ORGANIZING FOR HIGH GENERATIVITY: UNRAVELING THE NATURE OF INTERNET-BASED GENERATIVE COLLECTIVES

ABSTRACT

Analyzing generative group activities against the backdrop of an increasingly connected world, this paper develops the concept of "generative collectives" as a theoretical lens for explaining why some internet-based groups are more generative than others. Generative collectives are groups of people with shared interests or goals who mutually engage in rejuvenating, reconfiguring, reframing and revolutionizing acts. Although any type of collective has the capacity to be generative, some collectives are more generative than others. Using a mixed-method approach integrating findings from 20 qualitative Q-sorting interviews as well as a quantitative Partial Least Squares (PLS) analysis of 420 surveys, this study empirically disentangles the relations between three second-order dimensions of generative collectives—structure, cognition, and technology—and their levels of generative capacity. The findings show that structural ambidexterity and distributed cognition significantly predict collective generative capacity, explaining nearly two-thirds (65%) of its variance. Furthermore, the findings reveal that distributed cognition is a significant partial mediator for the effect of structure and technology on collective generative capacity, with 65% of the variance in cognition accounted for by structure and technology. Finally, implications for future research, practice, and systems design are discussed as well as important avenues for future research.

Keywords: Generativity, Collectivity, Generative Collectives, Generative Capacity, Generativity Support Systems, Distributed Cognition, Structural Ambidexterity, Tailorability

INTRODUCTION

The ubiquity of mobile computing has generated a worldwide integration platform for communication and collaboration that provides a space for universal compendia of ideas and an 'architecture of participation' (O'Reilly, 2004). Consequently, we witness a proliferation of group activities that occur via the Internet, both within and outside traditional organizations. Within traditional organizations, the Internet enables members of the organization to interact, exchange knowledge, and share ideas within and across organizational boundaries. Outside the realm of organizations, the Internet has enabled a whole range of collective activities, such as networking, friendship, sharing and co-creation, as well as the possibility to generate contributions and insights of all sorts from a very large and diverse group of people.

Despite the infinite variety of collective activities that occur online, one specific set of Internet-based activities that is of particular interest to organizational scholars relates to generativity. Generativity refers to the ability to originate, produce or procreate (Webster, 2009) and therefore is closely related to creativity and innovation. The internet has enabled virtual pools of talent and resources within which acts of generativity can occur in unparalleled scale and scope in ways not heretofore theorized.

In spite of a general awareness that Internet-based collectives and online platforms are important virtual places for generativity to occur (O'Mahoney & Ferraro, 2007; Tapscott & Williams, 2006; Von Hippel & Von Krogh, 2003; Von Krogh & Von Hippel, 2006; Alexander, 2006; Feldman, 2002; Kaufmann et al., 2003), we know very little about the characteristics of collectives that influence their generative capacity. Therefore, understanding the generative capacity of collectives is important, not only because of the increasing proliferation of such collectives, but also because these collectives shed light onto a set of dimensions of collectivity that fosters grassroots creativity and innovation, especially in dynamic, loosely structured and self-organized environments. Theorizing these dimensions—as induced by Internet-based collectives—has significant implications for understanding the more general case of generativity in organizations.

In this mixed-method study, the notion of "generative collectives" is introduced to describe *groups of persons with shared interests or goals who mutually engage in rejuvenating, reconfiguring, reframing and revolutionizing acts* (Van Osch & Avital, 2010). Hence, the focus is on those sets of Internet-based collective action pertaining to generative activities and creative outputs. Thus, generative collectives represent harbingers of creativity, innovation and change against the backdrop of a digitized and increasingly connected world.

Any collective has the capacity to be generative to some degree. In this paper, the quality to be generative is referred to as "collective generative capacity"; that is, *the ability of a generative collective to engage in acts of rejuvenating, reconfiguring, reframing and revolutionizing within a particular goal-driven context* (Van Osch & Avital, 2010). Therefore, collective generative capacity represents a trait of a collective. Like any trait, collective generative capacity can be absent or present, weak or strong, and thereby affects the actual generative acts and outcomes of a collective.

Given that the actual level of generative capacity of a collective can be high or low, this study aims to theoretically develop and empirically test a framework for analyzing how and why some collectives are more generative than others by zooming in on a set of structural, cognitive and technological dimensions of collectives that affect their levels of generative capacity. Hence, the overall question this study aims to address is *what are the dimensions of Internet-based collectives that affect their generative capacity*?

Understanding collective generative capacity is of interest, not only because of the increasing proliferation of Internet-based collectives, but also because these collectives shed light onto a set of dimensions of collectivity that foster grassroots creativity and innovation, especially in dynamic, loosely structured and self-organized environments. Hence, theorizing these dimensions has significant implications for understanding the more general case of generativity in organizations. Furthermore, understanding variations in the generative capacity of collectives can help us explain why some collectives are more generative than others. These insights can subsequently inform the design and development of information systems (IS) and online environments that are conducive to generative processes. Therefore, the findings of this study will have important implications for understanding how to enhance generative capacity and evoke generative processes in collectives and organizations of all sorts.

This paper is organized as follows. First, after an overview of the core theoretical foundations, namely generativity and collectivity, this paper will outline the proposed theoretical framework of collective generative capacity. Then, the mixed method approach underlying the empirical validation of the theoretical framework will be presented, followed by an in-depth overview of results. Finally, theoretical, practical, and design implications will be discussed.

THEORETICAL BACKGROUND

Collectivity

Collectivity is defined generally as a state constituting an aggregated whole. Hence, a collective is a number of persons that are considered as one group characterized by some sort of similarity among its members (Webster 2009), such as akin attribute, shared interest or common objective. Collectives can range from small groups (e.g. work teams) to organizations, from ad hoc alliances to longstanding federations, and various instances of society at large.

Collectivity has been applied frequently in the context of the social sciences and humanities, as evidenced by the abundant illustrations summarized in Table 1. When juxtaposing these multiple foundational conceptualizations of collectivity, three common denominators emerge, namely: (1) *shared interests or goals*; (2) *collective activities* (e.g. exchanging ideas); and (3) *mutual engagement*.

