed and resolved through the process of building shared understanding, and building such a consensus on even fairly mundane tasks is exceedingly difficult for teams separated by distance (R. E. Kraut, Fussell, Brennan, & Siegel, 2002). Moreover, technology mediation contributes to the negative effects, as communicating complex information via technology takes longer (Straus & McGrath, 1994), is subject to delay (R. Kraut, Galegher, Fish, & Chalfonte, 1992), and can require more cognitive effort (P.J. Hinds, 1999). Thus, distributed team members may have more difficulty resolving task conflict, and thereby will rarely benefit from it (Pamela J. Hinds & Bailey, 2003). Task conflict in the context of Wikipedia was shown to have direct negative effects and indirect positive effects (through moderating the effects of cognitive diversity) on group performance (O. Arazy et al., 2011).

Affective Conflict

Emotions are not inherently destructive for group processes, and emotional involvement acts to signal a member's credibility of commitment. Commitment leads to increased involvement, helps motivate others, and improves group performance (Meyer, Becker, & Vandenberghe, 2004; Siders, George, & Dharwadkar, 2001). However, when affect leads to conflict, it usually inhibits group performance. Researchers have reported that affective conflict consistently detracts from performance across varying contexts (Amason, 1996; Eisenhardt et al., 1997; Jehn, 1997; Jehn, Chadwick, & Thatcher, 1997). Affective conflict often hampers

performance as a result of the anxiety, hostility, and time and energy consumption associated with emotional disagreements (Pelled et al., 1999).

In general, the impact of affective conflict in distributed teams is similar to the negative effect observed in traditional teams. Geographic distribution has contradicting effects that cancel out each other (Pamela J. Hinds & Bailey, 2003). On one hand, distance and technology-mediation enable people to avoid interaction with members with whom they did not get along, and such avoidance restricts the effect of affective conflict (Pelled et al., 1999); on the other hand, distribution increases the chances of faulty and harsh attributions (Cramton, 2002), and thus enhances affective conflict.

Process Conflict

Process conflict has been investigated to a lesser extent than task conflict and affective conflict, and the few studies that have examined the relationship between process conflict and performance in traditional teams suggest that process conflict negatively affects group performance (Jehn, 1997; Jehn & Mannix, 2001; Jehn et al., 1999). Disagreements regarding procedures, resources, and responsibilities detract from performance, because they absorb effort, increase confusion, and result in inefficiencies (Jehn, 1997). Druskat and Wolff (2007) argue that the act of enforcing group norms can take up valuable time, negatively impacting the effectiveness of the group. This change of focus draws energy away from the creative process and may even spawn emotional conflict (Druskat & Wolff, 2007), further affecting group performance. In distributed teams, the impact of process conflict is magnified due to difficulties in communication and coordination (Grinter, Herbsleb, & Perry, 1999).

Multi-category Conflict

The classification reviewed above refers to "pure" conflict types; however, in reality, a disagreement between group members may intertwine task, process, and affective aspects, and often disagreements in opinions that begin with a focus on the task escalate to incorporate affective and procedural dimensions. Overall, there is very little prior research on the hybrid conflict types (namely task-affective and task-process conflicts).

Task-Affective Conflict

Task-affective conflict refers to emotional conflict that is grounded in disagreements related to the article contents. This often starts as a "pure task" conflict, and escalates to include emotional elements. In Wikipedia, task–affective conflict may manifest itself in (a) emotional statements regarding the topic of the article, or (b) personal attacks on other authors with reference to their opinions. Take for example the discussions between editors (carried out on Wikipedia's 'Talk" pages) for the article on Keith Olbermann, an American political commentator and writer:

> *Please "source" an article, book, or ANYTHING that shows he is a "news anchor." To place a JOB TITLE in this article, shouldn't the burden of proof lie with those claiming he does that job? Here's the fact: HE DOESN'T DO THE JOB OF A "NEWS ANCHOR"!!!! I like Keith, but that's just the truth! Watch the show. He doesn't function as a "news anchor." He doesn't CLAIM to function as a "news anchor." Why do you all insist on leaving that job in his bio? If there's no explanation for why it's there, should it not be removed? Consensus or no, based on the above--and general common sense--I am*

removing "news anchor" from the article. Please do not insert in unless you

have sourced where he does the job of a "news anchor."

Here we see how factual information regarding Olbermann's job begins to carry an angry

tone (evident through the capitalizing and exclamation marks).

A transition phase, where task conflict begins to carry an emotional tone, has been

identified in several studies (Jehn, 1995). Such escalation of conflict is common in peer-

production projects, as illustrated above. Task conflict can become destructive to a team and its

performance when it spirals out of control, provokes anger and becomes personal (Druskat &

Wolff, 2007). It has been shown that when task conflict escalates, it can quickly become

personal, negatively affecting members' willingness to compromise, and overall hurting

collaboration; groups that are more individualistic (or exhibit a more competitive orientation) are

likely to suffer more from such conflict escalation (Goncalo & Krause, 2010).

