LEADER INFLUENCE ON SUSTAINED PARTICIPATION IN SELF-ORGANIZED VOLUNTEER COMMUNITIES: A SIMULATION-BASED APPROACH

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Abstract

From the perspective of leader-member exchange (LMX) theory, we investigated how two forms of leadership style (uniform LMX (ULMX) and differential LMX (DLMX)) impact member participation in SOVCs. Furthermore, based on computer simulations we also examine the extent to which several contextual factors moderate the relationship between leadership style and member contributions. The key findings suggest that although DLMX appears to be a more effective governance style in the event of high environmental uncertainty, ULMX outperforms its counterpart in decentralized structures and during the early stage of community growth. Furthermore, leadership style plays a more important role for large SOVCs than small SOVCs, which are highly vulnerable to environmental turbulence. Regarding the impact of network structure, centralized structures facilitate higher levels of member participation than decentralized structures, but too much centralization may adversely affect member participation, particularly when a minimal environmental uncertainty exists.

Keywords: Self-organized volunteer communities (SOVCs), leadership style, uniformed LMX, differentiated LMX, sustained participation, network structure, network size, network maturity, computer simulations
Introduction

In recent years, self-organized networks of volunteers distributed worldwide have formed communities online and engaged in diverse activities that generate enormous economic value. Such self-organized volunteer communities (SOVCs) are responsible for collaboratively developing high quality open source software (von Hippel and von Krogh 2003), producing the free online encyclopedia Wikipedia (Nov 2007), co-creating millions of pieces of music remixes (Jarvenpaa and Lang 2011), and providing various forms of tangible and intangible support to people in need (e.g., Cummings et al. 2002; Moon and Sproull 2008; Wasko and Faraj 2000). However, the voluntary nature of SOVCs poses a challenge for their sustainability because of the many factors (e.g., availability of other SOVCs, reduced passion or enthusiasm, commercial intervention) that may induce members to cease contributing to a particular community. In fact, SOVCs have been found to be highly volatile in their membership with high rates of turnover (Butler 2001; Faraj et al. 2011; Ransbotham and Kane 2011), which can be detrimental to the community (Ma and Agarwal 2007; Wang and Lantzy, 2011). Member retention and sustained member participation are crucial for the viability and survival of SOVCs, influencing the volume as well as the quality of content, interactivity, and responsiveness (Wang and Lantzy, 2011). Therefore, the issue of member retention and sustained participation, despite being voluntarily established organizations, is a major concern for SOVCs.

Numerous studies (e.g., Dansereau et al. 1973; Graen and Ginsburgh 1977) suggest that leadership plays an important role in determining employee turnover in organizational and team settings. While the popular rhetoric regarding SOVCs invokes the image of a leaderless collective, almost all groups have formal leadership roles. Leaders in SOVCs perform an assortment of tasks that are important for group sustainability (Butler et al. 2007). They are most likely to exert active effort in maintaining appropriate norms of behavior within the group. Leaders also set the vision and design the initial blueprint for the collective goal of volunteer communities organized to produce a specific tangible output, such as software or an encyclopedia article. In addition to this influence on the attractiveness of a particular volunteer community for potential participants, leaders may also directly influence the likelihood that a volunteer will sustain participation. Prior research has shown that receiving a response from other community participants increases the probability of a volunteer sustaining participation in the future (Joyce and Kraut 2006). This effect is stronger when the response is received from a prominent core member or leader, as it may be viewed as an indication that one’s contributions are valued (Ducheneaut 2005). Leaders may be even more important in online voluntary settings compared to the traditional organization context, where formal hierarchies exist and employees are “bound” by legal contracts. In SOVCs, members can freely join or leave, and no formal governance mechanisms exist, except for the small core group of leaders who may exert some influence over member participation behaviors.

Furthermore, leaders of SOVCs are faced with a challenge that arises from the unique characteristics of online communities. Prior research (Chang et al. 2010; Oh and Jeon 2007) has revealed that member participation is highly peer-influenced as reciprocity among the participants serves as a driving force for the operation of SOVCs. In other words, SOVCs are often exhibit herding behaviors – members have a strong tendency to match their behaviors to the dominant actions of the community population. When some members opt to cease their contributions to the community or substantially reduce their degree of participation, those who frequently collaborate with them could become less productive and motivated and may also lessen their participation. Such “network influence” is most pronounced in knowledge-intensive SOVCs because knowledge is created and accumulated over time mainly through active interaction and dynamic reciprocity among the participants. Therefore, a key member’s discontinued contribution could induce other members to reduce their level of involvement and participation, and subsequently, threaten the stability of the SOVC.

A key question arises; how should leaders behave in these unique environments to best utilize network influence? More specifically, what leadership styles are most effective for retaining members and therefore sustaining SOVCs that exhibit such network influence? In spite of the importance of leaders in SOVCs, there has been little work regarding the impact of leader behaviors on retaining volunteer participation, particularly when network influence plays a moderating role in shaping membership dynamics. Therefore, the goal of this paper is to examine the influence that leaders have on volunteer participation decisions and the level of resources and effort they commit to the SOVC in which network influence plays an important role in member retention and sustained participation.
We focus in particular on the impact of different supervisory behaviors on member retention, as ongoing communications that leaders engage in are more important in exerting influence and shaping the collaboration dynamics within the community. As a frame of reference, we draw on leader-member exchange (LMX) theory (Graen and Cashman 1975) to elaborate on the quality and strength of leader-member relationships, which has been suggested as one of the dominant predictors that affects employee turnovers (Graen et al. 1982), and investigate their impact on volunteer participation decisions. Furthermore, prior research (e.g., Campion et al. 1993) has suggested that the effectiveness of leadership is moderated by several structural factors, such as organizational size, structure, and maturity (i.e., growth stage). These factors therefore may also have a significant bearing on the extent to which leadership style impacts member participation decisions in SOVCs. Therefore, we compare the leadership effects in communities of varying sizes, communication network structures, and maturity states. The impact of leadership styles on sustained member participation in SOVCs can be dynamically emergent and non-linear, which creates challenges for isolating, observing and quantifying the effects empirically. Due to the empirical difficulties associated with examining a spectrum of leadership styles and behaviors through sampling of actual communities and the need to investigate the effectiveness of leadership styles in the face of diverse moderating factors that may trigger member turnover, we adopt a simulation study approach. Computer simulations enable us to rigorously examine different patterns of leader-member communication and their effects on sustaining member participation in SOVCs.

