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## Online discussion group sustainability: Investigating the interplay between structural dynamics and social dynamics over time

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# Journal of the Association for Information Systems

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Special Issue

## Online discussion group sustainability: Investigating the interplay between structural dynamics and social dynamics over time

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### Abstract

*Online discussion groups have become an increasingly popular way to create social networks where individuals congregate electronically to share advice and ideas. In order to better understand sustainability, we propose that research needs to go beyond examining quantitative changes in the structural dynamics of online discussion groups (such as membership size and message volume) and include investigation of the social dynamics characterizing the underlying qualities of the interactions among members. We take a mixed-methods approach to provide qualitative and empirical support for our theory by investigating the dynamics of one successful online discussion group over a five-year period. Our data set includes all 150,267 messages posted to 27,743 threads by 9,042 unique individuals over a five year period in a group that is focused on sharing advice about a medical topic (back pain). We find support for our hypotheses that 1) shifts in the structural and social dynamics underlying resource availability lead to changes in communication activities, but in unexpected ways: Fewer members contributed significantly more message volume. In turn, 2) shifts in the structural and social dynamics underlying communication activities lead to changes in coping strategies: As message volume increased and became more social, members increased their efforts and were less likely to defect. Finally, 3) shifts in the structural and social dynamics underlying coping strategies lead to changes in attraction and retention: as individual efforts increased, more individuals were retained; however, fewer new members were attracted to join the group. Our main thesis is that each online discussion group is a product of its structural and social dynamics in combination, and the influence of these factors on sustainability is best understood when they are examined in relation to each other over time.*

**Keywords:** social networks, sustainability, online discussion groups

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# Online discussion group sustainability: Investigating the interplay between structural dynamics and social dynamics over time

## 1. Introduction

The popular Web 2.0 trend toward user-generated content supports the notion of computer mediated social interaction among users. The relationships between users can form a persistent social structure known as a social network. One of the most popular online forms of social networks is the discussion group. Approximately 100 million Internet users are estimated to belong to online discussion groups (Rainie, 2005) to exchange information, advice, and social support through the user-created content of publicly available messages (Preece, 2002; Ridings and Gefen, 2004b). The rapid growth of online discussion group membership suggests that participation in these groups provides significant benefits to members, including both information and social support to the individuals participating (Constant et al., 1996; Wellman, 1997; Wellman and Gulia, 1999a). However, even though there is evidence that true social behaviors in online discussion groups can occur, high levels of online interactivity are largely the exception, not the rule (Cummings et al., 2002), and sustaining a *social* network appears very challenging. Individuals participating in online discussion groups are essentially engaged in voluntary collective action creating an online conversation (Fulk et al., 1996; Wasko et al., 2004). These individuals must voluntarily contribute to this conversation in order for sustainability to occur.

Because these contributions are the key to the group's success, prior research has examined individual motivations to contribute to online discussion groups from the perspectives of social capital and collective action (Ridings and Gefen, 2004a; Wasko and Faraj, 2005) and notions of reciprocity (Connolly and Thorn, 1990; Thorn and Connolly, 1987). However, we have yet to explain how online discussion groups are sustained over time. Prior research has examined sustainability through large-scale field studies of hundreds of online discussion groups for relatively short time-frames by focusing predominately on the underlying structural dynamics of the networks (Butler, 2001b, Jones et al., 2004). By structural dynamics, we refer to quantitative assessments of the social network that describe its composition; e.g., membership size, communication volume, message length, and attraction and retention of members. However, we know relatively little about the *social* dynamics of the networks, or how the interplay among structural dynamics, social dynamics and sustainability play out over long periods of time. By social dynamics, we are referring to the underlying qualities of the interactions among members and how members relate to each other.

The purpose of this research is to examine the reciprocal interactions among an online discussion group's structural and social dynamics, and how changes in the structural and social dynamics affect long-term sustainability. The paper is organized as follows. First, integrating key findings from prior research, we develop the theoretical foundation guiding this research. We then describe the key social and structural dynamics underlying our constructs. We investigate how social and structural dynamics evolve over time by examining one online discussion group over a five-year period using data from individual members, their dyadic interactions and message content. By tracking one online discussion group over a five-year period, we take a richer, in-depth approach to understanding the interplay between social dynamics and structural dynamics and how they impact sustainability. The paper concludes with a discussion of our findings and areas of future research.