Task-Process Conflict

Task conflict may also escalate into process conflict in situations when disagreements

about the task itself shift into arguments about *how* the task should be done, often referring to

organizational regulations or procedures. These situations are common in online collaboration. In

Wikipedia, this is typically a discussion of how the text of the article stands in relations to

Wikipedia norms and standards, for example, disagreements about the contents of an article may

shift to focus on editing norms such as the Neutral Point of View (NPOV). Take for instance

Wikipedia's Talk page on the Buddhist leader Karmapa, where a controversy about the content

makes reference to earlier discussion and guidelines regarding the scope of articles:

"The links are there mainly as they provide historical information about the previous Karmapas, and come from both camps. As you can see from the discussion, the idea was to isolate the controvesial [sic] parts in one article, as otherwise annonymous [sic] edits from supporters of both camps were editing this, and various other Kagyu related pages, in ways to reflect their point of view. One thing you might consider is to make a page for Urgyen Thrinley Dorje. This way we can have accurate biographical information, hopefully still keeping the controversy isolated in one page."

In general, the positive effects associated with task conflict persist only when conflict is not complicated by process disagreements (Jehn & Chatman, 2000). When the focus shifts from controversies regarding what needs to be accomplished to disagreements on how to perform the task (i.e. task conflict is "contaminated" with process conflict), the result is inefficiencies that inhibit group performance (Jehn, 1997).

In sum, considering the conflicting evidence regarding task conflict reported in prior studies, we suggest these mixed results are due - at least in part - to under-specification of the conflict construct as well as a lack of focus on hybrid conflict types and the more nuanced understanding of group dynamics that they offer. While there is research on how the proportions of each conflict type affect performance (Jehn & Chatman, 2000), no prior study specifically examines what happens at the transition where task conflict begins to carry an emotional or procedural tone. Moreover, no prior study has examined the effects of these hybrid conflict types on group performance. Group members' orientation, with its demonstrated capacity to affect

conflict levels and information quality directly, may have an additional role to play in understanding how these transitional conflict states affect production.

Theory development

Given the absence of a theoretical model that explains how entangled forms of task conflict and group member orientation variables interact to determine content quality there is a need to develop a Wikipedia-centric theoretical model. A step in this direction is made by O. Arazy et al. (2011) who link theory from related work on virtual teams and online communities, examining how group composition and work processes such as task conflict interact to affect group output in a Wikipedia-centric setting. In developing our hypotheses we follow up on this earlier study and build upon three primary literatures: team conflict, group composition, and information quality. We explain what effects we expect to persist in our examination and extend frameworks where necessary.

Task Conflict Affects Information Quality

Conflict is often viewed as a central concept in explaining the links between group composition and performance (Hoffman & Maier, 1961; Pelled et al., 1999). Task conflict has been shown to have conflicting effects on group performance, with some studies associating task conflict with negative outcomes (Jehn et al., 1997), while others demonstrate its positive effects (Eisenhardt et al., 1997; Jehn & Shah, 1997; Jehn, 1995). However, for complex tasks requiring significant cognitive effort, such as the task we focus on in this research, task conflict has been shown to enhance group performance because teams benefit from differences of opinion about

the work being done (Bourgeois, 1985; Eisenhardt & Schoonhoven, 1990; Jehn, 1995; Shah & Jehn, 1993). The explanation for these positive effects is that task conflict (a) makes members more receptive to new information, (b) fosters a deeper understanding of task issues, (c) increases the range of alternatives considered, (d) motivates members to question fundamental assumptions and engage in cognitive restructuring, (e) allows assumptions and recommendations to be evaluated systematically, and (f) eventually leads to novel insights and enhanced problem solving (Amason, 1996; Pelled et al., 1999; Woodman, Sawyer, & Griffin, 1993). For example, Pelled et al. (1999) found that task conflict had a positive association with cognitive task performance in work groups and Amason (1996) reported that task (or cognitive) conflict is positively related to the quality of group decisions. In cognitively-demanding tasks, the synthesis that emerges from the negotiation of viewpoints is generally superior to the individual perspectives (Schwenk, 1990). Recently, a number of studies on organizational learning and innovation have stressed the positive role of creative friction - or abrasion - in facilitating innovation and learning (Leonard-Barton, 1995; Matsuo, 2006). Thus, task conflict can contribute to the quality of the information-based group output by encouraging members to reassess existing knowledge, challenge others' viewpoints, and come up with creative solutions.