Theoretical Background

Leadership in SOVCs

We define leadership as “the ability of an individual to influence, motivate, and enable others to contribute toward the effectiveness and success of the organizations of which they are members” (House and Javidan 2004, p. 15). Leadership in SOVCs is not usually limited to a sole leader, but rather shared by multiple long-term members of good standing who are recognized for their contributions to the group and for their demonstrated expertise. Prior research on online leadership in virtual team settings has focused on examining the behavioral attributes of emergent leaders (Yoo and Alavi 2004), discovering the nature of the work performed by leaders within these online collectives (Butler et al. 2007), and examining the factors that determine who successfully becomes a leader (Fleming and Waguespack 2007). Although there is a substantive body of research regarding the impact of leaders on various indicators of organizational and team performance such as employee retention and attitudes, there is little research thus far regarding the impact that leaders in SOVCs may have on inducing continued member participation (or inversely, on member turnover). The actions of leaders in SOVCs are more publicly visible and impactful relative to other members, and hence may have a stronger effect on community sustainability and success. One recent study found that direct interaction with leaders in an online community had a dampening effect on intentions to continue participating in the community (Johnson 2008). We contend that the impact of direct interaction may vary depending on the nature of leader behaviors towards all other members of the online community. Impact of leader communication styles on member retention may also vary depending on many contextual attributes of the self-organized communities, such as community size, community network structure and the evolution stage of the community. We examine this premise further in the following sections, after first discussing the types of leadership and network influence which form our baseline model of membership dynamics in SOVCs.

Uniform Leader-Member Exchange (ULMX) vs. Differential Leader-Member Exchange (DLMX)

During the past several decades, two different approaches to leadership have received central attention in the management field as they have a profound impact on employee turnover and organizational performance. The Average Leadership Style (ALS) approach assumes that “the behavior of the leader is in fact reasonably constant for all staff members” (Seeman 1957, p. 95). Studies building on this framework (e.g., Dansereau et al. 1975) posit that leaders should treat all their subordinates equally and in a relatively uniform manner and behave independent of the peculiar attributes of members (e.g., personality, attitudes, abilities). In this conceptualization, all of the dyadic relationships between the leader and the
member are presumed to be identical and the deviation from the “average” leadership style is thought to be random error (Dienesch and Liden 1986). Research leveraging this approach as a frame of reference has focused primarily on variation across groups with respect to leadership, while assuming no within-group variation.

In sharp contrast, the Vertical Dyad Linkage (VDL) approach, grounded in role theory, has emerged as an alternative to the theorizing of leader-member relationships, asserting that the behavior of a leader varies contingent on the relationship with his particular members (Graen et al. 1982). The basic tenet of this approach is that leaders have limited resources and time, and hence are not able to act uniformly towards all followers. Instead, leaders establish close relationships with only a few selected key subordinates, distinguishing “in-group” members (e.g., those characterized by high trust, interaction, support, and formal/informal rewards) from “out-group” members (e.g., those characterized by low trust, interaction, support, and formal/informal rewards). ALS and VDL have been later renamed ULMX and DLMX, respectively (Dienesch and Liden 1986; Graen et al. 1982).

Mixed reports have been found regarding the effectiveness of DLMX relative to ULMX. Sias and Jablin (1995) found that when a co-worker receives a favorable treatment from the leader, one perceives the differentiated treatment as unfair and tends to dislike the favored other, and decreases personal communication with him or her. This is somewhat similar to the “teacher’s pet” phenomenon widely known in the education literature (e.g., Tal and Babad 1989), which suggests that a teacher’s differential treatment to or preferential relationships with particular students have undesirable implications for the relationships and unity among the classmates. Similarly, Van Breukelen et al. (2002) demonstrated that DLMX has a negative impact on an individual’s team commitment, articulating that differential treatment by a leader adversely influences one’s perception about the integrity of the leader. Sherony and Green (2002) discovered that coworkers develop a stronger relationship with each other when ULMX leadership was employed. The Group Value Model (Tyler 1989) also suggests that leader neutrality is a critical factor for team members’ perception of procedural justice within teams, encouraging them to exhibit more group-oriented behaviors. Taken together, studies in support of ULMX generally view the principle of equality as an operating norm in team environments.

However, many studies have shown otherwise, providing evidence of DLMX’s superior performance. For example, DLMX has been found to increase work attitude and well-being (Epitropaki and Martin 1999), employee satisfaction, leader satisfaction, role clarity, member competence (Gerstner and Day, 1997), organizational commitment (Martin et al. 2005), and citizenship behaviors (Townsend et al. 2000). These scholarly investigations have regarded equity, rather than equality, as a more ideal and rational norm in group settings. Building on role theory (Merton 1949) and the principle of equity (Adams 1965), DLMX advocates postulate that given the limited resources, both tangible and intangible, leaders should utilize and distribute resources in such an “eccomonical” way that maximizes the team output and reward individuals according to their personal contributions.

The debate over equity versus equality in organizations continues, as does that over the effectiveness of DLMX and ULMX. However, the vast majority of these leadership studies have been confined to the examination of traditional organizations, while little research has been available to juxtapose these leadership styles in the context of SOVCs, where, network influence may be stronger, the size of the networks may be larger, and the network structure may be more varied than in traditional organizational contexts. The present study aims to fill this void.

**Network Influence in SOVCs**

Several studies (e.g., Chang et al. 2010; Faraj et al. 2011; Singh et al. 2011) have demonstrated that participants in SOVCs are highly interdependent with respect to their level of commitment, as well as participation decisions. As SOVC members develop a sense of community through intense, long-term collaboration and collective learning, they are significantly influenced by the behaviors and decisions of their “neighbors” with whom they interact frequently. In this respect, when regular members leave the community or substantially reduce their participation, other members may not be as motivated and functional in the community. In particular, in knowledge-intensive SOVCs (e.g., open source software communities) where one member cannot perform effectively without the help of others, a significant number of members may be de-enthused and lose a sense of responsibility as a result of the prolonged
absence of key members. This may cause them to follow the action of those who have left, resulting in a chain reaction. In the worst-case scenario, such “snowball effects” driven by network influence can result in the collapse of the entire community, although the impact might vary depending on the size and structure of the community network (Oh and Jeon 2007). Therefore, network influence is one of the key determining factors that affects membership dynamics in SOVCs. Details regarding how we quantitatively modeled network influence will be discussed in Section 3.