## 2. The Paradox of Size and the Logics of Opposition

Prior research on the sustainability of online discussion groups identifies a paradox related to size: While it is beneficial to have more members, because members are the primary source of resources, it appears harder to sustain benefits to large numbers of members. Research suggests that large online networks (in terms of many individuals) tend to lose more members as well as a larger proportion of their membership (Butler, 2001b). Although a certain level of "churn" suggests that increases in member loss may not be a bad sign, it is clearly a problem if member losses outpace member gains. Based on the results of his study, Butler (2001) argues that any study of size in online social networks must take into account that there are opposing forces, or logics of opposition, that serve to simultaneously promote and hinder the sustainability of the network. He concludes, "While

the use of networked communication technologies may alter the form of communication, balancing the opposing impacts of membership size and communication activity in order to maintain resource availability and provide benefits for current members remains a fundamental problem” (Butler, 2001b p. 346). Simply put, a small number of members are easier to support, but more members are better because they provide more support, hence the paradox.

As online groups add more members who contribute more resources, such as time, energy, and messages, the amount of communication activity increases to a point where the sustainability of the group becomes questionable. Jones, Ravid and Rafaeli (2004) extend our understanding of the sustainability of large online groups with significant amounts of activity. At some point, the members of large online discussion groups will find it difficult to reap the benefits due to information overload, when the number and/or length of messages becomes too high to process. These authors suggest that there are many coping strategies individuals can adopt to reduce the amount of effort needed to process the information (Jones et al., 2004). The most drastic strategy is to leave the online discussion group, resulting in membership turnover. If members elect to stay, an alternative strategy is to reduce their effort to an acceptable level to gain the benefits from the group. For example, this may be accomplished by either paying less attention to some of the messages, or shortening the responses made to other members (Jones et al., 2004).

Although Jones et al. (2004) focus primarily on strategies that reduce cognitive load, an alternative strategy individuals can adopt is to increase their efforts. These additional efforts could come from a critical mass of participants. A “critical mass” is defined as the small portion of a group or population that makes the largest contribution, while the larger portion makes little, if any, contribution (Oliver and Marwell, 2001; Oliver et al., 1985). Individuals within the critical mass are likely to have access to more resources, have more personal ties, and be in a position to benefit from those ties, taking on central positions within the network (Burt, 1997; Hansen et al., 1999). The essential issue for online discussion group sustainability is whether there is some minority of individuals who are interested and resourceful enough to provide this additional effort, and how much effort these individuals are willing to expend.

The integration of these theoretical constructs (resource availability, communication activities, coping strategies, and critical mass) provides insights into the opposing effects found by Butler (2001) and why there is a paradox related to size — individuals can change how they participate in response to changes in communication activities. What is less understood is how these coping strategies are deployed, under what conditions, how they change, and the impact on the long-term sustainability of the group. In order to understand the opposing forces at work, research needs to go beyond examining quantitative changes in the structural dynamics of online discussion groups. We propose that investigating the social dynamics, or the qualities characterizing how people participate, and the interplay between the structural dynamics and the social dynamics, provides a more accurate assessment of how online discussion groups are sustainable over time. For instance, resource availability is not simply a quantitative measure of the number of participants, but should also include investigation of *how* people participate. Communication activities include not only measures of message volume, but also message content – what are people talking about? Therefore, we take a logics of opposition approach to predict that rather than simple linear relationships among resource availability, communication activities and sustainability, there are opposing forces that make linear predictions too simplistic. Under some circumstances fewer resources may contribute higher levels of communication activities, and members may adopt a variety of coping strategies to deal with increased communication loads. Our main thesis is that each online discussion group is a product of its structural and social dynamics in combination, and the influence of these factors on sustainability is best understood when they are examined in relation to each other over time.

### **3. Structural and Social Elements of Sustainability**

A social group is sustainable if it can continue to provide valuable resources to its members (Butler, 2001a). Thus, to understand sustainability of online groups we must understand not only the resources available to produce these benefits but how these benefits are generated and sustained.

The relationships among our three main constructs are depicted in Figure 1. We start with Butler's (2001) proposition that an online discussion group's resource availability (members) influences communication activities (messages) (Butler, 2001b). As noted by Jones et al. (2004), we also theorize that as communication activities increase, individuals will adopt coping strategies in response to changing information processing demands. These coping strategies, in turn, directly affect the availability of resources in the group through the retention of existing members and attraction of new members. Our contribution is to not only link these three concepts together and understand their influence on one another, but also to understand the social and structural dynamics underlying each construct.

### 3.1. The Structural and Social Dynamics of Resource Availability

The resource-based model of sustainability proposes that an online discussion group must grow large enough to support the conversion of resources into benefits for the members, thereby attracting and retaining enough members for sustainability (Butler, 2001b). The resources of the online discussion group consist of the collective knowledge, attention, and effort of the individual members. Because it is the members of the online discussion group who produce the benefits, the size of membership can be a proxy for resources (Butler, 2001b). Sustaining the group by attracting and retaining participating members is essential — the members possess the resources necessary to produce the benefits. We define members as those who are active members — individuals who post messages to the group — because it is the active membership that makes resources available to others. Thus, structural dynamics of resource availability are membership attraction and membership retention.