Evidence suggests that creative abrasion occurs in online communities, and conflicts were found to help in clarifying issues, eventually resolving disagreements, and reaching an often better commonly-accepted solution (Franco et al., 1995; K. Williams & O'Reilly, 1998). We expect Wikipedia groups to experience such a creative abrasion since the collaborative editing task is complex and requires much cognitive effort. Therefore, we propose that "pure" task conflict (i.e. task conflict that is devoid of any affective or procedural elements) will have a beneficial effect on information quality:

Hypothesis 1: Pure task conflict is positively related to information quality.

The relative proportions of each conflict type (task, affective and process) have been shown to play a significant role in the success of group production (Jehn & Chatman, 2000). However, to date no work has examined what happens at the boundaries, where pure task conflict becomes complicated with either affective or process conflict. We specifically examine these areas, expecting to see different effects on information quality (from the effect hypothesized for pure task conflict).

In general, the positive effects associated with task conflict persist only when conflict is not complicated by process disagreements and does not degenerate into affective conflict (Jehn & Chatman, 2000). When the focus shifts from controversies over what needs to be accomplished to disagreements on how to perform the task (i.e. task conflict is entangled with process conflict), the result is inefficiencies that inhibit group performance (Jehn, 1997). Similarly, when task-related differences are misdirected towards affective conflict, group performance suffers, as emotional and task conflict reinforce one another, and the negative effects of affective conflict overshadow any positive effects derived from task conflict (Jehn & Mannix, 2001). When teams are distributed teams, it is more difficult to resolve task-related conflict, and thus we expect that any escalation of task conflict into other conflict types would inhibit group performance.

We can expect that along the task/affective border, when group work becomes distracted from the task and "pure" task-related disagreement begins to devolve into personal conflicts, we expect a negative impact on group outcome. We, thus, hypothesize:

Hypothesis 2: Task-affective conflict is negatively related to information quality.

Likewise, we would expect, then, that along the task/process border, when the group loses focus on the work task and gets occupied with procedural disagreements, the negative aspects of process conflict over-ride the positive effects of pure task conflict. We, thus, propose:

Hypothesis 3: Task-process conflict is negatively related to information quality.

Group Members' Orientation, Task Conflict, and Information Quality

While there is extensive literature describing the roles of administrators in Wikipedia (Aniket Kittur et al., 2007; Kriplean et al., 2007; O'Neil, 2009) and other communities (Butler, Sproull, Kiesler, & Kraut, 2007), as well as their contribution in terms of quality assurance, conflict resolution and the development of procedures, few studies link this administrative work to product quality. Recently, O. Arazy et al. (2011) developed the construct of group members' orientation, distinguishing between community and content orientations. They further showed that (a) the more the group's orientation gravitates towards the community end the lower task conflict levels are and (b) the more the group's orientation leans towards the content focus the higher the quality of the group product (i.e. the Wikipedia article). Drawing from O. Arazy et al. (2011), we conceptualize group members' orientation "as a single construct on a continuum between community and content orientation" (O. Arazy et al., 2011) (p.79). The proportions of group members acting as administrators versus occasional contributors to the article's topic determine the degree to which a group is community or content oriented. As community-oriented users have already internalized Wikipedia norms and processes such as Wikipedia resolution procedures, articles where group members are more community oriented would likely show lower levels of conflict. Thus, we propose that community oriented groups will show lower levels of pure task conflict.

Hypothesis 4a: The more group members gravitate towards community orientation, the lower the "pure" task conflict experienced by the group.

In particular, administrators are familiar with the specific Wikipedia procedures intended to address affective and procedural conflicts, and thus should be well equipped to handle task-affective and task-process conflicts. Hence, we hypothesize:

Hypothesis 4b: The more group members gravitate towards community orientation, the lower the task-affective conflict experienced by the group.

Hypothesis 4c: The more group members gravitate towards community orientation, the lower the task-process conflict experienced by the group.

Finally, there is a direct effect of group members' orientation; content-oriented members are responsible for the completeness and accuracy of the article. With insufficient content-oriented members, articles will likely be left incomplete. Further, it has been found that occasional contributors are essential in innovation processes, contributing subject area expertise that may not be possessed by the more community members (Anthony et al., 2009; O. Arazy et al., 2011; Kuk, 2006; G. K. Lee & Cole, 2003). Thus, we propose the following hypothesis regarding group orientation:

Hypothesis 5: The more group members gravitate towards content orientation, the higher the quality of the article the group produces.

Control Variables

Several control variables are used to control for exogenous factors. First, we control for the number of editors participating in the collaborative authoring process (i.e. *Group Size*). Second, we control for factors related to the Wikipedia article. Articles mature slowly through an active process of incremental refinements that improve the quality of the article. Thus, the age of an article reflects its maturity and is expected to be associated with quality. Likewise, the level of editorial activity (i.e. *Article Activity*) contributes to the quality, reflecting the pace at which improvements are being made. Finally, article length is also an important factor, possibly indicating the completeness of an article. In addition, we control for cognitive diversity that has been shown to impact information quality (O. Arazy et al., 2011). Overall, we control for five factors: group size; article age, activity, and length; and cognitive diversity. The proposed model is illustrated in Figure 2.