**Structural Attributes Affecting Leader Effectiveness in SOVCs**

**Community Size**

As the size of the community increases, it becomes more difficult for leaders to interact and collaborate with members and manage the network, diminishing leadership effectiveness and the possibility of interaction with participants (Campion et al. 1993). Furthermore, as the network becomes larger, individuals’ commitment is less likely to be recognized and such contributors are anonymously lost in the crowd (Mullen et al. 1987). In large groups, leaders may not be able to respond to all participant requests or effectively coordinate work processes, causing participants to feel “unnoticed” and to exit the leader’s sphere of influence. Such detachments may substantially weaken members’ intrinsic motivation and reduce their sense of responsibility towards the community’s goals. Finally, as the network size grows, the leader’s vision may not be transmitted clearly to participants, which may in turn result in dissatisfaction regarding community goals and directions. All of these factors are likely to de-motivate the participants and trigger a change in their attitudes towards their “community service.” Therefore, network size is expected to be negatively associated with sustained participation (i.e., leadership effectiveness).

Although network size, in general, may negatively impact leadership effectiveness, the extent of the negative impact may differ by leadership style. For example, when other factors are held constant, as the network expands, the effectiveness of ULMX style (i.e., a leader treats all his members equally) diminishes more rapidly than that of DLMX (i.e., a leader interact frequently only with a few selected members). The reason is that a leader can only continue to exercise ULMX by reducing his/her frequency of interaction with each member commensurate with the extent to which the network size increases. For example, if the network increases from 100 to 200 members, the frequency of interaction between the leader and each member will be reduced proportionally by 50% under the ULMX leadership style. As the leader’s attention and support for each member decrease owing to the increased network size, each member becomes de-motivated and loses their sense of communal responsibility. In contrast, the effectiveness of leaders who interact only with selected members (as following the DLMX leadership style) may not be as critically influenced by the increase of network size as those utilizing ULMX, since they interact with only a subset of members, rather than the entire population. Consequently, although increase in network size may generally reduce leadership effectiveness, it would result in more undesirable consequences for leaders utilizing ULMX than for those adopting DLMX.

**Community Network Structure**

The network structure of the community depicts how community participants (i.e., nodes) are connected to one another via communication linkages (i.e., edges). The network structure through which participants exchange knowledge and coordinate activities may moderate leadership effectiveness (Mullen and Johnson 1991). A centralized, scale-free (SF) network structure (Barabási and Albert 1999), in which node connections are unevenly distributed among leaders, enables communities to maintain cohesion and foster team trust, authority and enforce group norms (Baldwin and Clark 2006). Moreover, such network structures can provide an infrastructure that facilitates smooth vertical coordination among members in different layers in the pursuit of their interests and goals. In addition, SF network structures can facilitate the resolution of conflicts that may arise from differences in participants’ views. Several studies (e.g., Burke et al. 2008; Butler et al. 2007) have shown that many online communities, despite the voluntary nature of organizational establishments, exhibit hierarchical structures in which participants undertake differentiated roles, responsibilities, and decision-making activities. Many open content communities such as open source software (OSS) communities exhibit hierarchical structures in which leaders, coordinators, maintainers and users vertically interact and perform differentiated roles and
responsibilities (e.g., Lee and Cole 2003). Oh and Jeon (2007) found that the message exchange patterns in the Linux community indeed exhibited characteristics of a SF structure in which node connections are unevenly distributed among several key members, providing empirical evidence regarding the presence of a differentiated hierarchical network structure in the Linux community. This network structure may structurally support DLMX as the leader in this configuration typically has excessive power and authority and more importantly has too many followers, which makes it difficult to exercise ULMX.

In contrast to SF networks, a decentralized, random network (Erdős and Rényi 1960) in which each participant (node) has a similar number of communication links (edges) preserves a more “democratic” operation as the connection of nodes is evenly distributed. In essence, this network formation structurally prohibits the emergence of a powerful leader given that everyone is created equal in this network form. Recently, some open content communities have begun to rely on wiki platforms to enable participation that is “purely open” in the true sense of the word in that anyone can “jump in” and contribute. Wiki software platforms allow anyone to edit the contents of a web page, in other words, visitors to a site using the wiki platform may add new content and edit existing content. This effectively supports collaborative content production in which authorship and ownership of content is held jointly by everyone contributing to the community. Wikipedia, the free online encyclopedia is one example of a highly visible successful open content community based on this model (Wagner, 2004).

The online communication patterns among participants in some wiki-based communities seem to exhibit structures that resemble a random network structure in which connections among nodes are approximately equally distributed. This type of open content community is somewhat anarchistic, although there is some central authority that governs the interactions of the members, participation and contributions are truly discretionary and not subject to final incorporation decisions and vetoes by group leaders. Although there may be some leaders with more control over the coordination of the community for instance in conflict resolution processes, this network structure is considered more “democratic” because each node (participant) has a similar number of edges. As a result, in this decentralized, random structure DLMX by a leader may result in negative consequences, such as member demoralization, which may eventually drive them to leave the community.

Community Maturity

While some SOVCs are mature in the sense that all of their members vigorously participate in the development of the community, others are premature as they are just formed and run by a leader with only limited member support. A torrent of factors, such as the development stages through which the community has evolved, and the popularity of the community, may determine the degree of network maturity. From a leadership point of view, leaders may be encouraged to exercise different leadership styles contingent on the state of network maturity. For example, to elicit greater member participation leaders should utilize ULMX during the initial stage of community development when there are only a small number of active participants. However, as the community matures and the vast majority of members participate, DLMX leadership can be more effective and efficient as leaders in this state have a large number of ties with their members. Therefore, leaders could maximize member participation over the course of SOVCs’ lifecycle by exercising diverse leadership styles.

Simulation Model and Experimental Design

To provide empirical insights regarding the impact of leadership styles on member contributions, we developed computer simulation experiments based on Monte Carlo techniques. The simulation method is an effective mechanism in our research context since it offers the flexibility of predicting outcomes for a variety of scenarios and situations (Davis et al. 2007). More specifically, simulation experiments allow us to assess the effectiveness of two leadership styles (ULMX and DLMX) in relation to member participation for more general SOVCs varying in size, network communication structure, and state of maturity. Furthermore, we can control for the diverse environmental conditions unique to SOVCs for which empirical data are rarely available.
Modeling of Network Influence

Similar to Oh and Jeon (2007), we employed the Ising framework (Ising 1925) to model the quantitative patterns of interaction between leaders and members in simulated SOVC environments. The Ising model provides a simple, yet parsimonious framework for modeling spatial network influences (e.g., herding behaviors in social networks). Although more commonly applied to the study of patterns of interaction in the natural sciences, the conceptual underpinnings of Ising theory have also been widely utilized as a framework for investigating various issues in social sciences (e.g., herding propensity in OSS communities, information cascades in stock market investment decisions, etc.). The theoretical insights suggest that an individual’s decision-making behavior is greatly influenced by (1) the collective status of individual’s neighbors in a network environment and (2) the environmental uncertainty that affects his willingness to participate. To explain the framework’s theoretical building blocks, suppose we have N participants in a SOVC, and each member’s level of participation is numerically quantified: +1(highly active), −1(highly inactive), and 0(neutral). The participant is assumed to regularly “poll” his neighbors in order to understand the extent of their participation in the community and the intensity of interactions among network constituencies. This member may or may not then change the level of his own participation contingent on his neighbors’ levels and external factors. Some environmental factors (i.e., external recognition of the community) may positively influence member participation, while others (i.e., availability of other opportunities for contributing) may do so negatively.