However, individuals have choices about how they participate, and not all contribute equally. Some individuals may only post messages that seek information from others without providing responses in return (essentially becoming a form of free-rider). These individuals become “audience” resources (Butler, 2001b), supporting group sustainability because individuals who are willing to ask questions and receive the ideas and advice of others encourage information providers to share their knowledge. Alternatively, some individuals “pay as they go” by actively seeking information and serving as an audience, and in return actively posting responses, contributing to the information processing capacity of the group. A third classification of members consists of those who are primarily interested in visibility and providing advice and ideas by only responding to others. While responders may provide passive audience engagement by reading the messages of others, their primary focus is responding and dispensing information or advice. The social dynamics of resource availability are evidenced by the balance among the three types of participants — seekers, seeker/responders, and responders.

We hypothesize that both the size of the membership and the balance of how people participate influence the communication activities in an online discussion group:

*Hypothesis 1: Shifts in resource availability will lead to changes in communication activities.*

### 3.2. The Structural and Social Dynamics of Communication Activities

In order to be sustainable, online discussion groups must support social processes that convert resources into benefits for members through communication activities (Butler, 2001b). While the structural dynamics can be assessed by message volume and topic variation as indicators of communication activities (Butler, 2001b), it is important to acknowledge the underlying social dynamics. The typical benefits of online discussion groups consist of information and social support. For instance, one study found that online discussion groups focused on health-related concerns produced communications related to medical information (symptoms, diagnoses, mediations) as well as social support and feelings, while other groups focused on hobbies were dominated by communications on practical advice regarding the hobby (Galegher et al., 1998). Thus, there is a duality to beneficial communication activities in online discussion groups: messages that primarily meet an informational need (such as providing general topic-related information/knowledge or advice