Insert Figure 2 here

Methodology

We conducted an empirical study of the English version of Wikipedia. The unit of analysis is an article, the authoring of each article represents a distinct group project, and the group is defined by the set of authors who contributed to the article. Since group output in Wikipedia is an encyclopedic entry about a specific topic, group performance was defined by the quality of the article.

Modeling our approach after O. Arazy et al. (2011), we randomly sampled articles from Wikipedia, with the requirement that the article's length is between 200 and 3500 words. An

article's topic may impact conflict levels, since some topics are more controversial than others (Aniket Kittur et al., 2009). In order to represent the various Wikipedia topics, we used a stratified sampling approach, congruent with Wikipedia's top-level classification[3] (Aniket Kittur et al., 2009), which we organized into a smaller set of six mutually exclusive and collectively exhaustive classes: (a) culture, art, and religion, (b) math, science, and technology, (c) geography and places, (d) people and self, (e) society, and (f) history and events. The length limit excludes undeveloped ('stub') articles, and captures approximately 98% of the non-stub articles[4]. We randomly sampled articles from this population, 17 articles from each category (102 in total), using Wikipedia's "Random Article" feature. After some preliminary analysis, we found that we had to exclude 6 articles: articles that have not passed the early inception phase (of age less than one month), articles with two or fewer editors, as well as articles that were discontinued by Wikipedia during the study's duration, arriving at a list of 96 articles. As part of the discussion page analysis (see details below), 7 articles were used for training, leaving us with a sample of 89 articles.

In order to measure the quality of Wikipedia articles in our sample, we employed the article quality assessments from O. Arazy et al. (2011). A copy of each article in the sample was made, and this version of each article was analyzed by three senior librarians at a major North American university. The librarians used a variety of sources for judging the quality of Wikipedia articles, including reports that were prepared by undergraduate students as part of a class assignment. After an initial training session, each of the three librarians independently analyzed the articles in random order by both performing her own analysis of the topic and by using the students' reports. The librarians were asked to pay attention to the particular set of relevant information quality dimensions described in the section reviewing studies of

information quality: accuracy, completeness, objectivity and representation. Once the librarians independently marked their perceptions of the articles' quality along these dimensions, a researcher facilitated a consensus building process, where conflicting views of article quality were negotiated and an agreement was reached (in line with the Delphi methodology (Linstone & Turoff, 2002))[5]. The consensus quality value for each article (on a 7-point Likert scale) was used as the *information quality* measure.

The three conflict variables – *'pure' task*, *task-affective*, and *task-process*, were measured by an analysis of articles' Discussion Pages. Wikipedia associates a discussion page with each article's main page. Editors commonly use the discussion page to discuss, argue, and negotiate their views regarding the information that should be included in an article's main page. Thus, the discussion pages serve as the primary mechanisms for managing conflicts in Wikipedia (A. Kittur et al., 2007; Viegas et al., 2007; Viégas et al., 2004). Since the discussion page captures the conflicts, challenges, and decisions in the group involved in creating the article, it is recommended as a source for studying the group's dynamics (Kane & Fichman, 2009), and in particular, task-related conflict (O. Arazy et al., 2011). Four independent assessors who were undergraduate students at a large North-American university analyzed the discussion page of each article in the sample, and marked the text relating to either of the three conflict types. The basic unit of coding was "an idea": an undivided argument, proposition or explanation (Chi, 1997). An idea often corresponds to a paragraph and spans several sentences; however, messages in discussion pages do not always follow conventions, and an idea may in some cases cover a portion of a paragraph and in other cases more than a paragraph. Hybrid conflict types were marked only in cases where there was evidence for both conflict types within a single unit of coding. Building on the work of Jehn and Mannix (2001) on "pure" conflict types, as well as on

our newly-introduced definitions of task-affective and task-process conflict types, we developed a procedure for identifying evidence for the various conflict types in Wikipedia discussion pages. The four research assistants independently analyzed each article's discussion page (in random order) and highlighted the sections in each discussion page that reflect the various task-related conflict types. We began with a training session study, where the four assessors analyzed seven Wikipedia discussion pages. Through this process we refined our operationalization of the various conflict constructs, developed guidelines for handling borderline cases, and ensured that the assessors employed a common standard in their assessment (see Appendix). Once the procedure had been established, assessors analyzed the discussion pages in our sample. We estimated the scope of task conflict for each article based on the word count of the highlighted sections. We employed the average of the four assessors as our measure, and inter-rater agreement was calculated using the intra-class correlation agreement (ICC agreement). Inter-rater agreement was 0.97, 0.62, and 0.75 for "pure" task, task-affective, and task-process conflict respectively, indicating substantial to outstanding agreement levels (Landis & Koch, 1977).