Figure 1 below illustrates the mechanical aspects of the Ising framework with respect to the network influence in the SOVC context. In this spatial network setting, a participant (m0) is assumed to interact frequently with his four neighbors (m1, m2, m3, and m4). As mentioned above, the Ising model utilizes the two key concepts (collective status of neighbors and environmental uncertainty) in defining and explaining the interaction patterns and network influence among the members. In the original Ising framework, the former is referred to as “energy”, whereas the latter is described as “temperature.” More specifically, the propensity toward conformity (or “energy”), which is calculated as \( U = m_0(m_1 + m_2 + m_3 + m_4) \), indicates the collective interaction force between a member and his neighbors. Ising theory suggests that \( U > 0 \) implies that the majority of members maintain a status (e.g., high participation or low participation) opposite to his (m0), while \( U < 0 \) indicates that he (m0) is on the same side of the majority of his neighbors. \( U = 0 \), however, represents the situation where his neighbors are evenly split.\(^1\)

Another important factor in a member’s participation decision is environmental uncertainty (or “temperature”), which determines the degree of interdependency and influence between members with respect to their participation decisions. More specifically, in a stable environment (i.e., low temperature) a member’s decision is highly influenced by the collective status of his neighbors, while such high interdependencies diminish sharply in unstable environments (i.e., high temperature). The specific Ising formulae are as follows:

\[
P(\text{change}) = 1/[1+\exp (\Delta U/T)], P(\text{stay}) = 1 - P(\text{change}),
\]

\(^1\)See Oh and Jeon (2007) for further details regarding the Ising framework.
where $P(\text{change})=$probability that the member will switch his participation status, $P(\text{stay})=$probability that the member will maintain his participation status, $\Delta U=$difference between current energy and projected energy of changing participation status, and T=environmental uncertainty.

The formulae above aptly capture herding propensities due to network influences and the impact of environmental uncertainty. When a member changes participation status (i.e., from -1 to 1 or 1 to -1), the sign of its energy changes (i.e., $U_{\text{projected}} = -U_{\text{current}}$), and thus the difference in energy is given by $\Delta U = U_{\text{projected}} - U_{\text{current}} = -U_{\text{current}} - U_{\text{current}} = -2U_{\text{initial}}$. Therefore, the more a member’s neighbors’ participation status is similar to his own (i.e., decreasing $U$ with $U<0$), then the difference in energy is increased (i.e., increasing $\Delta U$ with $\Delta U>0$), and the likelihood that he will change participation status is decreased. Conversely, the more a member’s neighbors are behaving differently from him (i.e., increasing $U$ with $U>0$), the more likely he will switch his participation status to match his neighbors’ behaviors. This herding propensity is maximized when environmental uncertainty is low (i.e., $T\leq1$). However, as environmental uncertainty increases, network influence is weakened and herding is less likely to occur as the probability of maintaining one’s participation status and the probability of switching converge (i.e., $P(\text{change})=P(\text{stay})\approx0.5$). In other words, when environmental uncertainty is high, a member’s participation status no longer depends on his neighbors’ status and become less predictable.

In summary, the Ising framework takes into account external factors that affect the level of member participation. In our context, high temperatures indicate high levels of environmental uncertainty such that there are many external factors (e.g., availability of other projects, commercial intervention) that induce existing members to leave the community or substantially reduce their amount of contribution. In contrast, low temperatures refer to low levels of uncertainty and limited impacts of such destabilizing factors.

**Network Size, Structure and Maturity Stage**

SOVCs vary substantially in terms of size, network structure and state of maturity. For example, some established OSS communities (e.g., Linux, Apache, etc.) have hundreds of developers and a committee of leaders, while other less mature communities are managed by a single leader who interacts with only a small number of developers. In addition, although some SOVCs exhibit decentralized, random communication structures, many others form highly centralized, scale-free network configurations. Finally, while some communities are vibrant with full, active participation from their members, others are managed mostly by a leader with minimal member support.

For each leadership style, the simulation generates 250 data points representing community member participation, which are then averaged. Such comprehensive procedures are necessary in order to obtain accurate member participation values for a particular leadership style. Finally, we prepared a data file with both dependent (member participation) and independent (leadership style, size, structure, and maturity) variables. Similar procedures were repeated to construct networks of varying sizes (with $N=50$, 100, 250 and 500 nodes) and degree centralities (with $\gamma = 1.5, 2.5$ and 3). We chose these network structures with varying degrees of centrality ($\gamma$) based on Oh and Jeon (2007). Centralized scale-free networks (i.e., $\gamma=3$) were constructed by assigning the number of neighbors to each node randomly drawing from the distribution of the number of neighbors derived from observed SOVC networks (Walsh et al. 2000) and then repeatedly making connections starting from the most highly connected node. For example, if a node has 10 connections, then 10 nodes (among those not already connected to the focal node) were randomly selected and linked to it. To design decentralized, random networks (i.e., $\gamma=1.5$), we chose two random pairs to connect until we exhausted the (chosen) number of connections. To reflect the diverse maturity stages, we considered three cases in the simulation design (Case 1: “Highly active communities” where all members actively participate, Case 2: “Medium active communities” where only half of the members participate, and Case 3: “Highly inactive communities” where no one but a leader actively participates at the initial stage) and investigated how the two different governance styles (DLMX and ULMX) impact the average participation of members in these cases.
**Operationalization of ULMX and DLMX**