Furthermore, the conceptualizations in Table 1 emphasize different dimensions of collectives. Some conceptualizations emphasize dimensions of structure (Durkheim, 1893; Fleck, 1935; Olson, 1965) whereas other conceptualizations focus on cognition (Jung, 1953; Hutchins, 1995; Weick & Roberts, 1993; Lévy, 1994; Hargadon & Bechky, 2006; Erden et al., 2008). This implies that disentangling the cognitive processes and structural configurations that emerge and evolve in collectivities is crucial for obtaining a holistic understanding of generative collectives.

==Insert Table 1 about here==

Generativity

Generativity refers to the ability to originate, produce or procreate. The concept of generativity has been used effectively in multiple disciplines, an overview of which is provided in Table 2. In reviewing these multiple foundational conceptualizations of generativity, their common denominators are: (1) *the drive to* ***revitalize*** *or* ***rejuvenate***; (2) *the production of novel configurations and new possibilities (i.e.,* ***reframing****)*; as well as (3) an attempt *to challenge the normative status quo (i.e.,* ***revolutionizing****)*.

Furthermore, the conceptualizations in Table 2 emphasize different dimensions of generativity. Some conceptualization emphasize dimensions of cognition (Erikson, 1950; Chomsky, 1972; Schön, 1979; Pustejovsky, 1991; Gergen, 1994; Zandee; 2004; Yorks, 2005), other conceptualizations stress aspects of structure (Chomsky, 1972) and/or technology (Alexander, 1996; Frazer, 2002; Kornberger & Clegg, 2004; Zittrain, 2008; Avital & Te'eni, 2009). This implies that unraveling the cognitive processes, structural configuration as well as technologies and artifacts that emerge and evolve in generativity is crucial for understanding generative collectives.

==Insert Table 2 about here==

Merging Perspectives on Collectivity and Generativity

Based on the theoretical insights from this section, several motifs of collectivity and generativity are identified and summarized in Table 3 as follows, which jointly provide the foundation for our conceptualization of generative collectives in the next section.

==Insert Table 3 about here==

Furthermore, based on the review of these conceptualizations, the following dimensions of collectivity and generativity can be identified, which need to be further explored theoretically and empirically to obtain a holistic understanding of the functioning of generative collectives (Table 4).

==Insert Table 4 about here==

GENERATIVE COLLECTIVES

Building on the common themes of collectivity and generativity as described in Table 3, the following working definition of generative collectives emerges: *a group of persons with shared interests or goals who mutually engage in rejuvenating, reconfiguring, reframing and revolutionizing acts*. As aforementioned, albeit some collectives are more generative than others, the notion of generative collectives is based on the fundamental assumption that any type of collective has the capacity to be generative. This capacity is referred to as collective generative capacity: *the ability to engage in acts of rejuvenating, reconfiguring, reframing and revolutionizing within a particular goal-driven context.*

Hence, collective generative capacity can be considered a trait of a collective and the seed or root-cause of generative acts and outcomes (Avital & Te'eni 2009). Like any trait, collective generative capacity can be absent or present, weak or strong, and thereby affects the actual generative acts and outcomes of a collective.

In what follows, the three dimensions of collectives—structure, cognition, and technology—that emerged from the literature review presented earlier will be discussed in order to constitute the theoretical framework of collective generative capacity.

Structure

Within the organization science literature the relationship between structure and innovation has been analyzed and theorized repeatedly (Jansen et al. 2006; Atuahene-Gima 2003; DeCanio et al. 2000; Damanpour 1991; Sapolsky 1967), demonstrating that structure is an important dimension for understanding collective generative capacity. For instance, it has been shown that traditional organizations, built around norms of stability and routinization, display lower levels of creativity and innovation (Cummings 1965). Alternatively, in dynamic and changing environments that are unstable, variable and difficult to predict, new ideas and knowledge can be incorporated better to reach high levels of creativity and innovation (Cummings 1965). Furthermore, there is a widespread view that hierarchy discourages initiative and restrains creativity (Cummings 1965). Also in the literature on online communities, the factor of structure is considered to have an important impact on collective generative capacity (Butler 2001).

When studying generative collectives, two structural dimensions of collectives in particular are essential for understanding the relation to collective generative capacity, namely *level of transience* and *level of laterality* (Fleck 1935). With respect to transience, stable collectives emerge through repeated bonding and thus become more organized, often develop fixed routines and formal rules, and consequently practical performance takes precedence over creative tendencies (Fleck, 1935). On the other hand, more transient collectives can be fortuitous and thus may form and dissolve at any moment. However, they still trigger a certain mood toward engaging collectively in activities; that is, people still feel connected and motivated to act together. In fact, their known transient nature stimulates concerned people to engage expeditiously at their best, while they last.

With respect to laterality, whether or not a collective is organized hierarchically depends on the interplay between the esoteric 'elite' and the exoteric 'mass' (Fleck, 1939). If the elite occupy the stronger position, they distance themselves from the crowd and develop strong rules that restrain the behavior and actions of the masses. Consequently, the collective as a whole displays more conservative and rigid tendencies (Fleck, 1935). In contrast, if the masses occupy a stronger position, the elite often strive to preserve the assurance and support of the masses, resulting in the development of ideas and progress. Here, control does not reside in a centralized actor but rather emerges from the decentralized interactions of all actors involved, thereby leading to a democratization[1] of the innovation process (Von Hippel, 2005; Yoo *et al.*, 2009).

In short, then, when a structure is less solid and fixed, due to a highly transient and highly lateral nature of a collective—the generative capacity of that collective becomes greater. In short, the ability to rejuvenate, reconfigure, reframe and revolutionize—collective generative capacity—is greater when the level of transience and laterality is high (Yoo et al. 2009; Von Hippel 2005; Zhang & Storck 2001; Fleck 1935). Therefore, based on the above theoretical discussion, the following proposition is derived:

Proposition 1(a-b): *Lack of structure—i.e., higher levels of level of transience (a) or level of laterality (b)—is positively related to collective generative capacity*

[1] Yoo (2009) uses the term polyarchy in this context (Greek: *poly* means many, *arkhe* means rule) to describe a form of government in which power is vested in many persons, of whatever order or class (Webster, 2009).

Jointly, these propositions suggest that collectives with higher levels of transience and laterality are more likely to produce new or alter existing configurations, to reframe the way we see and understand the world and to challenge the status quo.

