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Designing a Successful Collaborative Wiki:
The Choice between Outcome Quality and Online Community Needs

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ABSTRACT

Designing a collaborative platform that produces project outcomes of high quality and allows for wisdom of the crowds to come together in the achievement of a common goal can be a challenge. Literature often addresses the interplay between designing for online community needs and outcome/product quality as coexistence, where design implementations in one positively affect the other. However, Human-Computer Interaction research has shown that performance and satisfaction need not be dependent on each other. This paper performs a theoretical analysis of the literature on the topic and identifies design gaps for collaborative projects. Findings derived by this theoretical analysis challenge existing design perspectives by demonstrating that there is often a tradeoff between designing for online community needs and outcome quality for these projects. Claims were developed that lead to research questions identifying the most important elements and design considerations are provided along with potential future directions for advancing the understanding of this relationship.

KEYWORDS

Collaborative Project, Community Design, Online Community Needs, Outcome Quality, Wikipedia

1. INTRODUCTION

Lü Buwei (291-235 BCE), counselor-in-chief of the Qin Ancient Chinese state, has been said to have recruited three thousand scholars that utilized their collective knowledge to generate one of the first encyclopedias in the world that was a product of a large group of authors. The result was Lüshi Chunqiu, which became an encyclopedic Chinese classic text, whose components remain almost unchanged for thousands of years. At the time it was produced, gathering a large group of people and assigning them to compile a work that will stand the test of time was no small feat. However, little is known on the processes and design that lead to the project's success. Lü had to deal with satisfying his scholars and also meet the goals that were set for his encyclopedia. Were the two objectives aligned or did he had to tradeoff one for the other? Similarly, in today's Web 2.0 world, our knowledge on what contributes to an online collaborative wiki project's success from a design standpoint is limited. Should design proactively promote satisfying community needs and expect that

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performance will be influenced indirectly through this process or are the two elements not mutually beneficial and under what conditions?

Over the course of the past decade we have seen social media and collaborative projects fill every aspect of our lives (Jiangnan, Chunling, & Miao, 2014; Kaplan & Haenlein, 2010; Lai & Yang, 2014; Yang & Lai, 2011). Collaboration has become diverse and is not just limited to encyclopedic editing but also tasks such as programming, activism and citizen journalism. Organizations are attempting to employ collaborative projects in order to become more efficient. However, historically some social media projects have been more successful than others (Boyd & Ellison, 2007) and the same applies for collaborative wiki projects. Investing human labor as well as finances towards a collaborative project is a timely as well as an expensive endeavor. Organizations, managers and designers need to make accurate decisions which affect the structure of a collaborative project in order to ensure its success. Therefore, since some collaborative projects are more successful than others, it is important to identify what design elements can enhance success in the context of serving online community needs while attempting to achieve project objectives.

There has been an extensive amount of research on the most prominent collaborative wiki project, Wikipedia. However, none of the previous literature studies have attempted to identify the design elements in order to address the interplay between community needs and outcome quality. As such this paper attempts to answer the research question of how one addresses design considerations between community needs and outcome quality.

In this paper, outcome quality refers to the quality of deliverables as mandated by a collaborative project's objectives. In the context of Wikipedia, that would be the quality of an article based on Wikipedia's article quality scale. For example, literature exists in building online communities (Kim, 2000; Kraut & Resnick, 2012) where it is often assumed that satisfying community needs will affect the success of project objectives and outcome quality. This paper introduces a theoretical analysis of literature that demonstrates that this is not always the case. I identify the most prominent design points that can have the largest impact on the quality of work conducted on collaborative projects as well as enhance the sustainability and performance of online communities. The goal is to offer a counter perspective compared to literature. That is, a mutual benefit does not exist when project objectives and community needs are satisfied. A general background is provided discussing how collaborative projects are situated in the overall domain of social media as well as collaboration technologies. The literature is then divided into the parts that make a collaborative project; organization & technology and users. The topics selected are not meant to be inclusive but rather representative for the purposes of highlighting the gap between project objectives and community needs. Finally, design claims are developed that introduce impact on quality and community depending on a designer's decisions. They introduce areas in which community needs and performance become mutually exclusive under design considerations as well as areas that the two concepts become antagonistic to each other. An overview is provided along with future challenges for researchers as well as designers of collaborative wiki projects.

2. METHOD

Literature was obtained and analyzed based on the respective topics based on community needs and quality of outcomes as they relate to wikis. The aim was to find literature gaps that would identify a tradeoff relationship between the two topics rather than a mutually beneficial relationship. Literature was identified through major scholar venues and search engines (ACM, IEEE, Google Scholar). The paper utilizes a perspective on Wikis as socio-technical systems. As such, the importance of topics

was selected on the basis of user behavior and technology. User behavior articles were identified based on a set of primary themes identified in literature for communities and online community success. Technology related topics were identified based on known applications of wikis and the technological design decisions that been reportedly developed in support of these wiki systems.