To operationalize the leadership, we first chose the node with the highest centrality in the network. This is based upon examination of the network centrality of the project administrators from our empirical observation – in 82% of the projects where leader-member interactions were to be found, the project administrator who we defined to be the leader, had the highest centrality. The relational strength between a leader and a member in the ULMX and DLMX cases was operationalized in the simulation as follows. For ULMX, we uniformly assigned a value of 1 to indicate the strength of the relationship between a leader and all developers. In other words, the relational value among all dyadic links between a leader and a member was assumed to be identical, which suggests that a leader treats all members equally. In the case of DLMX it was assumed that the strength of some of these relationships could be greater than or less than 1. To make the comparison more meaningful, no variation in a leader’s resource and capacity exists in both cases. In the case where leaders engaged in DLMX relationships with members, the strength of relationship between a leader and member is calculated as \( J_{L,M} = (N_L + N_M) / 2 <N> \), where \( J_{L,M} \) is the strength of interaction between a leader \( L \) and member \( M \), \( N_L \) is the number of neighbors that the leader has, \( N_M \) is the number of neighbors that particular member has and \( <N> \) is the average number of neighbors for the whole network. To elucidate numerically, suppose that (1) a DLMX leader \( L \) has 6 neighbors \( (N_L=6) \) and a member \( M_1 \) has 3 neighbors \( (N_{M_1}=3) \), and that (2) the average number of neighbors \( <N> \) is 4. If they are neighbors themselves, then they can interact. The DLMX strength is then calculated as \( (6+3)/8 = 9/8 \), which is greater than 1. Now consider that another member \( M_2 \) has only 1 neighbor, the DLMX leader. In this case, the interaction strength between \( L \) and \( M_2 \) is calculated as \( (6+1)/8 = 7/8 \), which is less than 1. Therefore, even if a leader \( L \) has more neighbors than the average, the individual interaction strength can be greater or less than 1 depending on the other agent’s number of neighbors. Of course, if \( N_{M_1} \) (the number neighbors interacting with \( M_1 \)) is larger than twice the average (in this case 8), then the interaction strength with any of his neighbors will be larger than 1. Consequently, if a node has more neighbors than the average, then on average he will exert a large influence on the network because his neighbors will most likely have an average number of neighbors.

**Measurement of Commitment**

The criterion for online community sustainability is the degree of member commitment (or intensity of member participation), which is measured as follows; for a given network configuration with \( N \) nodes, the member participation is represented as \( <m> = (1/N)(m_1 + ... + m_N) \), where \( m_i \) is the level of commitment of the \( i \)-th participant. Initially, the value for each participant is randomly assigned. For example, a random number is assigned 500 times for each participant, and all numbers are then averaged in order to accurately estimate the actual initial condition. This value changes in response to the leadership style.

**Simulation Procedure**

The simulation was conducted as follows. First, we construct an SOVC network according to the various parameters of size \( (N) \), structure \( (\gamma) \) and stage of initial maturity \( (maturity=\{highly active, medium active, highly inactive\}) \). We then operationalize the leadership style governing the SOVC networks by either uniformly assigning initial states of 1 to all edges for ULMX or by assigning differential weights to the edges based on the strengths of the relationships \( (J_{L,M}) \) for DLMX. Second, we start evolving the network according to the Ising Monte Carlo scheme outlined above. Specifically, at each simulated time step, a member is randomly chosen and his participation status is probabilistically determined by network influence for a predetermined level of environmental uncertainty. The overall intensity of member participation for the network \( <m> \) is recorded. The simulation ends once each node has been visited 100 times or more. This procedure was repeated according to a full factorial experimental design with 4 network sizes \( (N=\{50, 100, 250, 500\}) \) x 3 network structures \( (\gamma=\{1.5, 2.5, 3.0\}) \) x 3 initial maturity stages \( (maturity=\{highly active, medium active, highly inactive\}) \) x environmental uncertainty \( (T=0 \ldots 100) \). In the section that follows, for sake of brevity, rather than presenting all results in a sequential manner, we selectively report the highly salient and noteworthy results.
Results

Case 1: Highly Active Communities

At the initial stage, all members in this community are assumed to participate fully in the project (we assign “+1” for full participation as shown in Figure 2-(a)). We investigated how the two leadership styles differ in terms of maintaining member participation in response to the changes in level of environmental uncertainty. Figure 2-(a) shows that all the members in this community fully participate initially, but as the environment becomes increasingly unstable, their participation decreases. Reduced participation as a result of environmental uncertainty was found for both leadership styles. However, a more dramatic reduction in average member participation was observed in communities managed by a ULMX leader compared to the communities managed by a DLMX leader. For example, when environmental uncertainty increases from 0 to 5, member participation under the DLMX leadership style diminishes moderately by approximately 20% (from 1 to 0.8). However, with the same change in environmental uncertainty, member participation under ULMX decreases substantially by almost 80% (from 1 to 0.2). That is, in the event of such an environmental shift, only 20 out of 100 members actively participated in the software development in the case of ULMX. Furthermore, when environmental uncertainty reaches the maximal point in our experiment (i.e., 10), member participation under ULMX becomes almost zero, while DLMX still sustains member participation at a moderate level (i.e., 0.5).

![Figure 2. Community Maturity and Member Participation (ULMX vs. DLMX)](image)

Case 2: Medium Active Communities

We repeat the simulations using the procedures similar to those adopted for Case 1. However, for this type of community we assumed only 50% initial participation by members. In other words, only half of the members (i.e., 50 out of 100 members) actively participate in this community in a stable environment. The results show that as environmental uncertainty increases, member participation in this community
under ULMX increases initially, but decreases dramatically as environmental uncertainty exceeds a certain threshold (\(T\approx4\)). Interestingly, at certain levels of environmental uncertainty, member participation under ULMX is greater than member participation under DLMX. However, with DLMX member participation remains stable despite increases in uncertainty.

**Case 3: Highly Inactive Communities**

Finally, we analyzed the case in which no one except the leader is participating initially while all the members are initially inactive (i.e., in many communities, members exist only in name and do not actively participate). We assigned “-1” to indicate a member’s state of inactivity. In very stable environments, a community under DLMX performs marginally better than a community under ULMX. As uncertainty increases, however, people tend to look around for opportunities for participation (note that initially no one was interested in this project) and hence the participation rate goes up as uncertainty increases. Interestingly, ULMX was found to be more efficient in building up network participation, outperforming DLMX. However, beyond a certain point (e.g., around \(T\approx5\)), although still performing better than DLMX, member participation under ULMX decreases substantially. In contrast, the network with DLMX leadership, although slower to build up member participation, maintains relatively high participation rates (<\(m\>=0.4\), or 70% participation rate), even at very high levels of environmental uncertainty (\(T\approx10\)).