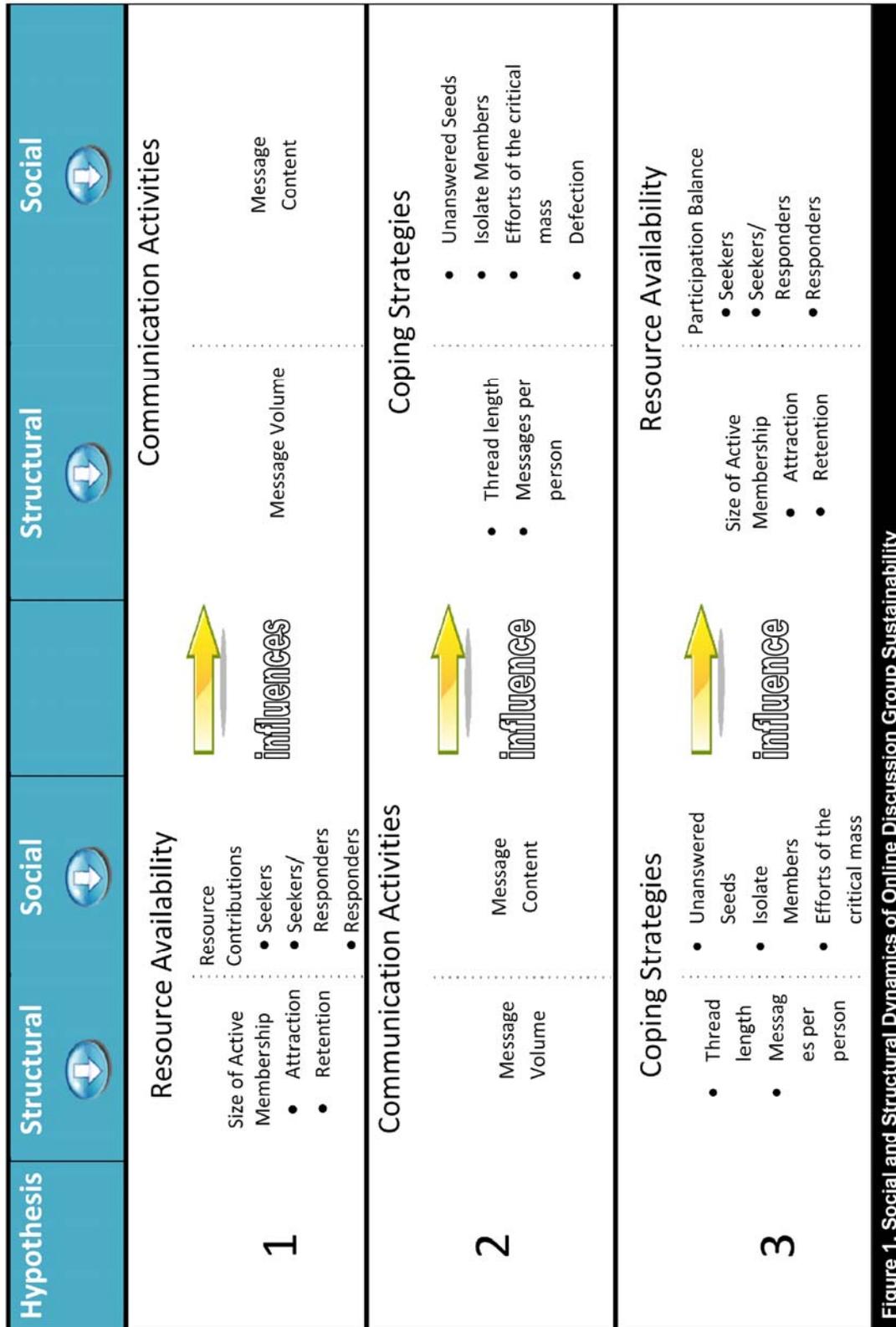


Figure 1. Social and Structural Dynamics of Online Discussion Group Sustainability

related to a specific problem) and messages that serve as a social or support component. In addition to these two types of communication activities that actually provide benefits to members, individuals can also post messages that do not provide information or support. These are messages that are off-topic and sometimes considered spam.

The social norms of the group shape perceptions about the quality or content of the messages (benefits), and it is this perception that is also likely to influence how messages are attended to and processed by members. If the communication activities are not perceived as beneficial, they are likely to lead to the adoption of changes in coping strategies. Messages that meet an informational need may require more cognitive effort to respond to than support messages, but may engender a desire to expend more efforts toward providing thoughtful responses. Additionally, as communication load increases, either in terms of message volume or in terms of the complexity of the content, individuals can ignore messages that are of little interest. Therefore, the balance among information, support, and other communication activities, and whether or not these activities are regarded as beneficial to members, depends upon the specific social dynamics of the group.

We hypothesize that communication activities — consisting of both message volume and message content - influence the coping strategies adopted by members in the group:

*Hypothesis 2: Shifts in the communication activities will lead to changes in coping strategies.*

### **3.3. The Structural and Social Dynamics of Coping Strategies**

Because online discussion group communication activities (posting and responding to messages) use the network membership's time, effort, and attention, each group has a finite capacity for activity. As online discussion groups get larger, at some point members will start to find it more difficult to reap benefits due to information overload. Jones et al. (2004) propose that individuals adopt two primary coping strategies to deal with the increased load: (1) change ongoing communicative behavior or (2) leave the group (Jones et al., 2004). In terms of identifying the structural dynamics underlying changes in communicative behavior, one coping strategy, simplifying responses, can be examined by thread dynamics (the number of replies directed at a specific seed message). Users generally have to make more of an effort to contribute to a chain of messages, rather than a single post, increasing the complexity of the interaction (Lewis and Knowledge, 1997). In terms of social dynamics, there may be implicit norms that develop about what types of messages individuals devote their time and energy to respond to. This may include norms about responsiveness to certain message content, as well as norms around ensuring that everyone seeking information or support receives a response. This may be evidenced by examining changes in the proportion of seed messages that go unanswered and the proportion of individuals who are "isolates," or ignored by other members. The expectations for communicative behavior, and whether or not this behavior creates benefits that outweigh the costs of participation, will influence members' decisions to continue participating in the group.

An alternative coping strategy that individuals can adopt is to increase their efforts. In terms of the structural dynamics, the relative amount of effort expended can be assessed by examining the average number of messages posted by each individual and how this changes over time. However, not every individual in an online discussion group contributes equally. It is not necessary that all, or even most, members of the online discussion group actively participate in order to ensure its ongoing sustainability. The costs for posting a message are the same, regardless of the number of individuals who benefit or the number of individuals who contribute. A minority of individuals can increase their efforts and take on a larger burden of communication activities. The social dynamics characterizing effort can be examined by investigating changes in the communicative behavior and commitment of the critical mass. Prior research indicates that online discussion groups are indeed sustained by a critical mass (Wasko and Teigland, 2002), resulting in a network structure referred to as "scale free networks," where the contribution rate among members varies radically, primarily sustained by a few very active individuals (Faraj and Johnson, 2005, Newman et al., 2002).