After the initial selection of articles, topics were reduced to those relevant to the current topic of study. For example, there is literature discussing the differences between experienced and new users in wikis, however, there has not been studies that introduce a conflict between how this topic influences community needs and outcome quality as a tradeoff relationship. As such, the topics that are highlighted in the literature review reflect articles that identify a gap in research between how designers build systems towards goals and how community needs may prove to contradict some of their design choices.

3. LITERATURE REVIEW

This section provides an introductory background on the topic and introduces the literature review. The literature domain extends beyond the topics that were selected in the study. However, due to size limitations, representative topics that highlight the challenges involved in the design of wikis were selected based on their relation to community needs and project objectives.

3.1. General Background

Collaborative wiki projects have existed long before the advent of modern social media or for that matter the World Wide Web. Vibrant communities have existed in networked technologies utilized by businesses and organizations in the early nineties (Gundry, 1992, 2006). The potential for collaborative technologies was also identified early on for decision-making.

Group decision-support systems (GDSS) were early technologies that captivated the potential for successful decision-making between groups. GDSS have the potential for discouraging negative group behaviors and to ensure effective decision-making (DeSanctis & Gallupe, 1984). Numerous studies have investigated the effects of these systems in organizations (Marakas, 2003). Others have expanded the focus from decision support systems to collaboration technologies in general (Munkvold, 2003; Rummler & Ng, 2009).

Collaborative projects belong to a subclass of collaboration technologies. They are social media applications that allow for the collective creation of knowledge as well as tasks by a group of individuals (Kaplan & Haenlein, 2014). They differ from broader collaboration technologies in the fact that as social media applications, the utilize Web 2.0 technologies and foundations to allow for the creation and exchange of user-generated content (Kaplan & Haenlein, 2010). The background of users participating in these projects is usually expected to be diverse. They are also fundamentally different from other social media applications since they are more task-oriented and have a lesser focus on the representation of self for their users. Other social media applications such as social networking sites, virtual social worlds and microblogging focus more on individuals rather than project objectives.

Collaborative projects include examples such as wikis, message boards, websites for exchanging feedback and anything else relevant to human life (Kaplan & Haenlein, 2014). The most notable example frequently mentioned is Wikipedia, the free encyclopedia, which currently has millions of users contributing to millions of articles across multiple languages. Other examples, include Openstreetmaps, an open source geographical information project as well as Ushahidi, a platform associated with projects of social activism and citizen journalism. Collaborative projects with various sizes of user population have also been found in industry where companies such as Shell, Nokia, Adobe and Dell have utilized them to manage tasks such as knowledge management and idea generation (Kaplan & Haenlein, 2014). There are also collaborative projects that made their code available to be utilized as well as modified by anyone. This has reduced the challenge of developing these tools and has popularized them as a result.

Wiki projects are particularly an interesting case since they demonstrate successful cases of knowledge management. Open access to data by many wikis has produced a wealth of research that varies from examining readership concepts (Okoli, Mehdi, Mesgari, Nielsen, & Lanamäki, 2014) such as readability to examining content production (Mesgari, Okoli, Mehdi, Nielsen, & Lanamäki, 2015).

3.2. User Behavior and Performance

3.2.1. Collaborative Project Size

Collaborative projects studied over the course of past decades predate the Internet and have come in all shapes and sizes. Community size is considered an important aspect of a collaborative project. Projects include user bases that are small (Fulk & Steinfield, 1990; J. Nunamaker et al., 1989) and extend to large communities with millions of users (Kaplan & Haenlein, 2014; Mesgari et al., 2015; Tsikerdekis, 2016). Small groups have been found to provide more satisfying experiences (Fulk & Steinfield, 1990). This can in part be attributed to the nature of control over a group's culture and values that a tightly-knit group can achieve. Larger communities are more challenged in developing a community culture due to the potential for large influx of newcomers as well as the inability to come to a consensus in an inexpensive way. There have been documented cases where new ideas brought in by newcomers to a community, alienated the early adopter core of users with devastating results to such a community. A popular example of this is the case of Friendster's major loss of its United States user population (Boyd & Ellison, 2007; Boyd, 2003, 2004). Once a community's culture and values are set, an influx of newcomers may disrupt processes in collaborative projects. As teams develop, they undergo stages of transformation that are detrimental to a community's success where stories of origin, mission, values and culture are being engraved into a group's identity (Howard, 2010). Small groups are also less costly since they require less moderation (Fulk & Steinfield, 1990) where it is often a really expensive task for large communities. In Wikipedia, vandalism is found to be increasing as user population increases. Latest estimates show that vandalism accounts for 1 percent of contributions (Kittur, Chi, Pendleton, Suh, & Mytkowicz, 2008; Suh, Chi, Pendleton, & Kittur, 2007). Smaller groups have also been found to be slightly more effective in past studies (Nunamaker *et al*., 1989).