In summary, the three results suggest that the effectiveness of leadership style on member participation depends on various factors (e.g., the maturity of the community and the degree of external influences.) Interestingly, in contrast to the findings of leadership studies that focused on traditional organizations, ULMX was found to outperform DLMX in certain situations.

**Impact of Network Size and Structure**

Do the results hold for communities with different characteristics (i.e., different size and structure)? Note that the results above were obtained for a community of a moderate size (\(N=100\)) and loosely centralized network structures (\(\gamma=1.5\)). To further shed light on this issue, we ran the simulation model for communities with various sizes (\(N\in\{50, 250, 500\}\)) and network structures (\(\gamma\in\{1.5, 2.5, 3\}\)). We present only the results for Case 3 (i.e., new communities where at the initial stage only the leader is actively participating) here because the results indicate that the patterns of member participation levels for Cases 1 and 2 are largely similar regardless of variations in network size and structure. Before comparing the effectiveness of the two leadership styles across the different network sizes, we first show separately how each leadership style differs in response to size variations.

![Figure 3: Impact of Network Size (\(\gamma=3.0\))](image)

As shown in Figure 3-a, for a given network structure (e.g., highly centralized (\(\gamma=3\))) the effectiveness of DLMX diminishes gradually as environmental uncertainty increases. At low uncertainty (i.e., \(T=1\)), DLMX is highly successful for small size communities. However, as uncertainty increases, DLMX is a more valuable governance mechanism to large communities (\(N=500\)) than to small counterparts (\(N=50\)). In contrast to DLMX, ULMX experiences “sudden collapse” that resulted from a small increase in uncertainty and becomes nearly insensitive to size variation. Figure 3-b shows that regardless of network
size, member participation sharply increases at low environmental uncertainty, but abruptly declines as the uncertainty increases. When DLMX is compared directly with ULMX in terms of their effectiveness in response to size variation, in a small community (e.g., N=50) DLMX was superior to ULMX regardless of different network structures (Figure 4). For a medium size community (N=250), at low levels of environmental uncertainty ULMX was found to be more successful than DLMX in attracting member participation. However, in highly uncertain environments, a reverse phenomenon was observed; DLMX outperforms ULMX in terms of maintaining member participation.

Finally, some interesting results were obtained concerning very large communities (i.e., N=500). Figure 4 shows that at low levels of environmental uncertainty, ULMX outrivals DLMX in this community with decentralized network structures. Interestingly, in a large community with ULMX, even small changes in environmental uncertainty can radically increase member participation. In contrast, under stable environments DLMX was only marginally effective in promoting member participation in a large community with loosely coupled network structures (γ=1.5). However, in a large community with more centralized structures, DLMX was not only as effective as ULMX in attracting member participation, but also more enduring than ULMX in response to increase in uncertainty. While ULMX was fragile to sudden “collapse” even by a small increase in environmental uncertainty, DLMX effectively preserves member participation at even high levels of uncertainty.

One consistent finding was obtained despite the variation in size and network structures. In contrast to our prediction, ULMX performs better than DLMX with respect to member participation in certain situations, particularly when communities were run only by a leader with minimal member participation. In other words, when members are not actively participating at the initial stage of the project, ULMX is a more effective leadership style than DLMX in inducing member participation. However, once a community becomes mature and maintains stable member participation, then DLMX outperforms ULMX in preserving member participation in response to environmental uncertainties.
Discussion and Implications

Table 1 summarizes the key findings of the simulation and their important managerial implications for SOVCs. Regarding the impact of network size, consistent with our conceptual articulation the effectiveness of both types of leadership tends to decrease sharply as the size of the network increases. When network structure, maturity state, and environmental uncertainty are all held constant, the average member participation rate for the small community with only 50 members was, at its peak, three times higher than the rates for the medium and large communities with 250 and 500 members, respectively. The results also suggest that for a small community DLMX generally outperforms ULMX in terms of enticing member contributions, although the performance difference was marginal. Furthermore, both types of leadership were ineffective in preventing small communities from experiencing a “sudden collapse” (e.g., an abrupt decrease in member contribution), which often arises from increased environmental uncertainty. Finally, for small communities the effectiveness of the two supervisory styles did not change substantially across different network structures, indicating that leadership effectiveness in small communities was almost insensitive to network structures.

For both medium- and large-sized communities, however, leadership styles play a more important role. When environmental uncertainty was low, ULMX was superior to DLMX in terms of stimulating member contributions, but a reverse phenomenon was observed at higher levels of environmental uncertainty. This finding suggests that the efficacy of leadership governance in SOVCs is greatly influenced by environmental conditions. For example, when the environment is stable, ULMX appears to be highly effective in stimulating inactive members to “awaken” and begin contributing, particularly in a decentralized, random structure (γ=1.5). In contrast, when environmental uncertainty is low, DLMX tends to exhibit a limited impact on member contributions in a decentralized network. However, when environmental uncertainty increases due to the many destabilizing factors that can threaten the survival of SOVCs, DLMX outperforms ULMX, irrespective of network structures. Interestingly, while member contributions under ULMX exhibit a sudden collapse even at low uncertainty, DLMX is more resilient against such abrupt cessations of member contributions. In fact, although variations exist across different network structures, member contributions cultivated by DLMX decline slowly and smoothly even in response to excessive increases in uncertainty. One of the main reasons for this stability is that those “in-group” core members who form close relationships with the DLMX leader are unlikely to leave the community and continue making their contributions even in the event of high environmental uncertainty. High levels of mutual trust, dependence, and respect fostered through high-quality DLMX will enforce in-group member unresponsiveness to environmental changes. Furthermore, psychological contracts (i.e., unwritten and implicit agreements) established between the leader and the follower through strong DLMX relationships will prevent core members from easily withdrawing from the group (Rousseau, 1995). Conversely, ULMX may have a structural disadvantage in obtaining and preserving such “loyal” and passionate members whose contributions are critical to the sustainability of SOVCs, particularly when environmental uncertainty is high.