Group members' orientation was measured by 'harvesting' Wikipedia, relying heavily on article history logs maintained by Wikipedia and contributors' personal pages. The data was cleaned by excluding all non-human authors (i.e. software bots). Since the contents of Wikipedia change continually, the estimates for all constructs were based on the article version on which quality assessments were made. The operationalization of group members' orientation was borrowed from O. Arazy et al. (2011), treating it as a reflective latent construct[6], where high values indicate community-orientation and low values denote content-orientation. We measured this construct using four items, in line with the characteristics described in Table 1. First, we calculated the proportion of group members who hold an official 'administrator' status within

Wikipedia. Second, we calculated the average number of edits the article authors have made across Wikipedia at large, where a high value is associated with community-orientation. Third, since content-oriented members concentrate on specific articles, but their overall contribution to Wikipedia is low, we calculated the ratio of members' overall Wikipedia edit activity to their article activity; a high ratio indicates a community–orientation and a low value denotes content-orientation. Fourth, since community-oriented members spread their activity across many articles and content-oriented contributors are characterized by a concentration on a few topics (Adamic, Zhang, Bakshy, & Ackerman, 2008), we analyzed – for each member – the dispersion in his Wikipedia activity pattern. We used the entropy measure (Ancona & Caldwell, 1992; Cummings, 2004), $Entropy = -\sum_{i=1}^{N} P_i \ln P_i$, where N is the number of states (i.e. different articles to which the member has contributed), and P_i is the probability of being in state i (i.e. the percentage of edits in that specific article). Entropy is high when a member contributed evenly across the various articles, and is low when he concentrated his activity on few articles. Entropy is well-suited for estimating the extent to which categories are equally represented, as it measures dispersion irrespective of the location of the mean, unlike variance which measures concentration only around the mean (Ebrahimi, Maasoumi, & Soofi, 1999). We then calculated the average of group members' entropy, where a high value denotes community-orientation and low entropy signifies content-orientation.

The operationalization of the control variables followed O. Arazy et al. (2011). *Group Size* was measured based on the number of editors who have contributed to the article. *Article Age* was measured by the number of days since the inception of the article. *Article Activity* was extracted from the article's 'History' tab and calculated as the number of revisions (i.e. edits) the article went through. *Article Length* was measured by the number of words included on the

article's wiki page. *Cognitive diversity* was estimated based on the uniqueness of group members' experiences within Wikipedia articles other than the specific article at hand. For each editor group, we created a 2 dimensional matrix; one dimension lists all the group members and the other dimension all the Wikipedia articles that were edited by at least one of the members. Each cell indicated whether the editor was active on that specific article (0 or 1). Our measure of cognitive diversity was based on the sparsity of the matrix (i.e. the percent of cells with zeros (Stoer & Bulirsch, 2002)).

Results

Descriptive Statistics

Descriptive statistics are outlined in Table 2 below. Discussion pages' average level of conflict was relatively low, where 28% of the discussion pages reflected "pure" task conflict, 5% showed evidence of task-process conflict and merely 0.2% reflected task-affective conflict. The average group included 49 active content contributors, where 15% of the contributors are administrators, 52% regular members, and 33% have contributed anonymously. Members of an article group made, on average, over 6,200 edits to Wikipedia articles. The average article was over 2 years old, went through roughly 90 edits, and included close to 1000 words. Cognitive diversity was on average 0.92, reflecting little overlap in members' activity outside the group. Finally, the average quality of articles was 4.4 out of 7.

Insert Table 2 here

Path Model

Data analysis was conducted using the *Partial Least Squares* (PLS) algorithm (Jöreskog & Wold, 1982), which estimates multi-stage path models using composite variables from a number of indicator items. In this respect, the variance-based PLS path modeling is similar to covariance-based structural equation modeling (SEM), because both algorithms estimate complex relations between several latent variables simultaneously. Compared to covariance-based SEM, PLS can be used with smaller samples, thus it is well-suited for this study. Furthermore, PLS requires fewer assumptions about data distributions, and is robust in case these assumptions are violated (Cassel, Hackl, & Westlund, 1999), making it suitable for dealing with varibles of non-normal distribution (some of our variables exhibit power-law distribution).

The ordinal indicator item of *information quality* was treated as interval scale variable. The psychometric properties of the instrument were analyzed before examining the data for hypothesis testing. The estimate for composite reliability of the multi-item *group members' orientation* construct was 0.94, well above the recommended threshold of 0.8 (Nunnally, 1978), thus demonstrating good internal consistency. Convergent validity for all constructs was good. The average variance extracted (AVE) for *group members' orientation* was 0.79, substantially greater than the suggested minimum of 0.5 (Fornell & Larcker, 1981), and item loadings were 0.79-0.94, greater than the suggested level of 0.7.