On the opposite side of the seesaw, there are tasks that necessitate a crowdsourced approach such as building a large encyclopedia. The early version of Wikipedia, Nupedia, attempted to apply strict peer-review on its articles which kept its user base from increasing. The result was also a limited amount of articles being released by the time Nupedia shutdown in favor of more open models such as Wikipedia (Kaplan & Haenlein, 2014). The task of building an encyclopedia required more active users than what a restricted system could afford. However, large projects not only provide designers with a larger user base but also a different systemic approach to collaborative work. Large collaborative projects not only transform the ways groups develop culture and values but also the way they function. Large scale collaborative projects function based on stigmergy; similar to the behavior of ants when building a nest (Elliott, 2006). Instead of having a fixed set of blueprints that guides the collaborative work, individuals contribute without having a complete or strict picture of the outcome in mind. Large groups require social negotiations to be limited in favor of creative output. The goal is the generation of content at the expense of the task of structuring and organizing content. The latter is found to be the responsibility of a minority of users (Arazy & Nov, 2010; Halfaker, Geiger, Morgan, & Riedl, 2013; Kittur & Kraut, 2008). This minority of users have also been found to implicitly mentor inexperienced users (Tsikerdekis, 2016). Openstreetmaps, another collaborative project not in the wiki family, has been found to exhibit the same collaboration patterns. Few individuals do most of the highly complex tasks (e.g., developing streets) with the larger part of the community contributing to easier tasks (e.g., adding points of interest on the map) (Mooney & Corcoran, 2012b). This strategy also removes the boundaries for a large user base being required to learn about a community's rules and policies and as such lowers the cost of contributions. It also lowers the need for individuals to maintain relationships with fellow contributors (Elliott, 2006). Instead, what is observed is that most

users end up forming networks based on interests than tightly-knit groups. That is not to say that vibrant groups within the community are not developed but rather that their importance is reduced in favor of larger structures. This is also in line with previous studies suggesting that community size tends to promote the success for collective actions (Fulk & Steinfield, 1990). However, larger communities are also found to have more individuals that are not actively contributing. The degree of engagement can vary between users of collaborative projects but the core of contributors is the most essential part for a collaborative project (Panciera, Halfaker, & Terveen, 2009).

3.2.2. Openness and Anonymity

Large communities tend to be challenged in the nature of how users are represented as well as brought in the communities. Online anonymity has been the subject of a larger discussion on Internet accountability and security (Caspi & Gorsky, 2006; Davenport, 2002; Donath, 1999; Galanxhi & Nah, 2007). Allowing users to operate under pseudonyms or anonymously has been found to affect a community's incidents relating to deception (Tsikerdekis & Zeadally, 2014b) and can also lead to aggressive behavior (Suler, 2004). In general, the loss of accountability can lead to many users abusing a system and the prevalence of abuse can be costly for a community. Wikipedia has been the recipient of constant vandalism on its articles (Shachaf & Hara, 2010) since it allows users to use their real names, pseudonyms to make anonymous contributions (with their Internet Protocol address being the only reference to their contribution) (Tsikerdekis, 2013).

Evidence in support of easing user access as well as anonymity have also been found for collaborative wiki projects and for the larger social media application domain. For example, freedom of speech is a common argument for anonymity (Akdeniz, 2002). However, it is the results of anonymity in collaboration that strengthen the position in support of anonymity. Anonymity has been found to reduce the likelihood for conformity (J. F. Nunamaker, Dennis, Valacich, Vogel, & George, 1991) in decision-making and potentially reduce the likelihood for groupthink (Tsikerdekis, 2013); a phenomenon that has been linked to bad decision-making in incidents such as Pearl Harbor and the Challenger Disaster. The higher the level of self-perceived anonymity by users, the higher the likelihood for more opinions to be heard and evaluated. The result is a more democratic governing process and less peer pressure on community users to conform. Empowering users to voice out their opinions however, can also be costly. A study has shown that anonymity has been found to reduce conflict on content contributions in wikis although it increased conflict in discussion spaces (Kane, 2009; Kittur, Suh, Pendleton, & Chi, 2007). Arguably, the cost of an increased conflict on a discussion could be acceptable if democratic processes are to prevail in a collaborative project along with the reduction of conflict in content contributions, which reduces the cost of moderation. When examining Wikipedia, some have even argued that rigor and authorial credentials are no longer necessary characteristics for a collaborative project's success. Instead, a radical decentralization and openness to anonymous users is what elevated Wikipedia to the level that it is in today (Olleros, 2008). According to latest estimates, about 26 percent of revisions made to Wikipedia articles are from anonymous users (Steiner, 2014). Considering that only 1 percent of revisions account for vandalism on Wikipedia (Kittur et al., 2008, 2007) it is apparent that anonymous users contribute a large portion of Wikipedia's content. Additionally, long before the success of anonymous contribution was seen on Wikipedia, early collaboration technologies have shown that even in small groups all these effects of anonymity were pronounced. For example, another study has shown that anonymous contributions are judged based on their merit not based on the credentials of the author (Jessup, Connolly, & Galegher, 1990), which is an important quality measure for any collaborative projects since they involve by definition, task-oriented processes (Kaplan & Haenlein, 2010). A meta-analysis study on computer-mediated communication and decision-making has revealed that anonymity is a necessary condition for a group's performance to be as effective with face-to-face performance in decision-making (Baltes, Dickson, Sherman, Bauer, & LaGanke, 2002).