Empirical studies have shown that on the Usenet discussion boards, generally, a small number of posters are responsible for a larger proportion of the activity, with variations depending on the group (Smith, 1999b). Other researchers have found various posts-to-poster ratios, but nearly always non-linear, with a large number of participants making little or no contribution (Nonnecke and Preece, 2000), and a small number making the bulk of the contributions (Jones and Rafaeli, 1999). In online discussion groups, one way to cope with increases in communication load would be for the critical mass to increase its efforts and contribute a higher proportion of communication activities. Under increased communication load, the critical mass could expend more efforts and contribute more of the message volume, or, alternatively, more members outside of the critical mass could increase their efforts to reduce the prominence of the critical mass.

Additionally, the level of commitment of the critical mass is indicative of the amount of effort or resources individuals are willing to provide to the group over time. Increased commitment of a critical mass has shown to benefit online discussion groups, as returning members provide a sense of familiarity (Figallo, 1998), there is the impression of some permanence among the membership of the community with continuing frequency of visits (Smith, 1999a) and long term interaction (Erickson, 1997). An online discussion group becomes more attractive and successful if members continue to return to the group, providing a sense of community (Hagel and Armstrong, 1997; Wellman and Gulia, 1999b). Of course, members can also cope with increased communication loads by leaving the group. The key issue for sustainability is whether enough veteran members are retained and new members attracted to compensate for those who choose to leave.

In our final hypothesis, we propose that changes in the combination of coping strategies (e.g., changes in communicative behavior, changes in efforts, and defection) will affect sustainability of the online discussion group in terms of resources:

*Hypothesis 3: Changes in the coping strategies will affect resource availability.*

To summarize, we expect findings will show that online discussion groups are sustained through the dynamic combinations of resources, communication activities, and coping strategies, including efforts of the critical mass, over time. For example, at one period in time an online discussion group may have a relatively small membership yet be able to sustain a great deal of communication activity due to the efforts of the critical mass. Alternatively, the structural and social dynamics may evolve such that the group has a larger membership, but lower levels of communication activities, as members have adopted different message content and coping strategies to reduce cognitive load. To better understand this interplay and sustainability, we examine the structural and social dynamics of one online discussion group over a five-year period.

#### 4. Research Site and Measures

To investigate the hypotheses posed above and provide evidence for our theory, we gathered data from the Back Pain Support Group bulletin board at the WebMD web site ([http://boards.webmd.com/topic.asp?topic\\_id=42](http://boards.webmd.com/topic.asp?topic_id=42)). WebMD is a provider of online health and medical information serving consumers, physicians, and health care professionals through public and private online forums and health-related publications. WebMD in its current state was created through the \$7 billion merger of Healtheon Corporation (created by entrepreneur Jim Clark who also founded NetScape) and Atlanta-based WebMD in November 1999 ([www.fundinguniverse.com](http://www.fundinguniverse.com)). The main portal, <http://www.webmd.com>, is geared toward consumers by providing health information, feature articles on more than 90 lifestyle and condition areas, and an online community that includes more than 140 moderated expert-led and peer-to-peer online discussion groups. As of July, 2007, WebMD attracted more than 20 million users each month ([www.fundinguniverse.com](http://www.fundinguniverse.com)). WebMD was chosen for this study due to its prominence and longevity as a top medical information site (Forster, 2002).

We focused our study on the Back Pain online discussion forum for several reasons. Medical/health-related information is one of the most searched for topics online (Brann and Anderson, 2002; Fox, 2005; Fox et al., 2000; Higgins, 2005), and an estimated eight in 10 Internet users have searched

online for medical information (Fox, 2005). Back pain affects approximately 30 million Americans and is second only to the common cold as the ailment most responsible for sending patients to their physicians (Landro, 2007). Back pain can be a long term, chronic condition that generally transcends gender, ethnicity, and age, as opposed to many other popular online health topics that are gender-specific or short term (e.g., pregnancy, cancer, heart disease, children's health). The nature of back pain, therefore, would promote greater heterogeneity of members and might necessitate network members to remain in the online discussion group longer. We also choose this site to explore the social dynamics of a primarily informational online discussion group (advice about back pain) that would likely have a strong social component (emotionally supporting others in pain).

We gathered data consisting of all messages to the WebMD Back Pain Support Group for the five-year period from January 2000 (two months after the merger) to December 2004.<sup>1</sup> The Back Pain Support Group is fairly active, with more than 100 messages posted each day during the study period. The dataset includes 27,743 conversations (or threads including an initial "seed" message and all of its replies), 150,267 message postings, and 9,042 unique posters. This data reflects only the dynamics of active members — we do not capture lurkers or changes in the user registration. Because lurkers and nonactive members do not contribute resources to the group that are visible to other members, the influence of lurkers on sustainability is beyond the scope of this study.