Cognition

In order to understand how people in collectives engage in generative acts collectively, I draw upon the notion of distributed cognition in order to understand cognitive processes in a collective not as an individual process, but as a process involving the collective as a whole. Distributed cognition is a process whereby individuals in a group or organization exchange their personal interpretations of a situation, reflect upon them, engage in dialogue about them and inform action with them (Boland et al. 1994). As such it provides the conditions for surfacing and challenging underlying assumptions, for complicating thinking, and for enabling change and other generative acts. Based on distributed cognition theory, three cognitive processes can be distinguished which lie at the heart of generative acts, namely *reflecting, interacting and representing* (Boland et al. 1994) (see Table 5).

==insert Table 5 about here==

First, in the context of generative collectives, the cognitive process of *reflection* refers to the questioning and challenging of fundamental assumptions that form the basis for collective acts in order to uncover potential flaws (Levina 2005; Schön 1983). Given the centrality of critical thinking and transforming the status quo in generative acts, it is evident that the *level of reflection* is closely related to the level of collective generative capacity.

Second, in the context of generative collectives, the cognitive process of *interaction* refers to the need for dialogue and conversation in the context of collective act as a basis for subsequent confrontation and transformation and, in turn, generative acts. Finally, the cognitive process of *representation* plays a variety of roles in generative collectives, namely (1) envisioning practice and goals, (2) structuring activities, (3) revealing progress, (4) building shared understandings, (5) externalizing outcomes (Okhuysen & Bechky 2008; Bechky 2003; Boland & Tenkasi 1995).

Based on the above theoretical discussion, the following proposition is derived:

Proposition 2(a-b-c): *Distributed cognition—high levels of reflection (a), level of interaction (b), or level of representation (c)—is positively related to collective generative capacity*

Jointly, these propositions suggest that collectives with higher levels of reflection, interaction, and representation are more likely to produce new or alter existing configurations, to reframe the way we see and understand the world and to challenge the status quo.

Technology

When studying generative collectives, two technical dimensions of Internet-based collectives are essential for understanding the relation to collective generative capacity, namely *level of tailorability* and *level of openness*.

Tailorable technologies are flexible and conductive to effective use and modification by a heterogeneous set of people in their own respective environments and for various tasks within an intended scope, hence, are flexible yet powerful enough to enable the generation of new ideas and configurations (Zittrain 2008; Avital & Te'eni 2009; Germonprez et al. 2007).

Open technologies emphasize permeable boundaries in order to promote exchanges and interactions of any kind. These systems thus provide connectivity, enable transparency, allow for free and unrestricted information sharing, encourage dialogue with no regard to institutional, cultural, or geographic boundaries (Zittrain 2008, Culnan 1984). Based on the above theoretical discussion, the following two propositions are derived:

Proposition 3(a-b): *Technological flexibility—high levels of tailorability (a) or level of openness (b)—is positively related to collective generative capacity*

Jointly, these propositions suggest that collectives, which are enabled by technologies with higher levels of tailorability and openness are more likely to produce new or alter existing configurations, to reframe the way we see and understand the world and to challenge the status quo.

Amalgamating the three theoretical domains of structure, cognition, and technology, the following framework of collective generative capacity emerges.

==insert Figure 1 about here==

RESEARCH DESIGN

In order to address the abovementioned research question and objectives with both in-depth and generalizable results, this study adopted a multi-method approach encompassing two phases; a qualitative exploration and theory-refinement phase and a quantitative theory-testing phase, each of which will be described as follows. While the most pertinent tables regarding data analysis are presented in the narrative below, a comprehensive set of analysis tables is provided in an online appendix (see http://bit.ly/XbQrte).

Phase 1: Theory Exploration and Refinement Through Qualitative Data

Q methodology represents a systematic study of subjectivity (Brown, 1986) through a modified rank-ordering procedure in which stimuli—i.e. statements—are placed in an order that is significant and meaningful from the standpoint of the respondent (Brown, 1980). The use of Q methodology is primarily aimed at accessing diverse perceptions and therewith forms a good exploratory point of departure for the initial testing of theoretically founded propositions.

According to Thomas and Watson (2002), Q-sorting offers several benefits to information systems researchers; including: the support of exploratory, in-depth research; the capturing of subjectivity in operation through a person's self-reference; and protection of respondent self-reference from researcher influence through the specific analysis techniques it uses.

Concourse and Q Sample. The concourse—the sum of all things people say or think about the issue being investigated, i.e., collective generative capacity—for this study was collected from diverse expert sources including exploratory interviews, journal articles, websites, blogs, and magazines. Subsequently, a final selection of 40 statements that formed the final Q sample was drawn from the concourse of approximately 100 statements to ensure manageability of the sorting process for participations (Van Eeten, 1998). The selection process was aimed at maximizing diversity of statements (Thomas & Baas, 1992)2.

Q-Participants. The Q-method requires a limited number of respondents (Webler, Danielson & Tuler, 2009). For a Q-sort with 40 statements, approximately 14 participants are needed

[2] Although the selection of the Q sample is a subjective process undertaken by the researcher, it is the research subject that gives meaning to the statements by sorting them, hence, it is expected that factor convergence occurs (Thomas and Baas, 1992)

(Webler et al., 2009), however, it is commonly advised to use somewhat larger samples. Hence, we invited 20 participants; a commonly used sample size for a study with 40 statements (Webler et al., 2009). These participants were selected to represent a diverse range of backgrounds and areas of expertise in the realm of Internet-based communities—ranging from community managers, to platform designers, to social media marketers, bloggers, and researchers.

Data Collection. During the Q-sorting interview, participants were presented with the Q-sample of 40 statements and asked to rank-order these statements from their individual point of view using a quasi-normal distribution (Brown, 1980). Hereto, they were asked to first divide the statements into three piles: 'agree', 'disagree' and 'neutral' after which they were asked to lay the cards on a response chart in the form of a quasi-normal distribution. During the sorting process, no outside source was allowed to guide the participant (Thomas & Watson, 2002), to ensure that participants' sorting is based on self-reference rather than external factors.

This self-referent response may be termed accurate from the participant' perspective as he or she has made the best choices possible within the options available (Thomas & Watson, 2002). Given that the forced quasi-normal distribution requires decisions, the interpretation of statements around the center of the distribution (-1, 0 and +1) may be intentionally neutral or leftovers with little value, therefore containing little to no information (Stephenson, 1974). Upon completion of the sorting process, participants were interviewed regarding (1) the statements on both extreme ends of the distribution and (2) other statements they had strong opinions about.