3.2.3. User Networking

Studies have been observing the formation of networks in online wiki communities, but accommodating for a successful network and understanding their function within a community can be a challenge. In terms of a definition, online community is different from a social network in several ways (Howard, 2010). A social network has members with weak secondary interests. As such, it is good for sharing activities and bad for cooperation as well as collective actions. Its structure is focused on one-to-one relationships. Social networks are core components that make it easier for users to build online communities that have a shared goal. Put simply, users in a collaborative project may belong to multiple social networks, which help them share information quickly among them while still utilizing the core components of the software for collaborating.

Networks in collaborative project can form in variety of ways. Watch list or follower lists are one of the common features found on collaborative projects such as Wikipedia or OpenStreetMap. Personal messaging that produces a one-to-one communication also generates networks. An example of this is Wikipedia's personal talk pages, which have been found to have positive effects on article quality and the community overall (Tsikerdekis, 2016). The network enabled the means through which experienced editors communicated with less experienced editors. The study suggested that this was indicative of a mentoring process enabled through the network which eases the introduction of new users to community norms and culture. Another popular collaborative project, OpenStreetMap provides its users with the ability to network with others and collectively track changes friends make on a map. Similar to Wikipedia findings, networks tend to be sparse but important for online community development (Mooney & Corcoran, 2012a).

3.2.4. User Motivation

Historically, collaborative wiki projects were considered unlikely to succeed. Since their early beginnings, individuals have questioned the likelihood for Wikipedia's success or long term existence (Goldman, 2006). A commonly suggested reason for Wikipedia's anticipated downfall was the luck of monetary incentives. However, today there have been numerous studies demonstrating that not only are users participating in these communities highly motivated, but they also have a diverse variety of motives depending on collaborative project objectives. By understanding motives, designers can make decisions that will directly satisfy user motives.

Some collaborative projects have managed to invite participation at an extraordinary rate in their short history. For example, the OpenStreetMap community response to Haiti's earthquake had a tremendously positive impact on the aid work for recovery efforts (Soden & Palen, 2014). The success of such responses have even developed new projects for disaster preparedness that have aided numerous global and local issues worldwide. Motivations in such projects are more direct since many of the participants may be directly influenced or benefited in their everyday lives by contributing. For example, editing OpenStreetMap near a street that a person lives has an impact on aspects such as GPS navigation or real estate. Other collaborative projects such as Wikipedia or Github (open source code collaboration tool) have users with more diverse motives. Top motivations on Wikipedia have been found to be fun and ideology (e.g., information should free) while the least likely motivations referred to social, career and protective issues (e.g., eliminating loneliness by contributing to a larger community) (Nov, 2007). However, users that identify with the objective of the collaborative project do not necessarily contribute more. Instead, people that are motivated by the fun aspects of editing were found to contribute more. Inhibiting the fun experience especially for newcomers has also been found to affect participation if not outright rejection of the community (Halfaker, Kittur, & Riedl, 2011). On the other hand, studies on motivation for the Chinese administrators of Wikipedia have shown that collective motivators associated with self-growth and sense of mission were the most powerful while entertainment was lower (Liang, Chen, & Hsu, 2008). Others have also shifted the focus between intrinsic and extrinsic motivators in relation to design features (Kraut & Resnick, 2012).

3.3. Organization and Technology

3.3.1. Gamification

Gamification is the application of gaming metaphors to tasks in order to influence behavior, improve motivation and enhance engagement (Marczewski, 2013). Gamification as a strategy, has been found to alter the social experience for a variety of platforms (Crumlish & Malone, 2009). This can include leaderboards, rankings, avatar customization, gift exchanges and collecting. Problem-solving activities that take part in video games have been suggested to provide learning experiences and literacy that can benefit gamers as much as professionals (Gee, 2014).

A popular example of a collaborative project where gamification has been successful is Wikipedia. The community on Wikipedia has developed an awards system referred to as Barnstars that are meant for work recognition of members. These are delivered to editors' pages where they are often put on display for everyone to see. Awards recognize administrative and editing work among other tasks (Kriplean, Beschastnikh, & McDonald, 2008). Many of the recipients initially, are likely to have never known of the existence of these awards upon first receipt and others are likely to never have encountered all of them them as there are thousands of Barnstars. Barnstars have also been shown to indirectly act as a motivator by demonstrating appreciation of work (Viegas, 2007; Yang & Lai, 2010).