#### 4.1. Measures

We focus on the structural and social dynamics underlying our theoretical constructs of resource availability, communication activities, and coping strategies. All measures are assessed at the group level of analysis, and we aggregate data by month, such that the dataset is aggregated into 60 time periods (one for each month). Included are content analysis and word counts of over 150,000 message headers, participation rates of each member, dyadic relationships between members, and consecutive months of participation. The measures used in this study are summarized in Table 1, and details on the calculations for each measure are provided in Appendix 1.

### 5. Methods and Results

We employ three primary methods to examine our hypotheses: scatter plots to display the data in the order in which they arose to show trends over time, mean comparisons across aggregate points separated in time, and qualitative discussion of how the interplay between the structural and social dynamics evolves. One reason we chose these methods was due to concerns about the independence of observations in our data. First, given the longitudinal nature of our data, the presence of even a moderate amount of time dependence among observations is highly problematic for multivariate analysis (Johnson and Wichern, 1998). Although more robust quantitative techniques for longitudinal data analysis are available (Singer and Willett, 2003), an additional concern relates to the high correlations among our variables: Many of the constructs of interest covary, such as membership size and new member attraction. The main reason for choosing a mixed-method approach was that the synthesis of quantitative and qualitative methods allowed us to develop a deeper understanding about the interplay between the social and structural dynamics of the group over time.

#### 5.1. Descriptive Statistics and Trends

Rather than choose arbitrary time periods such as a year or six-month period, we divided the study period into naturally occurring phases based on the main constructs from Butler's (2001) resource availability model. We selected both membership size (resource availability) and message volume (communication activity) as criteria to determine phases. Using visual analysis of the trends in these two variables, we identified six distinct phases that indicate shifts in the group's structural dynamics.

<sup>1</sup> Because the participants could reasonably expect their conversation was being recorded and made public, the data collected was not deemed "identifiable private information" as defined by The Federal Policy for the Protection of Human Subjects (2001) Federal Policy for the Protection of Human Subjects, in *Code of Federal Regulations*, vol. Title 45. Further, the WebMD privacy policy clearly states that all bulletin board postings are public information and can be collected by third parties. Therefore, we did not seek informed consent of the participants.

Figure 2 illustrates the changes in the group over time. Tables 1 and 2 contain descriptive statistics for each phase. Figure 3 represents a graphical summary of Table 2. We discuss each phase in more detail below.