Discriminant validity was examined by comparing the square root of the AVE (RAVE) of a particular construct (presented in Table 3 on the diagonal, in bold) and the correlation between that construct and other latent constructs (Fornell, 1987) (presented in the off-diagonal positions of the table), as well as based on item loadings. We found discriminant validity to be good. The constructs' RAVE are 0.89 or higher, RAVE for every construct is higher than the correlation between that construct and all other constructs. The correlations between latent constructs were

below the recommended threshold of 0.5, with one exception related to the control variables. The correlation between two of the control variables - *group size* and *article activity* - was extremely high (0.98). Due to multi-linearity concerns we were not able to include both controls in the same model, and tested the model twice, alternating between *group size* and *article activity*. Item loadings on their corresponding constructs were all above 0.7 (the lowest value was 0.78), and those loadings were substantially higher than any cross-loadings on any other construct, thus further supporting discriminant and convergent validity.

Insert Table 3 here

Next, we tested the research model by specifying paths in the PLS structural model corresponding to the model's hypotheses. The significance of structural path estimates was computed using the bootstrapping re-sampling method (with 200 re-samples; cf. (Tenenhaus, Vinzi, Chatelin, & Lauro, 2005)), and the structural model was evaluated based on both the R^2 for each composite variable and the statistical significance of structural paths. All the independent variables were standardized. Figure 3 shows the results of the PLS analysis (when using *Group Size* as a control; similar results were found when using *article activity* instead).

Insert Figure 3 here

A substantial amount of variance in *information quality* was explained by our model ($R^2 = 32\%$)[7]. The effects of all paths but one (the effect of "*pure" task conflict* on *information quality*; H1) were statistically significant. The results of the PLS analysis demonstrate that the *task-affective conflict* (H2) and *task-process conflict* (H3) have a negative impact on *information*

quality. Group member's orientation has negative effects on all task-related conflict constructs (H4a-c), as well as a direct negative effect on *information quality* (H5).

Discussion and Conclusion

The success of community-based projects has attracted significant attention in the research community (Von Krogh & Von Hippel, 2006), and Wikipedia has been investigated extensively in recent years (Kane & Fichman, 2009; Wagner & Majchrzak, 2007). Yet, by and large, these studies provided limited insight on the factors contributing to Wikipedia success (and specifically to article quality). A recent study (O. Arazy et al., 2011) has identified two key factors affecting Wikipedia article quality: task conflict and group member's orientation. In this study we followed up on this earlier study, we took a closer look at the construct of task conflict and distinguished between "pure" task conflict and task conflict that begins to escalate towards affective or process conflict. We, then, analyzed the relationships between *group members' orientation*, the three conflict types – *"pure" task*, *task-affective*, and *task-process conflicts* – and *information quality*.

A key finding from our study is that *task-affective* and *task-process conflicts* negatively affect the quality of the peer-produced articles (H2 and H3; effects sizes 0.17 ($p < 0.001$) and 0.24 ($p < 0.01$), while *"pure" task conflict* does not have a significant effect (H3). Our study also shows that *group members' orientation* negatively affects the three conflict constructs: *"pure" task conflict* (H4a; effect size = 0.39; $p < 0.001$), *task-affective conflict* (H4b; 0.13; $p < 0.001$), and *task-process conflict* (H4c; 0.20; $p < 0.001$). The direct effect of *group members' orientation* on *information quality* is also negative (H5; effect size = 0.28; $p< 0.001$). Finally, one of the

control variables: *group size* had a significant positive effect on the outcome variable (effect sizes was 0.35), while *cognitive diversity, article length,* and *article age* had insignificant effects. The results when using *article activity* as a control instead of *group size* were indistinguishable[8]. Overall, the control variables exerted significant effects on *information quality*, raising R^2 levels from 16% to 32%. This is not surprising given that the controls captured the *magnitude* of activity (in terms of number of unique contributors, total activity, age, and content scope), showing that variables capturing the *nature* of groups' membership and dynamics (i.e. *group members' orientation* and task-related *conflict* variables, all measured in terms of relative proportions) have significant effects even when controlling for the magnitude of activity illustrates the importance of these constructs.