Data Analysis. Q-factor analysis is the mathematical technique that is used to identify patterns among Q-sorts; i.e., social perspectives of the relations between the features of collectives and generative capacity compromising many people's subjective expressions (Webler et al., 2009). In order to conduct the factor analysis, the software program PQMethod (Schmolck,

2011) was used that revealed three distinguishing factors, which will be interpreted and labeled in the next section on results. All three factors had eigenvalues greater than 1 (ranging from 1.324 to 9.883) and therefore were considered significant (Van Exel & De Graaf, 2005). Furthermore, correlations between these three factors were poor, i.e., lower than .6 (Bagozzi, Yi, & Philips, 1991), showing high discriminant validity[3].

These resultant three factors[4] represent groupings of people with similar patterns of response during the sorting—i.e. similar viewpoint. Hence, the loading of a particular respondent on a given factor indicates the level of (dis-)agreement with this particular viewpoint (Stephenson, 1979; Brown, 1980). Results from the Q sorting, including the interpretation and subsequent labeling of the three factors, will be further discussed in the next section.

Phase 2: Theory Testing through Quantitative Data

In the second data collection phase of this study, a survey was conducted to test the theoretical model and reveal the explanatory power of each of the factors in the model.

Participants and Sampling

Given the aim of this study to disentangle the generative capacity of Internet-based collectives, the target respondents for this study are active managers or members of Internet-based collectives. In order to obtain a sample of managers and members of Internet-based collectives, a convenience, snowballing sampling strategy was used. LinkedIn was used to identify people who indicated to be managers or members of Internet-based collectives for innovation or change. These respondents in turn were asked to further distribute the survey invitation through the mailing lists of their respective collectives.

[3] See online appendix at: http://bit.ly/XbQrte
[4] Factor scores and loadings are provided in an online appendix at: http://bit.ly/XbQrte

The final sample encompassed 420 complete surveys with no missing data originating from 29 different countries. The sample displayed a near even gender split, with 55% women (N=221) and 45% men (N=189). The majority of participants (74%; N=312) were between 19 and 30 years of age. The remaining 26% were between 31 and 74 years old. From the 420 participants, the majority (54%; N=225) had a Master's degree, followed by another 38% (N=159) with a Bachelor's degree. The remaining 8% has a doctoral or high school degree. Finally, nearly half of participants (N=207) spent 3-6 hours per week on community platforms, followed by an additional 27% (N=111) that spent between 9-12 hours. The remainder spent over 12 hours per week on community platforms. Hence, all respondents were active members.

Survey Instrument and Validation. The questionnaire contained self-developed scales for all seven dimensions of structure, cognition, and technology as well as the dependent variable collective generative capacity, given the absence of pre-existing scales for these latent, theoretically informed constructs.

In order to operationalize both the independent and dependent factors, a deductive approach to item development—i.e., the generation of items from the theoretical foundation—was adopted (Hinkin, 1998). The advantage of a deductive approach is that it helps to assure content validity. Furthermore, through the development of adequate construct definitions and conceptualizations, items should capture the domain of interest (Hinkin, 1998). Based on the seven first-order dimensions[5] underlying the three second-order constructs—structure, cognition, and technology—in the theoretical model, 14 survey items were derived and an additional two items were formulated to represent the dependent variable; collective generative capacity.

[5] Structure: transience and laterality; Cognition: reflection, interaction, and representation; Technology: tailorability and openness

Items were formulated simple and short, using language that is familiar to the respondents. Furthermore, the development of items was informed by the results of the Q sorting study and the significant statements that emerged during the Q analysis. Content validity was assessed by a small student sample (N=10) that matched the various items with their corresponding definitions. An overall acceptable agreement index—the percentage of respondents who correctly classify an item—of 80% increased confidence in the content validity of the fourteen items.

For each item, the participants characterized their own online community for each of the items from “completely agree” to “completely disagree”. Furthermore, in order to operationalize the dependent variable—collective generative capacity—two questionnaire items were formulated pertaining to two of the core dimensions of generativity, namely the production of novel or altering of existing configurations as well as the reframing and transforming of existing viewpoints. For each item of the dependent variable, respondents were asked to rate their own community on a 5-point Likert scale from “very successful” to “very unsuccessful”. In addition to these independent and dependent variable items, the survey included a series of control variables, namely gender, age, education, and activity levels in online communities[6].

The evaluation of the survey measures was conducted through various tests, starting with an exploratory factor analysis in SPSS, which revealed the expected factor structure for the first-order constructs. Hence, subsequently the data was transferred into Smart-PLS to further test the reliability and validity of the items and the overall model using first-order and second-order formative partial least squares analyses.

Validation of the first-order formative constructs was conducted through a review of the significance of paths and variance inflation factors (VIFs). Whereas the validity and reliability of

[6] Survey instrument is provided in an online appendix at: http://bit.ly/XbQrte

reflective latent variables is tested through factor loadings, these measures are not relevant for formative constructs. Rather, p-values are used as an indication of the proper construction of formative latent variable measurement items and VIFs provide an indicator of the lack of redundancy (i.e., multicollinearity) of the measurement items. Whereas reflective latent variable indicators are expected to be redundant, formative indicators should measure different facets of the same construct and thus be non-redundant.

With respect to the p-values, all paths in the first-order model—i.e., the paths for the eight first-level constructs of transience and laterality; reflection, interaction, and representation; as well as tailorability and openness—displayed significance at the .001 level. With respect to the VIFs, none of the VIFs for all first-order construct measurement items exceeded the 3.3 threshold for PLS based analyses (Kock, 2011). Both t-statistics (p-values) for all first-order paths and VIFs for all measurement items from the first-order formative constructs are presented in Table 6.

Table 6 further shows that all first-order constructs displayed adequate reliability (Carmines & Zeller, 1979) and internal consistency well above the 0.7 threshold (Nunnally, 1978). Cronbach α-values were satisfactory for all constructs and AVE exceeded the 0.5 benchmark for convergent validity (Fornell & Larcker, 1981) for all variables. Discriminant validity was supported by confirming that the square root of the variance shared between a construct and its items was greater than the correlations between the construct and any other construct in the model (Fornell & Larcker, 1981). Discriminant validity was further supported by multicollinearity tests, which showed that no mulitcollinearity existed between first-order or second-order constructs (highest VIF was 2.257).