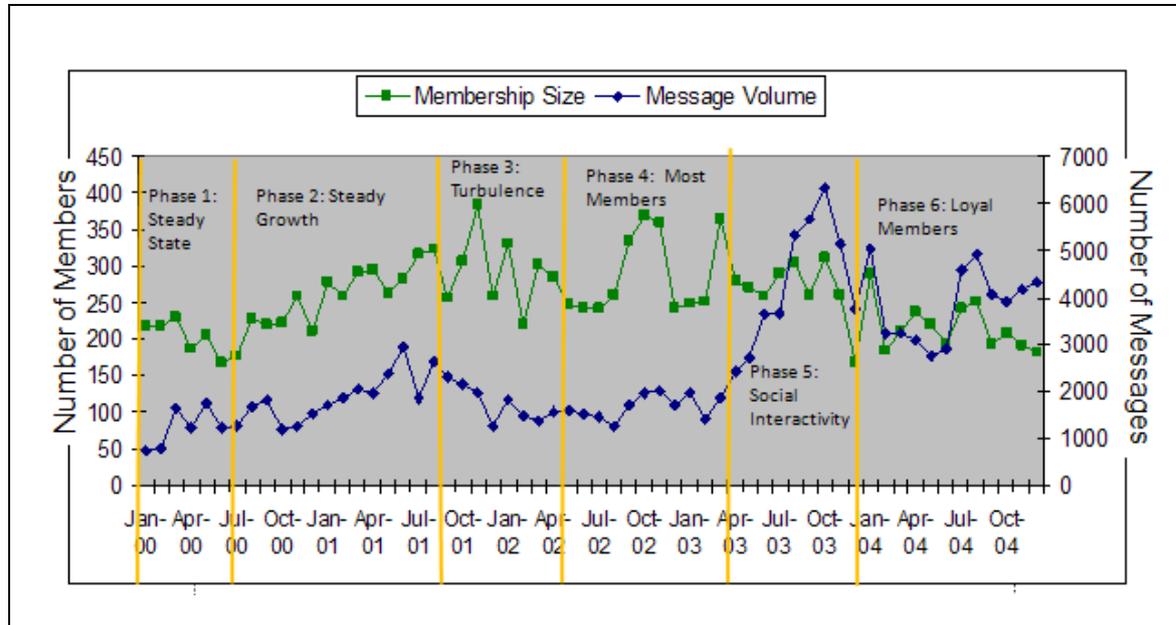


Figure 2. Membership Size and Message Volume over Time

Table 1. Phase Descriptives						
	PHASE 1	PHASE 2	PHASE 3	PHASE 4	PHASE 5	PHASE 6
Description	Steady State	Steady Growth	Turbulence	Most Members	Social Interactivity	Loyal Members
Date	Jan 2000 To June 2000	July 2000 To Aug 2001	Sept 2001 To May 2002	June 2002 To Mar 2003	April 2003 To Dec 2003	Jan 2004 To Dec 2004
Length (Months)	6	14	9	10	9	12
Membership Trend	Decrease	Increase	Unstable	Unstable	Decrease	Decrease
Volume Trend	Increase	Increase	Decrease	Flat	Increase	Up and Down
Message Content	Information	Information	Information	Information	Social	Social
Message Volume	Lowest	Low	Decrease	Low	Highest	High
Membership Size	Lowest	Increase	High Unstable	Highest	Decrease	Low
Critical Mass	High turnover	High turnover	High Turnover	Slightly more stable	More Stable, very active	Highly Stable
Turnover	Moderate	High	High	Highest	Low	Lowest
Internal and External Events	Superbowl Ad, Chat feature, Dot com boom	Dot com bust, official WebMD participates	Dr. Gilmer, 9/11, press coverage, pop-up ads	Dr. Glimmer leaves, WebMD ends active participation	Roll call threads prevalent	Vioxx recalled, Pacific tsunami

**Table 2 – Structural and Social Dynamics for Each Phase**

	PHASE 1	PHASE 2	PHASE 3	PHASE 4	PHASE 5	PHASE 6
<b>RESOURCE AVAILABILITY</b>						
Size of membership (monthly average)	201	259	287	291	267	217
Proportion of participants seeking information	.20	.21	.34	.32	.24	.21
Proportion of participants seeking and responding	.52	.51	.45	.47	.58	.64
Proportion of participants responding only	.28	.28	.21	.22	.18	.15
<b>COMMUNICATION ACTIVITIES*</b>						
Message Volume (monthly average)	1330	1867	1733	1686	4292	3849
Proportion Information Messages	.59	.56	.63	.59	.33	.33
Proportion Social Messages	.30	.33	.28	.32	.52	.51
Proportion Off-Topic Messages	.04	.05	.04	.03	.08	.08
<b>COPING STRATEGIES</b>						
Thread Length	5.19	5.81	4.41	4.46	5.88	5.92
Proportion of Singletons (seeds without responses)	.13	.09	.14	.13	.09	.07
Proportion of Isolates (individuals never responded to)	0.04	0.02	0.08	0.05	0.02	0.01
Average messages per person	6.60	7.20	6.00	5.80	16.10	17.70
Proportion of total messages posted by the critical mass	.74	.78	.77	.76	.84	.83
Average commitment of critical mass in months	1.42	1.40	1.26	2.01	2.73	4.70
Rate of Defection	.70	.69	.73	.73	.67	.58
<b>SUSTAINABILITY</b>						
Proportion of new member attraction	.68	.71	.72	.74	.64	.58
Proportion of member retention	.32	.29	.28	.26	.36	.42

\*Messages coded as "other" are not in the table, so phase proportions in terms of message content do not add to 1.