The main contribution of this study is enhancing our understanding of task-related conflict within community-based knowledge production. Our model distinguishes between "pure" task conflict and task-related conflicts that are tainted with affective or process conflicts. We argue that the inconclusive results regarding the effects of task conflict in prior studies are, at least in part, due to underspecification of the task conflict construct.. In particular, our study demonstrates that only when group members' disagreements – originally task related – begin to carry an emotional tone or hinge on procedure do these disagreements impede group performance. Disagreements that remain focused on the task do not have significant effect on group performance, at least in the context of our study. Prior studies on task conflict did not make this distinction between pure and hybrid task-related conflict and have pulled all under the task-conflict constructs. Our study shows that even when the hybrid conflict types represent a small proportion of the conversation (in our case, 5% of articles' discussion pages), they can have significant effects. Thus, we argue that when both hybrid and pure task conflict constructs

are amalgamated (as was the case in many prior studies), the negative effects of the hybrid conflict constructs can overshadow the effects pure task conflict. The key implication for research is, then, a call for a more careful measurement of task conflict, where all evidence for task-related conflict that is tainted with either affective or procedural elements is excluded. Perhaps measuring task-conflict through the use of perception-based scales (as in (O. Arazy et al., 2011)) is suboptimal, calling for a more fine-grained examination of group conversation along the lines of the method developed in the current study. Our findings inform the active discussions of conflict in online groups (Franco et al., 1995; Lehmann, 2004; R. L. Williams & Cothrel, 2000), and in particular in the context of Wikipedia (O. Arazy et al., 2011; A. Kittur et al., 2007; O'Neil, 2009).

A third contribution of this study is in demonstrating that group members' orientation has a consistent effect on the three task-related conflict constructs, such that the more group members are community-oriented the more the group is able to restrain conflict levels. While there is extensive literature describing the roles of administrators in Wikipedia (Aniket Kittur et al., 2007; Kriplean et al., 2007; O'Neil, 2009) and other communities (Butler et al., 2007) and their contribution in terms of quality assurance, conflict resolution and the development of procedures, few studies link administrative work to product quality. Recently, O. Arazy et al. (2011) developed the construct of group members' orientation, distinguishing between community and content orientations. They further showed that (a) the more the group's orientation gravitates towards the community end the lower task conflict levels are and (b) the more the group's orientation leans towards the content focus the higher the quality of the group product (i.e. the Wikipedia article). In addition to corroborating findings from this earlier study regarding the effect of group members' orientation on information quality, the contribution of the present study

is in demonstrating that a group's community orientation acts to curb each of the three conflict types under investigation: "pure task, task-affective, and task-process conflicts.

Optimal group composition includes a balance of community- and content-oriented members. On one hand, group members' community orientation acts to restrain task-affective and task-process conflicts, limits their negative impact, and thus indirectly positively affects information quality; on the other hand, content-oriented members are essential for developing high-quality articles, since these occasional contributors sometimes possess expertise that surpass the skills of those in official roles. Our findings regarding the direct effects of members' orientation are of special importance, given that most research on online communities, and in particular studies of peer-production, assumes that greater engagement leads to more successful projects, and thus focuses on the motivational factors driving participation and engagement (O Nov, 2007; Oreg & Nov, 2008; Von Krogh & Von Hippel, 2006). Our findings reveal that this line of research provides only a partial explanation of the factors driving the success of online communities, and that the inclusion of occasional, content-oriented contributors (who are often less engaged and active) is essential to producing quality outputs.

In addition, our findings have two important implications for practice. First, managing task conflict and providing conflict resolution tools is essential for online communities. Communities should follow Wikipedia's example to develop norms and procedures that encourage groups to stay on task, ensure that disagreements of opinions remain task-related, and provide the tools for preventing conflicts from escalating into affective or process conflicts. Our results regarding the significant negative effects of very small amounts of task-affective and task-process conflicts suggest that communities should react promptly and effectively to any signs of conflict that gets away from strict task-related disagreement. Some have suggested that the success of Wikipedia

can be attributed to the diversity of opinions and knowledge-bases it attracts (i.e. 'The Wisdom of the Crowds' argument); our findings suggest that Wikipedia's extensive conflict resolution mechanisms are responsible for ensuring collaboration is effective. A second important practical implication is in illustrating that it is difficult to compose groups for effective performance, since opposing ends along the group members' orientation continuum – community- and content-orientation – both play an important role, and it would be challenging to optimize the effects of these opposing forces. Organizers of online production communities should strive to reduce entry barriers in order to entice the participation of occasional content-oriented contributors (which may possess relevant expertise) and increase group diversity; at the same time, they should strive to include some community-oriented members that would streamline the production process and help diffuse conflicts.