==insert Table 6 about here==

Furthermore, the second-order PLS analysis revealed that all paths from the first-order to the second-order constructs were highly significant ($p=<.001$) (see column 5 in Table 6) further enhancing confidence in the structural and measurement models.

The final reliability test performed was the Lindell & Whitney (2001) marker variable test to assess the presence of common method bias. It involves employing a theoretically unrelated construct, a "marker variable", to observe whether there is any high correlation between it and the study's principal constructs. The marker variable used was gender and its correlation with our study's constructs—generativity, structure, cognition, and technology—was extremely extremely low (-.026, -.082, .0003, .026 respectively), offering further support for the non-presence of common method bias.

FINDINGS

The Structural Ambidexterity of Generative Collectives

Based on the theoretical review, it was proposed that higher levels of the structural dimensions of transience and laterality positively affect collective generative capacity.

The findings from the Q-sorting study and Q factor analysis revealed that structure was a highly significant factor in the context of generative collectives. When further investigating the specific items—i.e., statements—loading highly on the first factor termed *structure*, it became clear that there was general consensus among the Q sample that fluid and open structures characterized by a lack of rules and procedures enable collective generative capacity to materialize and flourish.

Furthermore, the follow-up interviews further emphasized the importance of flexible structures as evident by a set of representative statements from respondents: "*I'm an advocate of as little hierarchy as possible, lots of freedom and happiness, let things happen by chance*." "*You should create a framework in which members are flexible and can interact freely, and then people become creative and innovative*."

Furthermore, the follow-up interviews with the Q-sorting participants appeared to suggest that in addition to the direct effect of structure on collective generative capacity, fluid and open structures also positively affect the cognitive processes of reflection, interaction and representation. Participants' responses thus indicated an indirect relationship—mediated by cognition—between the structural configurations of a collective and its generative capacity.

These two relationships—i.e. between structure, on the one hand, and collective generative capacity as well as cognition, on the other hand—were subsequently tested and confirmed through a Partial Least Squares (PLS) analysis. Both relationships turned out to be strongly significant—$\beta=.427$ ($t=7.867$, $p=<.001$) and $\beta=-.791$ ($t=26.792$, $p=<.001$)—and the structural configuration of an Internet-based collective was found to account for 32.8% and 39.9% of the variance in collective generative capacity and cognition respectively.

Hence, this indisputably confirmed that the structural configuration of an Internet-based collective is crucially important to both the success of its cognitive processes as well as to its level of generative capacity. Yet, through a closer inspection of the items that correlated highly on the structural dimension of collectives it was revealed that rather than highly lateral and transient structures, it is a collective's structural ambidexterity, originating from an apparently contradictory amalgamation of elements of laterality and hierarchy as well as transience and stability that leads to enhanced cognition and collective generative capacity.

Structural ambidexterity, in this context, refers to a dual structure of an entity—e.g. an Internet-based collective—with the aim of enabling concurrent exploitation and exploration. An ambidextrous collective requires mobilization and flexibilization—i.e. laterality and transience—as well as coordination and integration—hierarchy and stability— in order to enable operational efficiency and generative capacity simultaneously (Avital & Te'eni, 2009).

Integrating exploitation and exploration requires the integration of seemingly contradictory, yet, practically complementary modi operandi, namely practicing both convergent and divergent cognition, following procedures while being creative and innovative, performing restricted as well as open-ended tasks, managing both low and high ambiguity, working toward both known, certain outcomes as well as unknown, uncertain outcomes, as well as amalgamating different standards of success—namely efficiency and accuracy vis-à-vis making a difference and novelty.

Enabling an interplay of these two, virtually opposite, modi operandi, represents the structural ambidexterity, that is, the simultaneous need for laterality and hierarchy as well as transience and stability, that is at the heart of generative collectives.

Hence, *structural ambidexterity*—through a careful balancing of laterality and hierarchy as well as transience and stability—results in a significant enhancement of the *cognition and generative capacity* of Internet-based collectives.

The Distributed Cognition of Generative Collectives

Based on the theoretical review, it was proposed that the higher levels of the distributed cognitive dimensions of reflection, interaction and representation enhance collective generative capacity.

The findings from the Q-sorting study and Q factor analysis revealed a general consensus among participants that cognitive processes are most significant for enhancing generative capacity. From the three factors that emerged from the factor analysis, two factors emphasized the importance of cognition in relation to generativity. One factor emphasized primarily the cognitive processes of interaction and reflection, that is, the generating and sharing of ideas through dialogues and negotiations with others. The other factor emphasized primarily the cognitive process of representation, that is, the documenting and exchanging of outcomes of the generative process for future use by others.

Participants emphasizing the importance of interaction and reflection remarked that the "*The strength [of internet-based collectives] is the interaction with other people. Creativity is stimulated through out-of-the box thinking and the learning of ideas one would not think of themselves*." "*In your work it is important to interact with people from the same work field. Online one can get into contact with experts easily, share ideas, read what others wrote, gain new information and get more ideas yourself.*"

Furthermore, those discussing the importance of representation emphasized that: *"When you're writing your ideas down, you force yourself to rethink these ideas and create the possibility for others to criticize your ideas*." "*You have to document your ideas well, because* *what is the use when it is abstract and vague? When people don't understand ideas they cannot criticize and improve them"*.

The direct relationship between cognition and collective generative capacity was subsequently tested and confirmed through a first and second-order Partial Least Squares (PLS) analysis. Where the first-order analysis revealed that the reliability and validity of the three first-order cognitive constructs—reflection, interaction and representation—, the second-order analysis showed that higher levels of distributed cognition were found to significantly predict higher levels of collective generative capacity—β=.416 (t=7.238; p=<.001)—and to account for nearly one-third of the variance (31.7%) in collective generative capacity. Furthermore, distributed cognition (R^2 = .65) turned out to be a significant mediator for both structure and technology.

Hence, results of the multiple Q-sorts and PLS analyses described in the results section above revealed that processes of distributed cognition are at the heart of generative collectives—explaining a large part of the variance in the generative capacity of these collectives as well as mediating the relationships between structure and technology, on the one hand, and collective generative capacity. Hence higher levels of *distributed cognition*—through *high levels of reflection, interaction and representation*—results in a significant increase in the *generative capacity* of such collectives.