3.3.2. User Development Paths

Although a lack of organization may enhance participation due to a perceived simplicity, organization is necessary for small as well as large collaborative projects. Users tend to organize themselves in various roles that are not explicitly given to them (Kittur & Kraut, 2008; Mooney & Corcoran, 2012b; Welser et al., 2011). Beyond the self-appointed roles, more engaged users are likely to seek recognition and further privileges as well as responsibilities in a community. These can be assigned in a top-bottom approach or bottom-up. For example, Wikipedia employs both aspects of organization having some members being elected while others awarded a certain role (Forte & Bruckman, 2008). The roles involve mediators, administrators and bureaucrats among others, and they play an important part in guaranteeing information quality (Stvilia, Twidale, Smith, & Gasser, 2008). Community members have been found to evolve through the path of these roles from lower level positions to higher levels (Arazy, Ortega, Nov, Yeo, & Balila, 2015). There have also been cases of retrogression or promotions that skipped levels. As such, collaborative wiki projects provide the potential for a wide variety multifaceted organizational structures (Butler, Joyce, & Pike, 2008). Levels of advancement are also forms of formal recognition of past successes. Performance of a member in a community often results in promotion (Burke & Kraut, 2008).

3.3.3. Task Mechanization

Collaborative wiki projects such as Wikipedia depend on a series of bots and cyborgs (advanced robotic suits for editors) that help manage the growth of the community (Halfaker & Riedl, 2012). Tasks vary from content creation, to article quality tracking, copyediting, archival and vandalism fighting. Without this army of computerized robots, predictions of Wikipedia's downfall collapsing under vandalism (Goldman, 2006) may have come to pass. In fact, in several occasions vandalism bots have broken down, leaving the community to defend itself against vandalism (Geiger & Halfaker, 2013). During these robot blackouts, performance against vandalism was almost halved while new users joined the tasks that were previously assigned to the bot. Bots have been used on the online community of Wikipedia since its early beginnings but a rapid pace of curation and vandalism fighting bots started after 2006 (Halfaker et al., 2013). Bots have been used so much so that 15% of revisions made to the online community are made by bots (Steiner, 2014). More advanced bots that also demonstrate the use of large volumes of data and machine learning have been successful in detecting more lucrative attacks (Solorio, Hasan, & Mizan, 2013; Tsikerdekis & Zeadally, 2014a).

However, all these advances are appearing to also come at a cost to the community. Bots have been found to be a large de-motivator for newcomers to online communities with large consequences affecting the number of contributions and community growth (Halfaker et al., 2013; Halfaker & Riedl, 2012). Tools like Wikipedia's Huggle that identifies potential malicious revisions to articles not only makes it easy for people to revert a revision but also rewards editors (using a score) that revert many revisions. Hence, a paradox was formed when a bot that was created to eliminate the issue of vandalism ended up vandalizing the community itself by creating a hostile environment for newcomers and incorporated game practices which rewarded this hostile behavior.

4. DESIGN CONSIDERATIONS BETWEEN COMMUNITY NEEDS AND PROJECT OBJECTIVES

There has been much discussion on what satisfies community needs and what elevates outcome quality for collaborative wiki projects. However, upon examination, there appears to be a knowledge gap when it comes to satisfying the two concepts. This stems from the observation that the two are not always mutually beneficial but they are often treated as such. That is, while often there is a symbiosis between the two, design decisions that influence one aspect may lead to negative consequences for the other.

Based on the selected literature review, an analysis of literature findings was performed to identify the most prominent issues relating to satisfying community needs and outcome quality. The initial analysis examined each literature paper and the considerations provided as they relate to the main research question of this study. This analysis is summarized in Table 1. Based on the literature gaps identified on Table 1 a set of design claims and research questions was generated.

Claims, design considerations and research questions are developed in order to guide designers and researchers into bridging the gap between the relationship of community needs and outcome quality. Claims are developed based on empirical evidence derived from literature review and present future research directions that can assist in developing a more holistic view of the issue. These claims should not be treated as confirmed hypotheses but rather as indicators of what the literature suggests that one will observe when designing collaborative wiki projects. Design considerations are presented alongside claims as assistive commentary that presents what the literature suggests about a particular claim. These considerations can also help researchers form the theoretical basis in designing future research and formulate directional hypotheses for evaluation. The following claims are covered in detail:

Claim 1: Size does matter for a project's outcome quality and designers need to contextualize the size of the user base within a wiki's objectives.

Claim 2: Anonymity can positively impact outcome quality, however, it will likely work against community needs and satisfaction.

Claim 3: User development paths that lead to a decentralized form of governance can enhance both community and outcome quality.

Claim 4: Designing to satisfy user motivations can substantially impact community collaboration but effects on outcome quality are limited.

Claim 5: Social networking can enhance outcome quality and address community needs.

Claim 6: Gamification can improve both outcome quality and address community needs in collaborative wiki projects when it does not encourage negative behaviors.

Claim 7: Robots are the only means that can render a large-scale collaborative wiki project sustainable and successful in terms of outcome quality but they could negatively impact community.

4.1. Designing User Base and Policy

User base and policy are often directly used to influence outcome quality and community needs.