The findings pertaining to the size of communities provide several important implications for the leaders of SOVCs as well as the managers of firms who utilize SOVCs as conduits for knowledge and innovation. First, the larger the community becomes, the weaker the effectiveness of leadership in terms of retaining members and motivating them to contribute. Therefore, top executives of SOVCs should “appoint” additional leaders to maintain the leader-member ratio at a reasonable level. In fact, recently many SOVCs implement a “shared-leadership” approach to governance (Carson et al. 2007) by which multiple leaders collaborate and jointly make key decisions. This emerging leadership form also embraces a division of labor principle in which each leader, on a day-to-day basis, can focus on his or her own expertise and interest, while strategic decisions critical to the SOVC are made by a “committee” of leaders. Alternatively, when shared leadership is not a feasible option, leaders of SOVCs must significantly enhance their interaction with members as the community expands. This means that leaders must increase their time- and resource-commitments proportional to the expansion of the community. However, this approach may be neither ideal nor practical when a particular SOVC grows dramatically to a level that cannot be managed properly by the limited number of leaders. It is also worthy of noting that too much control or hands-on management of existing members, which is often found in frequent leader-member interaction, may de-motivate members and result in other adverse consequences (e.g., increased conflicts and member dissatisfaction) (McWilliam 2000). Therefore, it is a leader’s dilemma to identify
the optimal level of interaction with members to maximize the benefits for the SOVC.

Table 1: Summary of Key Findings and Implications

<table>
<thead>
<tr>
<th>Key Findings</th>
<th>Managerial Implications</th>
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<tbody>
<tr>
<td><strong>Network Size</strong></td>
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<tr>
<td>In general, the effectiveness of both types of leadership styles (e.g., DLMX and ULMX) diminishes as the network expands.</td>
<td>As communities increase in size, leaders, regardless of what governance mechanism they employ, should interact with more community members and ensure that all members maintain a sense of community and attachment.</td>
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<td>Small networks are susceptible to “sudden collapse” even in response to small increases in environmental uncertainty, while medium and large networks are relatively less vulnerable to such radical erosions.</td>
<td>Leaders who manage small SOVCs should be mindful about the vulnerability of their communities in the face of environmental changes. They should frequently scan the environment and exert considerable effort to maintain member participation, particularly when environmental uncertainty looms.</td>
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<td>For both medium and large networks, ULMX outrivals DLMX in stable environments. However, as uncertainty increases, DLMX becomes more effective than ULMX as a governance mechanism.</td>
<td>Leaders of medium and large SOVCs should utilize a “contingency” approach by which they flexibly employ, depending on the degree of environmental stability, various leadership styles in order to maximize member participation.</td>
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<td><strong>Network Structure</strong></td>
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<td>In general, centralized structures promote a higher level of member participation than random structures, regardless of the network size and leadership style. However, a moderately centralized network outperforms a highly centralized one, particularly when the environment is stable.</td>
<td>Leaders must establish and promote centralized structures for their SOVCs in order to facilitate higher levels of member participation. However, too much centralization might adversely affect member participation, particularly when a minimal environmental threat exists. Leaders should determine the “right” level of centralization that facilitates the optimal level of member participation.</td>
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<td>In decentralized networks, ULMX outperforms DLMX in stable environments. However, in large communities with more centralized structures, DLMX is not only as effective as ULMX at attracting member participation, but also more enduring than ULMX in response to increases in environmental uncertainty.</td>
<td>SOVCs that have decentralized structures may not welcome “undemocratic” operations facilitated by DLMX. A “cultural mismatch” might exist between decentralized SOVCs and DLMX, which may adversely affect member participation. However, the importance of such cultural alignments diminishes as environmental threats grow. Consequently, leaders should adopt DLMX to preserve high levels of member participation given elevated environmental uncertainties.</td>
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<tr>
<td><strong>Maturity State</strong></td>
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<td>In inactive networks, ULMX outperforms DLMX at both low and medium levels of environmental uncertainty. Furthermore, DLMX does not effectively promote member participation, except at very high levels of uncertainty.</td>
<td>When SOVCs are in their infancy, the majority of members are just “observing” and not actively participating in community development. In such situations, leaders must adopt more “democratic” leadership styles (e.g., ULMX) to substantially increase member participation. In such “quiet” SOVCs, interacting intensively with only a select few members through DLMX appears to de-motivate other members’ active participation. Leaders of such SOVCs should be more open-mined and responsive to their members’ various ideas and suggestions.</td>
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<td>In moderately active networks, DLMX performs slightly better than ULMX in terms of attracting member participation. However, compared to highly active networks, the difference is negligible. Interestingly, compared to other maturity states, member participation in these networks is less sensitive to changes in environmental uncertainty.</td>
<td>When the members of SOVCs exhibit a moderate level of participation (e.g., only half of their “existing” members actively participate), leaders may utilize DLMX to maximize member participation. DLMX is particularly useful when a high degree of environmental uncertainty exists. However, when the environment is stable, ULMX and DLMX can be equally effective. Therefore, leaders in these SOVCs should choose the style that best “fits” their community norms and values.</td>
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<td>In highly active networks, DLMX outrivals ULMX regardless of environmental uncertainty. The difference between the two mechanisms becomes wider as the level of uncertainty increases.</td>
<td>When all SOVC members fully participate, the leader’s main concern is preserving the current state in response to environmental uncertainties. DLMX is more resilient to environmental changes than ULMX and can structurally preserve a higher level of member participation. Consequently, such a leader should leverage DLMX to its full capacity in order to maintain the integrity of the SOVC.</td>
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Another important insight is that leaders should wisely and flexibly adjust their leadership style depending on many factors, including community size, maturity states, network structures, and environmental uncertainty. The simulation experiment suggests that leadership effectiveness is contingent, to a great extent, on these contextual attributes, rejecting the idea of “one leadership style fits all.” To attain a maximal outcome, leaders should utilize a contingency approach by which they flexibly change their governance styles between DLMX and ULMX over the lifecycle of an SOVC.

Apart from network size, network structure was also found to significantly moderate the effectiveness of leadership in SOVCs. When other factors (e.g., size, maturity state, and uncertainty) are held constant, centralized networks generally exhibit outcomes that are superior to their decentralized counterparts. This finding indirectly supports the assertion that leaders’ direct interaction with members has a positive performance implication for the member’s level of contribution. According to social network theory (e.g., Coleman 1988), a centralized network in which a leader typically establishes a close relationship with a large number of followers structurally promotes norms and trust and enables them to utilize their available complementary skills. Furthermore, a cohesive network structure is useful for quality control, an issue that is faced by many SOVCs. As the project is centrally managed and monitored, consistency is well preserved, while conflicts among members are resolved amicably through a leader’s intermediation. However, such benefits are difficult to realize in decentralized structures, although the autonomy and diversity available in decentralized formations facilitate the retention of a creative work environment in an SOVC. This finding is in accordance with social capital theorists’ proposition that centralized networks are more ideal for preserving and maintaining existing resources, while decentralized networks are more effective for searching for and obtaining new resources (Burt 1982). In this light, although decentralized structures can be more attractive to entice new members to join, centralized structures are more competent formations for sustaining member participation in SOVCs.