The Technological Flexibility of Generative Collectives

Based on the theoretical review, it was proposed that higher levels of the technological dimensions of tailorability and openness enhance collective generative capacity.

Interestingly, the findings from the Q-sorting study did not result in technology emerging as a separate factor from the analysis. Rather, there appeared to be general consensus that technology should be designed in such a way that it allows maximum freedom in use in order to enable reflection, interaction and representation, i.e., distributed cognition. Hence, suggesting that higher levels of tailorability and openness are positively related to collective generative capacity, but indirectly, through their positive effect on cognition. Respondent comments emphasized the importance of technologically supporting processes of distributed cognition: *"You should create a platform on which members are flexible and can interact freely, and then people will generate ideas." "You have to design technology in a way that you can do whatever you want and interact with whoever you want".*

This finding was confirmed by the results from the Partial Least Squares (PLS) analysis, which revealed that no direct relationship exists between technological degrees of freedom and collective generative capacity. Instead, higher levels of technological degrees of freedom do result in significantly higher levels of a collective's cognitive degrees of freedom, β=.132 (t=3.620, p=<.001) accounting for one-fourth (25%) of the variance in cognitive degrees of freedom.

Therefore, the overall conclusion regarding technology within generative collectives is that flexible technology platforms—through high levels of tailorability and openness—result in a significant increase in cognitive degrees of freedom, which in turn, positively affects the capacity of a collective to be generative. This implies that Internet-based collectives using a *highly tailorable and open platform*, which allows user-induced adaptation and easy access, have a significantly *higher ability for distributed cognition*.

DISCUSSION

In this paper, a theoretical model of collective generative capacity was conceptually developed, and empirically refined and tested. Specifically, it examined the impact of a set of structural, cognitive and technological dimensions of Internet-based collectives on their generative capacity through 20 qualitative Q-sorting interviews and a PLS analysis of 420 surveys.

Based on the amalgamation of qualitative and quantitative findings, three main conclusions have been derived. First, higher levels of distributed cognition—through high levels of reflection, interaction and representation—result in higher levels of collective generative capacity. Second, higher levels of structural ambidexterity—through an apparently contradictory amalgamation of elements of laterality and hierarchy as well as transience and stability—result in higher levels of collective generative capacity. Additionally, higher levels of structural ambidexterity result in significant increases in distributed cognition. Third, higher levels of technological flexibility—through high levels of tailorability and openness—do not result in a significant increase in collective generative capacity. However, higher levels of technological flexibility do result in significant increases in distributed cognition.

A Refined Theory of Generative Collectives

Jointly these findings result in a renewed model of collective generative capacity (Figure 2) compared to the original model presented, where distributed cognition lies at the heart of generative collectives, with higher levels of reflection, interaction and representation resulting in a higher capacity for generativity. Furthermore, distributed cognition is enhanced by the ambidexterity of a collective's structure and the tailorability and openness of its technology platform. Finally, strong structural ambidexterity, based on a delicate balance of elements of laterality and transience with hierarchy and stability, also directly results in higher levels of collective generative capacity. In what follows, implications for theory, practice, information systems design as well as challenges for future research will be discussed.

==insert Figure 2 about here==

The Future of Generative Collectives Theory. Drawing on the insights from this study, several important contributions to research and theory on Internet-based collectives are offered. First, by conceptualizing generative collectives this study offers a theoretical lens for analyzing and understanding a vast variety of Internet-based group activities for creativity, innovation and collective action in a wide range of collectives.

Second, by proposing the seven dimensions of generative collectives, this study offers a holistic framework for analyzing such collectives and for assessing their levels of collective generative capacity by classifying their levels of structural ambidexterity, cognitive degrees of freedom and technological degrees of freedom.

Third, despite the limitations to generalizing beyond the context of analysis, the proposed model can be applied to all sorts of collectives, including those that are not Internet-based, such as traditional organizations. As such, the analysis of generative collectives and collective generative capacity can throw new light on several topics in organizational theory, including organizational types—high-generative versus low-generative organizations—and the measurement of performance—in terms of generative capacity in addition to standard measures of operational efficiency.

Fourth, by revealing the indirect effect of technology (i.e., information systems) on generative capacity, this study reveals the need for information systems to first and foremost affect distributed cognition, which in turn will enhance generative capacity, as will be further explored below.

The Future of Generative Collectives Practice. Besides important implications for research, the insights from this study can inform the practical organization of all sorts of collectives with generative aims. First, by proposing the seven dimensions of collective generative capacity, this study provides a framework for assessing the levels of generative capacity of collectives as well as for identifying areas for improvement in order to further enhance the generative capacity of these collectives. Hence, this framework can help us to make sense of the proliferation of Internet-based collectives for creativity and innovation as enabled by mobile, ubiquitous computing.

Second, despite that the proposed model has been developed, tested and refined in the context of Internet-based collectives, the same model can apply to organizations and help us understand why organizations with different structural configurations, different cognitive processes, and different technological support perform differently with respect to creativity and innovation. Consequently, the insights from this study can help to support the formation and continuation of highly generative groups and organizations beyond the context of internet-based collectives.

Third, thinking about novel organizational types—highly generative organizations—and organizational performance—in terms of generative capacity—is highly relevant for practice. Through the concept of generative collectives, organizations can approach issues of organizational structure and performance from a new angle so that the dominant focus on hierarchy, stability and operational efficiency can be complemented with a focus on laterality, transience and generative capacity needed for supporting innovation, which is a critical driver of our national economy[7].

The Future of Systems Design for Generative Collectives. Finally, the findings from this study show that information systems play a crucial role in evoking and enhancing distributed cognition and hence indirectly affect collective generative capacity through their impact on collective reflection, interaction and representation. These findings imply that information systems should create a supportive environment for reflection, interaction, and representation to occur freely and unrestrictedly for subsequent generativity to emerge and evolve.

With respect to the design characteristics of information systems that enable distributed cognition, hence, generative capacity in Internet-based collectives, the findings show that first and foremost these systems need to be *tailorable*—that is adaptable to new and changing needs and circumstances of the users—as well as *open*—that is easily accessible. Given the diversity of users in Internet-based collectives, systems should enable a variety of tasks as well as support general ease of use regardless of individual differences in computer literacy. Understanding the importance of these two design principles—tailorability and openness—can further inform adoption decisions of organizations with respect to information systems with the aim of enhancing generative performance through increasing distributed cognition.