Our study provides preliminary results and further research is warranted. The study concerns a large number of projects in one setting (i.e. Wikipedia), providing a useful context for the preliminary validation of our research model, as the setting controls for exogenous factors that might have interfered in an inter-organizational study (e.g. differences in organizational culture and norms). We expect our findings will generalize to other forms of community-based knowledge production projects; however, it is possible that specific features of Wikipedia (both in terms of the social mechanisms and underlying technological infrastructure) play a role in allowing the effects of group composition and task conflict. Hence, further research is warranted in order to test whether our findings hold in other types of production communities (e.g. open source software development (Lakhani & Wolf, 2005; O. Nov & Kuk, 2008) or wikis within a corporate setting (O. Arazy & Croitoru, 2010; Ofer Arazy & Gellatly, in press). Another way in which our study could be extended is in the operationalization and measurement of the newly-

introduced hybrid conflict constructs. Finally, our proposed model is limited in scope and we hope that future research would conduct more comprehensive investigation of the factors explaining the success of community-based projects. In particular, it would be interesting to explore a more dynamic model of Wikipedia's collaborative authoring process, for example by studying group dynamics (e.g. how insiders influence peripheral members; how authors move between roles) or temporal activity patterns.

In conclusion, we believe that Wikipedia can serve as a test bed for studying decentralized IT-enabled production of knowledge-based goods. Although recent years have seen an explosion in the number of studies of Wikipedia, and the success of Wikipedia-like projects remains to a large extent unexplained. This study extends current understanding of online production communities by enhancing our knowledge of the role of relatively unexplored, yet important, factors, namely task-affective and task-process conflict. We hope that this study will open the door to future research in this area.

Acknowledgements

Appendix – Categorizing Conflict in Discussion Pages

Assessors were asked to categorize the discussion page text, using "an idea" – an undivided argument, proposition or explanation - as the unit of coding. An idea often corresponds to a paragraph and spans several sentences; however, messages in discussion pages do not always follow conventions, and an idea may in some cases cover a portion of a paragraph and in other cases more than a paragraph.

Text analysis was based on the following guidelines.

Task Conflict – conflicting views and opinions regarding the article being authored. These typically include disagreements regarding the contents of the article. We distinguish between three types of task conflict:

Pure task – strictly about the information that should be included in the article. The task involves writing an encyclopedic entry that is accurate, comprehensive, unbiased, and clear. Thus any arguments or opinion exchanges that relate to the accuracy, bias, reliability of references, or clarity fall into this category. Example: *"Jim was born in Argentina in 1954 and not in Belgium"*

Task-Process – task-related conflict that includes procedural elements. Typically, this is a discussion of how the text of the article stands in relations to Wikipedia norms and standards. Example: *"This article should be merged with article XYZ as they both describe different aspects of the same phenomenon, and Wikipedia guidelines state that we should have one article per topic"*

Task-Emotional – emotional conflict that is grounded in disagreements related to the article contents. This often starts as a "pure task" conflict, and escalates to include emotional elements. Task – emotional conflict may manifest itself in (a) emotional statements regarding the topic of the article, or (b) personal attacks on other authors with reference to their opinions. Example: *"You are full of bullshit; how can you write such nonsense; you obviously have never read the key references on this topic."*

Borderline Cases – Some statements are hard to classify, as they fall in between categories. The following guidelines should help categorization in these cases:

Pure Task vs. Task-Process: Task-Process refers to Wikipedia standards, while Pure Task conflict does not.

Process vs. Task-Process: Process conflict does not relate to the contents of the specific article (or to the contents of the discussion page); it is strictly about Wikipedia-wide procedures. Task-Process relates existing standards to a topical disagreement.

Emotional vs. Task-Emotional: Task-Emotional conflict relates to the contents of the article or the discussion page; it is linked to a disagreement about the article, while pure emotional conflict isn't.

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Footnotes

[1] Arazy et al. (2011) used the term "administrative-oriented" group members. However, in order not to confuse with editors who are formally designated as administrators, we prefer to use the term "community-oriented" to describe editors whose primary focus is meta-work and community building.

[2] We do note in reference to the work of Wang and Strong (1996) the concept of 'data quality' is considered distinct from 'information quality.' However, for the purpose of our investigation, there is sufficient similarity between information and data quality.

[3] For a list of Wikipedia top-level categories, please refer to
http://en.wikipedia.org/wiki/List_of_overviews

[4] The lower limit of 200 words excludes stubs, which represent roughly 30% of all Wikipedia articles. Very long articles are rare since Wikipedia's guidelines suggest that articles be concise, such that Wikipedia articles contain on average 460 words. Thus, the upper limit of 3500 words on article length excludes only extremely lengthy outliers.

[5] We used a consensual approach for measuring information quality since agreement levels between assessors' independent assessments did not reach satisfactory inter-rater agreement levels.

[6] Modeling members' orientation as a formative construct was not appropriate in this case because of concerns related to content coverage, as well as multicollinearity and network effects (Cenfetelli & Bassellier, 2009)

[7] When excluding control variables, R^2 was = 16%.

[8] It is worth noting that when running the model without the control variables, the same set of hypotheses were supported (i.e. all hypotheses but H1).