Although ULMX is generally more effective than DLMX in stimulating member contributions at the low end of environmental uncertainty, the dominance of DLMX over ULMX was observed at high uncertainty consistently across diverse network structures. Furthermore, when all else is equal, DLMX becomes more valuable than ULMX as the degree of network centralization increases. DLMX has a “cultural match” with centralized networks, while the same can be said of ULMX and decentralized networks (Sparrowe and Liden 2005). Decentralized networks in which everyone has a similar level of authority and responsibility may not welcome a leader’s undemocratic operation with only his “in-group” members. Moreover, in centralized networks where a leader has many followers, he or she is simply unable to interact intensively with everyone in his or her circle due to limited time and resources. Consequently, for networks with high degrees of centralization DLMX is culturally and practically a more successful supervisory form than ULMX. If member retention and sustained participation are of utmost importance, SOVC leaders may consider enhancing the centrality of their community structures by initiating new ties with members who are not currently under their sphere of direct supervision. As the network centrality expands, leaders are required to make additional investments in time and effort. The spirit of equality manifested in ULMX supervision is often beneficial to SOVCs, particularly under low environmental uncertainty. However, when uncertainty looms large and a significant portion of members are lured to leave a particular community or substantially reduce their commitment, leaders must turn to their “loyal” and passionate members in order to sustain their communities.

Finally, a community’s state of maturity can also influence the effectiveness of leadership in SOVCs. For example, when SOVCs are in their infancy and the majority of members are just “observing” and not making frequent contributions, leaders must treat everyone more or less uniformly. For SOVCs in their nascent stage of development, interacting intensively with only a select few members through DLMX could severely de-motivate other members and hinder their participation. Therefore, leaders should be more open-minded and responsive to the diverse ideas and suggestions of their members, particularly during the early stage of the community’s development. However, when SOVCs have reached a certain critical mass in terms of member participation, preserving a few passionate followers through DLMX is necessary for the sustainability of the community in the event of increased environmental uncertainty.

It should also be noted that all of these findings and implications are relevant and useful when the community’s main objective is to retain its existing members and increase their level of contribution. However, there may be a situation where a certain degree of member turnover is desired and required for the community’s membership fluidity that is accomplished through the dynamic inflow and outflow of
members (Faraj et al. 2011). These authors argue that high member retention may, in fact, have a negative impact on an SOVC’s creativity and ingenuity, elements that are often thought to be imperative for the survival of knowledge-intensive online communities (Ransbotham and Kane 2011). If innovation and knowledge novelty are deemed more vital than member retention, leaders may behave differently and counter the suggestions provided to dampen member retention. For example, leaders should promote, rather than inhibit, decentralized structures such that members themselves can collaborate intensively with limited leader supervision and entice new members to join. Similarly, if the community’s primary goal is not to retain members, but to create and share new knowledge, ULMX, instead of DLMX, may be more effective for a community that is fully vigorous with full member participation. Yet, the challenge to uphold fluid membership in SOVCs is that the community should ensure that it can attract a sufficient number of qualified new members who can replace experienced, “old-timers” without experiencing a major disruption and other transitional difficulties (Butler 2001). If the number of incoming members is far less than that of departing members, fluidity cannot be easily maintained.

This study has several limitations. First, the simulation experiment was employed as a primary analytical instrument because of the difficulties associated with obtaining empirical data for many of the parameters investigated in our study. Some of these variables include degrees of environmental uncertainty, extent of network influence, and amount of member contributions. Personal interviews and survey methods may be instituted to operationalize these constructs, but they themselves may be incomplete and inaccurate due to respondents’ potential subjective biases. The simulation experiment met our research objective because it allowed us to observe the phenomenon in question in diverse situations and contexts that differ in terms of community size, structure and maturity states. Nevertheless, we admit that the findings from the simulation could only provide initial insights into the relationships between leadership style and member contributions, which are moderated by many contextual factors. Therefore, our findings call for further research based on empirical data that represent the properties of real-world SOVCs as closely as possible.

We also acknowledge that our simulation model was not, by any means, complete and can be further refined. For example, degrees of DLMX variability can be divided into finer levels of granularity (e.g., high, medium, and low DLMX) in order to provide more in-depth and comprehensive insights into the role of LMX variations on member behaviors. Furthermore, the strength of a leader can also be incorporated into the model to enhance the realism of our simulated environment. However, although technically feasible, more specific categorizations on the contextual variables will generate numerous combinations of parameters, which might make the findings difficult to interpret. Therefore, in this study we opted for model parsimony at the expense of complexity and completeness.

We also note that any results derived from simulation research are firmly based on the construction of the simulation model. For example, our model assumes that network structure (i.e., centralized scale-free vs. decentralized random networks) and leadership styles (i.e., ULMX vs. DLMX) are independent. However, it is plausible that leadership style may lead to different network structures, which may in turn further influence the type of leadership style adopted. Our current model does not allow for this kind of dynamic evolution of the network structure. Further research is needed to explore these possibilities.

Finally, the Ising perspective employed in this study is just one way to quantify the patterns of network influence. In this type of conceptualization (e.g., Oh and Jeon 2007), a member’s level of contribution is significantly influenced by the collective status of his or her peers who interact frequently with him. However, it is possible that network influence can be operationalized differently. For example, when determining the level of contribution or making membership decisions, a member could simply reference one particular member of his choice instead of all of the individuals in the group with whom he interacts. This alternative conceptualization can also be adopted if it is firmly grounded in theory.

Conclusion

From a LMX perspective, this study aimed to provide initial stylized insights regarding the factors that influence the sustainability of SOVCs. Although some SOVCs successfully preserve their membership fluidity through the continuous influx of new members, many others suffer from member turnover and reduced participation. The simulation-based insights suggest that supervisory behavior does matter to member retention and sustained participation in SOVCs, but its impact is significantly moderated by many contextual factors, such as community size, structure, maturity, and environmental uncertainty. In
certain situations ULMX prevails, but in others DLMX is more effective. These two forms of governance in fact complement each another, rather than compete. Therefore, the traditional debate over which form of leadership universally dominates the other does not provide much fruitful guidance for understanding leadership dynamics in SOVCs. Savvy leaders should understand the complex nature of SOVCs, leveraging the contingency approach by which they can successfully adjust their supervisory behaviors and complementarily utilize both DLMX and ULMX for the maximum benefits to their SOVCs.

References


Fielding, R.T. 1999. “Shared leadership in the Apache project,” Communications of the ACM (42:4), April,
pp. 42-43.