Finally, the findings from this study point to a novel approach to systems design, namely *Generative Design*, that focuses on the development of systems, artifacts and environments that

[7] http://www.whitehouse.gov/innovation/strategy/introduction

elicit and enhance generative capacity. Such an approach opens vast opportunities for the exploration of design attitudes and principles that embrace and enrich social contexts, expand and enhance human capabilities, as well as evoke and encourage positive change, discovery and learning.

Challenges and Avenue for Future Generative Collectives Research. The results from this study point to several challenges that need to be further addressed in future research on generative collectives.

First of all, the framework proposed in this study relate to generativity, which is primarily an activity of exploration. However, the notion of ambidexterity (Tushman & O'Reilly, 1996; Birkinshaw & Gibson, 2004; He & Wong, 2004), as embedded in the final model, suggests that whereas exploration is needed to engage in innovation, exploitation is needed to implement these innovations effectively. Hence, future research should analyze which dimensions—structure, cognition, and technology—of the proposed model stay the same and which dimensions change when the focus is on implementation and exploitation, rather than idea generation and exploration.

Second, since the PLS analysis revealed the importance of ambidexterity in the context of generative collectives, future research can further explore the applicability of the notion of structural ambidexterity for generative collectives. Also, future research can explore alternative theories that offer a similar blend of characteristics of coordination and flexibility, such as the notion of chaordic systems (Hock, 1995). Chaordic systems are self-organizing, adaptive, non-linear and complex systems—e.g. organizations—that blend characteristics of chaos and order and therefore represent a harmonious coexistence of both chaotic and order behaviors instead of a dominance of one over the other. As such chaordic systems are characterized by coordinated yet flexible structures; stable yet open membership; and competitive yet cooperate relationships.

Third, given that the aim of generative collectives is primarily the exploration and generation of new ideas, rather than the implementation and exploitation of existing ideas, this may suggest that Internet-based generative collectives and traditional organizations are complementary in their respective roles. Whereas generative collectives have the ability to generate, foster and provide support for ideas—i.e. invention—organizations may play an important role in subsequently translating these ideas into marketable products and services—i.e. commercialization. This interplay between Internet-based collective and traditional organizations and their distinct, yet, complementary and perhaps even sequential roles in the innovation process is worthwhile exploring further.

Finally, while the variance explained (R^2 = .65) by the research model is quite high for behavioral research and thus provides a comprehensive and cumulative theory of generative collectives while retaining a parsimonious structure, further work should attempt to identify and test additional dimensions of collectives and therewith provide more holistic explanations of collective generative capacity. Other potentially significant dimensions include *size* of the collective may significantly impact the generative capacity of the collective as it may be anticipated that larger collectives tend to develop more hierarchical and stable structures when compared to smaller collectives. Furthermore, the *nature of the product and service* that the collective aims to develop and provide—e.g. its *technological complexity* or *political sensitivity*—may also affect the way in which collectives are organized, hence, how generative the collective is. It can be anticipated that the more complex and sensitive the nature of a product or service is, the higher the need for rules, procedures and stability of membership. Other issues to consider further include *motivation*, *vision*, *work practices*, *structural pluralism* and so on.

CONCLUSION

Generative collectives are virtual organizational forms where acts of rejuvenating, reconfiguring, reframing and revolutionizing occur in unparalleled scale and scope in ways not heretofore theorized. This study developed and tested a framework of generative collectives and collective generative capacity and therewith provides useful theoretical and practical insights into many relevant, not hitherto understood, issues of collective problem solving, innovation and change occurring in unbounded, undefined online spaces.

Generative capacity appears to emerge and evolve from realizing a delicate and challenging balance between openness and control, flexibility and permanence, that provides the structural and technological foundations from which distributed cognition—through reflection, interaction and representation—can grow and flourish in order to trigger ongoing generative cycles of rejuvenating, reconfiguring, reframing and revolutionizing.

Thus, whereas generative collectives are inhibited in restricted, regulated and highly organized environments for action and innovation, they thrive in ambidexterous structures using tailorable, open IS that elicit distributed cognition and enable a fluid set of people from all walks of life to rejuvenate, reconfigure, reframe, and revolutionize collectively.

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TABLES AND FIGURES

TABLE 1
Interdisciplinary applications of collectivity concepts

Theory	Discipline	Collective feature
Collective consciousness	Sociology (Durkheim, 1893)	Higher-order consciousness shared by members of (traditional) societies collective representations
Thought Collective	Philosophy of Science (Fleck, 1935)	A group of persons mutually exchanging ideas or maintaining intellectual interaction
Collective Unconscious	Psychology (Jung, 1953)	Encompasses archetypes—definite pre-existent forms in the psyche—that are shared in all individuals.
Collective Action	Political Science, Sociology, (Olson, 1965)	The pursuit of a shared goal, or the provision of public goods by a group of people.
Distributed/ Collective cognition	Cognitive Psychology (Hutchins, 1995)	Focuses on distributed cognitive system encompassing group of people interacting with each other and representational media toward a common goal.
Collective Mind	Organization Science (Weick & Roberts, 1993)	Pattern of heedful interrelations of actions and collective mental processes of group of individuals
Collective Intelligence	Communication Science (Lévy, 1994)	A shared or group intelligence results in enhanced intellectual performance.
Creative Collectives	Organization Science (Hargadon & Bechky, 2006)	Creativity results from (re)combining ideas of individuals with shared interests and joint engagement
Collective Improvisation	Organization Science (Erden et al. 2008)	Ability of group to act together spontaneously even in uncertain and unfamiliar situations.