Claim 1: Size does matter for a project's outcome quality and designers need to contextualize the size of the user base within a wiki's objectives.

One of the major considerations for a collaborative wiki project design identified in this paper is the matter of user base; the total number of people that will be participating in the online community. Although the size will be influenced by the openness of a project as well as its objectives, user base will not alone determine a project's success. In fact, community needs, project objectives and outcome quality, need to be balanced. However, there are design decisions that need to accompany the respective user base as well as implications that are likely to force designers into seeking solutions that can balance community needs and project objectives that align with outcome quality.

Initially, the size of the group and the objective of the collaborative project, will determine the need for a large-scale or small-scale user base. Small groups effectively allow users to form community culture and values that become a collaborative project's identity (Howard, 2010). Designers however need to provide paths where newcomers can get acquainted to a community's values as well as work process and ethics. These are found to be achieved through gamification strategies (e.g., profile completion tasks that link to project outcomes as a training method) or indirectly through networks that enable user mentorship. This is a task that should not be mechanized as robots have been found to negatively impact participation of newcomers (Halfaker & Riedl, 2012). While positive evidence for robots may not exist, further research may enable productive ways for robots that can be used to get newcomers acquainted with the community. This is especially important since much of the literature in designing communities focuses on design features rather than structural or algorithmic solutions (Kraut & Resnick, 2012). Although these are more expensive to implement, for larger communities they may prove to be more effective in the long-term.

As the user base increases, designers need to change strategies in order to ensure the success of a collaborative project. A large-scale project may necessitate the need for an initial small group to act as a seed that will establish a community's culture and values. Designers can use strategies such as invitation-only approaches or beta development stages that will control for the influx of users. This is also likely to improve the quality of users at least for the initial stage of a collaborative project's development. However, these values need not be introduced to the majority of users once the community grows. In fact, designers need to shift their attention to enabling stigmergy by decreasing the learning curve for newcomers. There is a need for separating discussion and socializing in favor of fostering creativity. An example of this is Wikipedia's design which positions article discussion on a different space and limits the need for participating on discussion when contributing to an article. Design should allow for contributions to be made easily by members of the community without prior requirements for discussions, moderation, socializing or even understanding the rules of the collaborative project. This does not mean that paths of development should not be present but rather that they should not be enforced. This is found to be a successful strategy for large-scale communities that will however result in higher moderation needed due to erroneous actions by a minority of users.

Several research questions can be derived from claim 1:

- Is there a critical mass for community size that reduces community satisfaction or effectiveness in achieving project objectives?
- What is the threshold in which design attention should be given to accommodate stigmergy needs?
- How can robots be introduced that can help newcomers learn about community culture and norms?

Claim 2: Anonymity can positively impact outcome quality, however, it will likely work against community needs and satisfaction.

Regardless of the size of a project there is also a need of addressing a project's openness as a design feature. Who can contribute and under what representation is an often overlooked design decision that will have reaching consequences. Users on a collaborative project will manage contributions, values, culture, policy, decision-making and more aspects of the community. As such, how individuals are represented in the cyberspace is a design decision that should not be taken lightly.

Varying degrees of anonymity are recommended based on the theoretical analysis in this paper. Anonymity has been found to effect decision-making as well as contributions (Kittur et al., 2008; Steiner, 2014; Tsikerdekis, 2013). This is an important design aspect of collaborative projects regardless of its community size. In general, the higher the anonymity as perceived by individuals, the better its influence on community performance and decision-making. Perception of anonymity is more important than designer classifications as past studies have shown (Tsikerdekis, 2013). For example, a designer may elect to provide a feature for anonymous contributions to a Wiki while users may be biased of the ability to exist anonymous in the collaborative wiki project. As such, users will act as if they are not anonymous while the designer will expect a different behavior from this feature. Another caveat related to anonymity is the need for monitoring and ensuring that anonymity does not break community trust as often the two concepts are intertwined (Bella, Giustolisi, & Riccobene, 2011). Depending on the openness and size of the project, there is also the danger of an increase prevalence of deception, which can affect outcome quality (Tsikerdekis & Zeadally, 2014b). Arguably, the cost of moderation could be acceptable but designers are likely to utilize user labor along with computational resources in order to deal with erroneous contributions.

The following research question can further be derived from this claim. This aim to address the point in which anonymity is still beneficial to project objectives but has a limited negative impact on community needs.

- What levels of perceptual anonymity are the most beneficial for outcome quality?
- What levels of perceptual anonymity can impact negatively community development and community perceptions?
- What levels of perceptual anonymity can be considered to have a minimum impact on increasing vandalism and content deception in general?

Claim 3: User development paths that lead to a decentralized form of governance can enhance both community and outcome quality.