TABLE 2
Interdisciplinary applications of generativity concepts

Theory	Discipline	Generative feature
Psychosocial generativity	Psychology (Erikson, 1950)	Focus on productivity and creativity; the drive to rejuvenate and to reproduce
Generative grammar	Linguistics (Chomsky, 1972)	Finite set of rules that generate infinite syntactical configurations.
Generative metaphor	Organization science (Schön, 1979)	Figurative description of social events by which we gain new perspectives and reframe attitudes
Generative lexicon	Lexical semantics/ Computer Science (Pustejovsky, 1991)	Focus on multiplicity of word meanings; ability to give infinite number of senses to words through finite means.
Generative capacity	Social psychology (Gergen, 1994)	Ability of the individual to challenge the status quo and to transform social reality and social action.
Generative schemes	Architecture (Alexander, 1996)	Simple instructions that allows anyone to create artifacts and give rise to infinite variations.
Generative design	Computer science (Frazer, 2002)	Generating design concepts capable of being expressed in infinite forms for different contexts.
Generative inquiry	Social studies (Zandee, 2004)	Recurring, reflective hermeneutic process; generates theoretical quantum leaps; revitalization/reframing process of epistemic stances.
Generative buildings	Organization science (Kornberger & Clegg, 2004)	Undefined space that invites its inhabitants to (ab)use and (re)define space in infinite ways.
Generative learning	Educational science (Yorks, 2005)	Learning necessary for transformational changes in practice, assumptions, and interpretive schema.
Generative systems	Internet law/ Computer science (Zittrain, 2008)	System capacity for unanticipated change/innovation through unfiltered contributions by varied audiences.
Generative fit	Information systems (Avital & Te'eni 2009)	System feature that enhances generative capacity; ability to produce novel configurations.

TABLE 3
Common themes of collectivity and generativity concepts

Collectivity	▪ ***Shared*** interests or goals ▪ ***Collective*** acts ▪ ***Mutual*** engagement, interaction, and exchange
Generativity[8]	▪ Producing new (***rejuvenating***) or altering existing (***reconfiguring***) configurations and possibilities ▪ ***Reframing*** the way we see and understand the world ▪ Challenging the status quo (***revolutionizing***)

TABLE 4
Dimensions of collectivity and generativity for further exploration

Collectivity	▪ ***Structure*** (Durkheim, 1893; Fleck, 1935; Olson, 1965) ***Cognition*** (Jung, 1953; Hutchins, 1995; Weick & Roberts, 1993; Lévy, 1994;

[8] The terms "generativity" and "generative capacity" have been used interchangeably in this context.

	Hargadon & Bechky, 2006; Erden et al., 2008)
Generativity	▪ ***Structure*** (Chomsky, 1972) ▪ ***Cognition*** (Erikson, 1950; Chomsky, 1972; Schön, 1979; Pustejovsky, 1991; Gergen, 1994; Zandee; 2004; Yorks, 2005) ▪ ***Technology*** (Alexander, 1996; Frazer, 2002; Kornberger & Clegg, 2004; Zittrain, 2008; Avital & Te'eni, 2009).

TABLE 5
Concepts and definitions of distributed cognition

Distributed Cognitive Process	Source	Definition
Reflection	Boland et al. (1994)	Questioning and challenging of fundamental assumotions that form the basis for collective acts in order to uncover potential flaws
Interaction	Boland et al. (1994)	Need for meaningful dialogues and conversational negotiations in the context of collective acts
Representation	Boland et al. (1994)	Use of representational media to envision goals, structure activities, track progress, create mutual understanding, and externalize outcomes of collective acts

TABLE 6
T-Statistics and Variance Inflation Factors for First-Order Items

2^{nd} Order Construct	1^{st} Order Construct	Item Name	T-Test 1^{st} Order Path	T-Test 2^{nd} Order Path	VIF Items	Cron. α	Comp. Rel.	Ave	√Ave
Structure (S)	Transience (T)	S-T1	71.908***	25.201***	1.249	.697	.844	.711	.843
		S-T2	32.021***		1.249				
	Laterality (L)	S-L1	90.862***	29.427***	1.221	.698	.839	.722	.849
		S-L2	34.021***		1.221				
Cognition (C)	Reflection (Rf)	C-Rf1	100.076***	39.602***	1.638	.769	.917	.812	.901
		C-Rf2	73.149***		1.638				
	Interaction (I)	C-I1	131.823***	28.406***	1.583	.755	.890	.802	.896
		C-I2	63.411***		1.583				
	Representation (Rp)	C-Rp1	111.553***	36.463***	1.697	.781	.901	.820	.806
		C-Rp2	97.916***		1.697				
Technology (T)	Tailorability (T)	T-T1	63.236***	17.648***	1.142	.721	.842	.781	.884
		T-T2	24.387***		1.142				
	Openness (O)	T-O1	9.449***	16.922***	1.047	.750	.866	.805	.897
		T-O2	40.496***		1.047				

*** significant at p=.001 level

FIGURE 1
Theoretical Framework of Collective Generative Capacity

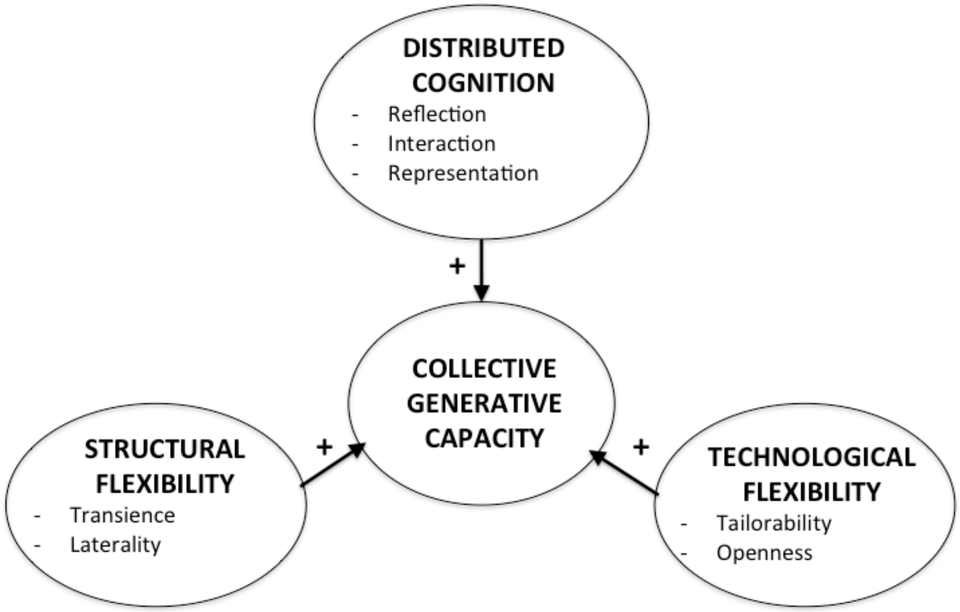

FIGURE 2.
A Comprehensive Framework for Enhancing Collective Generative Capacity