Analysis of past literature in this work suggests that designers should aim for establishing organizational structures but in a looser form that will not impact stigmergy. Providing users with a development path not only provides the community with organizational structures that can serve the collaborative project's objectives, but also serve as recognition and motivators for the community members. Large-scale collaborative projects have been found to be more effective when they employ a decentralized formed of governance (Forte & Bruckman, 2008; Forte, Larco, & Bruckman, 2009) and a multifaceted organizational structure. A loose computer science metaphor for this is the difference between hierarchical and relational database systems.

The following research questions can be derived from this claim:

- To what degree in terms of size and structure can user development paths increase community satisfaction?
- To what degree in terms of size and structure can the presence of user development paths impact outcome quality?
- Are there centralized forms of governance that can be just as effective in a collaborative wiki project?

4.2. Designing Collaboration

Elements of collaboration often lie in the processes that involve individual and social behaviors. Design can impact collaboration through these elements. However, their effects on outcome quality and community needs do not always align.

Claim 4: Designing to satisfy user motivations can substantially impact community collaboration but effects on outcome quality are limited.

Collaboration cannot exist without participation, which is contingent upon user motives. This paper argues that designers are recommended to incorporate policies and design aspects that will not inhibit but enhance satisfiability for user motivations. For example, if users are motivated to contribute due to an ideology of freely sharing information with others, exposing how much of their work is shared with others can be a powerful motivator. Entertainment has also been found to be a powerful motivator which would require gamification practices as well as enabling networking features but this is limited to community culture. While strategies for designing motivations are found to address user needs, preliminary work finds that their effect on outcome quality can vary (Nov, 2007). Various groups will generate different motivations based on a project's objectives as well as the cultural background of members. Designers need to identify community motives which are likely to change over time as community culture changes. Upon identification, design decisions can be made in order to satisfy these motives. There could be also the potential for design to enhance or enable new motivations for community members. Further, research on motivation is still missing important links as to the differences between intrinsic and extrinsic motivators as well as their relation to the size of the community (Kraut & Resnick, 2012). In effect, it is unclear on whether larger or smaller communities are more effective in establishing motivations and in particular intrinsic motivations.

The following research questions can be derived from this claim:

- Which types of motivations (intrinsic or extrinsic) have the largest impact on outcome quality?
- To what degree can design successfully impact intrinsic and extrinsic motivations?
- How does community size influence intrinsic and extrinsic motivations?

Claim 5: Social networking can enhance outcome quality and address community needs.

Though collaboration is often contingent on how motivated users of a community are, designers can elevate collaboration by providing channels of communication and in particular networking. This is true even for large-scale collaborative wiki projects (Tsikerdekis, 2016) and it is partially counter-intuitive to what literature suggests about stigmergic collaboration (Elliott, 2006). Literature analysis in this paper suggests that this strategy enables mentoring processes, it has been directly found to influence outcome quality and it enables the formation of clusters around a particular interest or activity within the community. These networking features can be enabled by design elements such as Facebook's status updates, feeds, or Wikipedia's personal talk pages and OpenStreetMaps geographical updates. All these features constitute solutions of social features that aim to provide users with channels of communications. However, literature has been scarce in comparing these different social features in terms of how they impact community as well as project objectives and quality.

The following research questions can be derived from this claim:

- What types of social networking in collaborative wiki projects influence outcome quality?
- To what degree is social networking affecting community satisfaction and development?
- Are there social features that negative impact outcome quality or collaboration and should be avoided?

Claim 6: Gamification can improve both outcome quality and address community needs in collaborative wiki projects when it does not encourage negative behaviors.

This paper asserts that designers should encourage gamification even for serious collaborative projects. While collaborative projects are task-oriented tools, the means of achieving those tasks need not be mundane. Applying game metaphors not only increases the engagement of users in a community but presents other large opportunities for educating users on community objectives, norms, policies and culture. For example, many websites (e.g., LinkedIn) include a profile completion progress that resembles many character development strategies found in role-playing games. This not only creates more active community members but provides a path through which community members can learn more about the community and integrate with it (Howard, 2010). In fact, in the context of a collaborative project, the tasks that lead to profile completion may directly be linked to project objectives (e.g., make ten revisions to codes found in the website or find two errors in policy pages). Gamification develops remuneration which is what will make users to keep coming back and contribute to a collaborative project (Howard, 2010). The largest challenge of this strategy is in identifying what can successfully be transformed into a game metaphor and has a positive impact on the collaborative project's objective. Identifying what produces value for users in order to be developed into an award should be effectively contextualized in a community's culture (Marczewski, 2013). Mechanization of tasks for awarding users may be needed especially for large communities. However, caution is advised when it comes to utilizing automation in order to deliver features of gamification. Users have been found to appreciate receiving an award by another user, and it is unclear if a machine could elicit the same response. Further, gamification could also lead to have adverse consequences such as rewarding bad behaviors. Substantial monitoring of a community's behavior post-implementation of a gamification procedure is essential for detecting problems that may arrive by such implementation.

The following research questions can be derived from this claim:

- Can gamifications practices have a direct impact on outcome quality through enhancing user skills or increasing user activity and productivity?
- What types of gamification strategies can enhance a wiki community's satisfaction and engagement?
- What design methods can improve gamification practices in order anticipate adverse consequences of gamification to the community and outcome quality?

4.3. Designing Computational Solutions

Robots as well as human assistive tools can help with community sustainability especially for large-scale projects. However, these tools are often been developed with a techno-centric approach which fails to examine their environmental impact on an online community. While they resolve problems, the can be the cause of adverse outcomes. For example, Wikipedia's assistive tools for determining malicious revision changes in articles have pitted user against user in a "revert revision war". Users were committed to seeing malicious intent in many cases where there was none, instead of users becoming aware of the inaccuracy of the system, which if not accurate it could have been fully automated. Moreover, gamification practices tracked the number of revisions being reverted without classifying reverts of genuinely malicious content and invalid reverts. A better practice for this tool would have been rewarding accurate reverts, while penalizing inaccurate reverts. That would have likely made administrators more cautious.

Claim 7: Robots are the only means that can render a large-scale collaborative wiki project sustainable and successful in terms of outcome quality but they could negatively impact community.

Literature findings in this paper suggest that designing robots for online communities is a challenge in that they become tools and entities within the collaborative project itself. Just like the organizational, policy and design elements can affect performance and culture in an online community, so is the potential for robots to affect these processes as well. There have been successful examples and demonstrated uses of robots in large scale collaborative projects like Wikipedia or Openstreetmaps (Neis, Goetz, & Zipf, 2012). Therefore, it is advisable for designers to utilize robots that can provide support with tasks in the community. They have the potential to shift labor hours to more productive tasks for community members. Designers need to ask questions referring to what they aim to achieve with a specific bot and predict adverse effects. Particular attention should be given to human-augmenting tools where humans still interact with humans as they can affect culture and community performance directly.

The following research questions can be derived from this claim:

- How do robots affect community satisfaction and performance in relation to the level of their invasiveness?
- What designs of human-augmenting tools can provide control for the interactions between administrators and users in order to limit the negative effects of moderation for newcomers?
- What are the most effective types of robots both in terms of affecting positively outcome quality and community needs?

5. FURTHER CONSIDERATIONS

The claims that were produced based on the theoretical analysis conducted in this paper demonstrate how diverse design choices can impact outcome quality and community. In some cases, designing for community needs can positively impact outcome quality but this is far from a rule of thumb. In many cases, the relationship between what a community wants and what a project ought to deliver are two different aspects. By having design unintentionally impacting outcome quality negatively, the purpose of a collaborative wiki project is defeated. On the other hand, by having a negative impact on a community, wiki project goals may never come to be realized. The theoretical analysis in this paper demonstrates this delicate balance and claims have been presented to assist with future research on the topic.

As research on the topic of collaborative projects expands, more attention should been given to identifying alternative design solutions for consequences of design implementations. For example, in this paper, it was recommended that designers provide users with varying degrees of anonymity due to its effect on performance. However, anonymity affects at the same time the cost of moderation, which in turn needs to be balanced by computational solutions. In other words, supporting one design decision may also force subsequent design decisions to be made in order to balance community needs and outcome quality. Ideally, alternative design paths need to be assessed and provided. Due to limited studies on the topic, it is unclear if in the absence of computational solutions, anonymity's benefits would still outweigh the expense of moderation. Studies in collaborative project design need to seek alternative solutions. For example, in the case of anonymity, deception prevention strategies could be an alternative to computational solutions (Tsikerdekis & Zeadally, 2014b) but it is at the moment experimentally undetermined on whether such a strategy would benefit collaborative project performance.

There is also a need for future work to make findings more easily relatable to designers of collaborative projects. Many papers cited in this paper have hinted on the effect of design on outcome quality as well as online community. However, their recommendations do not provide enough information for designers to make choices that suit their collaborative wiki projects. While the creative process of designing these platforms should not be restricted by narrow guidelines, it is imperative

that the effects and delicate balances be provided for designers that need to critically evaluate and frequently doubt their choices.

6. CONCLUSION

It has been said that the success of Wikipedia is a triumph of process over substance (Zuckerman, 2011). The nature of people trusting in a process that will eventually lead to substance. However, much like ancient China's "crowdsourced" encyclopedias it is the design that allows for a process that leads to substance. While not much is known about Lü Buwei's design that helped make his encyclopedia come to fruition, we know that he treated his scholars generously. Perhaps, decentralized organizational structure and gamification practices may have been used. Similarly, designing Wikipedia to function the way it does today allowed for the triumph of a successful collaborative project. The delicate balance between satisfying community needs and designing for outcome quality determines the overall success of a collaborative wiki project. This paper attempted to identify design elements through a theoretical analysis of a diverse literature which can produce successful wiki projects. However, projects are ever-changing as technologies change along with the people comprising a community. As they change, so should the design. One thing that designers should pay attention to above everything else when it comes to collaborative project design, is to listen to their users while keeping an eye on outcome quality and to always be prepared for the inevitable technology and community changes.

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