## 6. Analysis

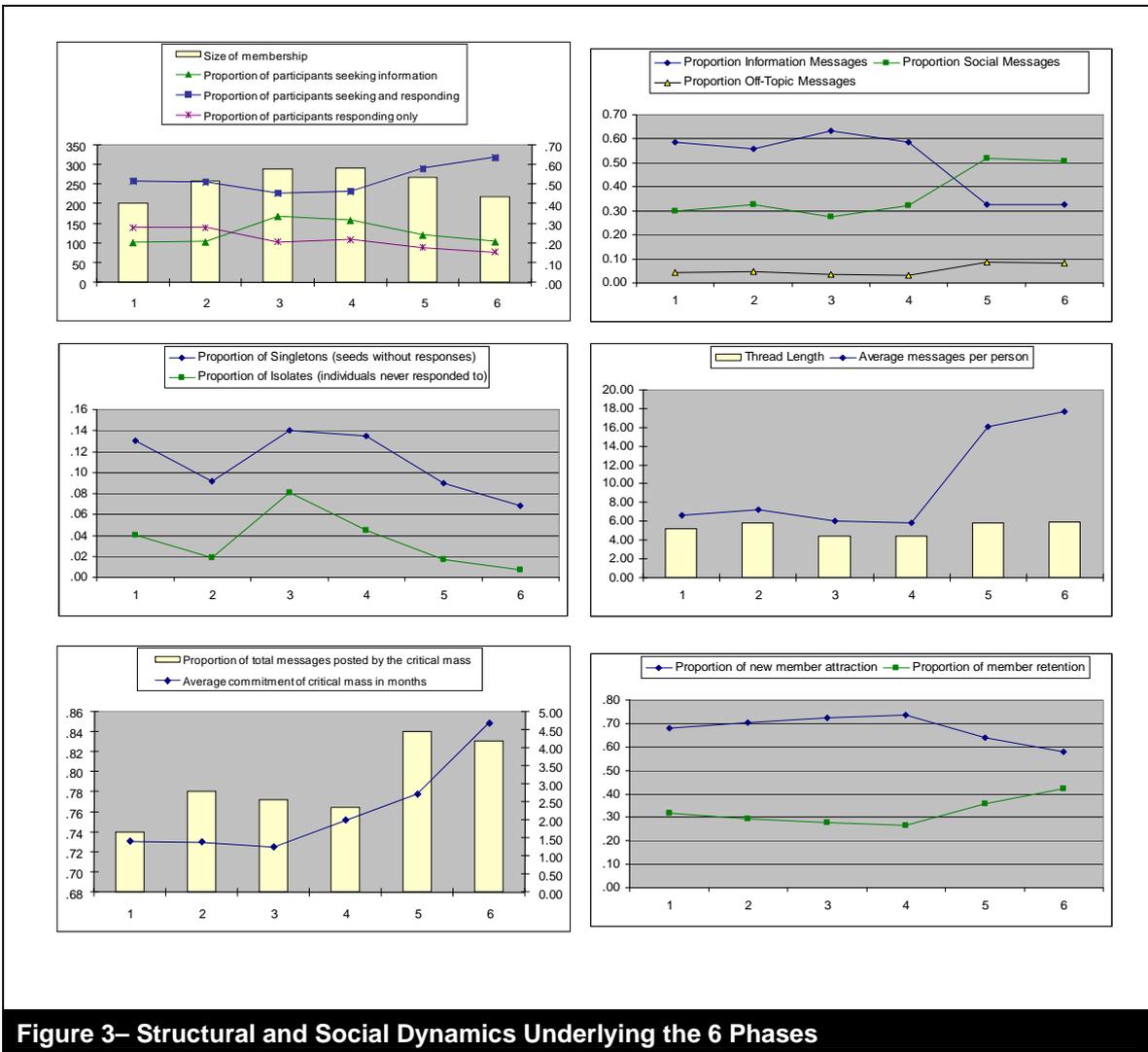
To test our hypotheses, we examine the trends in the structural and social dynamics over time and aggregated into phases. Figure 3 provides an overview of changes in the structural and social dynamics over time. Clearly, it is not the simple case that more members generated more messages, or the case that an increase in messages triggered member defection or a single coping strategy. Rather, the hypothesized complex dynamics among the three constructs of resource availability, communication activities, and coping strategies are played out over the five-year period. We summarize the evidence of the shifts in social and structural dynamics that support our hypotheses with a detailed description of the trends in each phase.

### Phase 1: "Steady State" (January 2000 to June 2000, 6 months)

Our study begins in January 2000, two months after the merger between Healthon and WebMD. Membership is lowest in the study period, an average of 201 active members per month. The proportion of individuals that are seekers is relatively low (20 percent), but the number of responders is higher (28 percent). This is a period of moderate yet stable communication activity, with the lowest level of average message volume per month (1,330 messages per month). The messages are predominately informational and related to back pain (60 percent). The most common topic words include: back, pain, disc, herniated, surgery, help, epidural, medications, and injections. Social messages (30 percent of communication activities) are mostly related to emotional issues such as feeling frustrated/depressed or thanking the others in the community.

The vast majority of members appear to be concerned consumers with a great deal of experience in back pain. What is immediately noticeable from the messages is that back pain is not just about pain

and potential cures – back pain causes a great deal of emotional stress. People are unable to work, sleep, or engage in what are typically considered normal daily activities without being in constant pain. Additionally, the treatments for back pain are invasive. Therefore, much of the interactions are emotional in nature.



**Figure 3– Structural and Social Dynamics Underlying the 6 Phases**

In terms of general effort, members invest a moderate amount of effort (6.6 messages per month). As for norms of responsiveness, in phase 1 it appears relatively acceptable to ignore some seeds and some members. The critical mass is relatively inactive compared to other phases, contributing 74 percent of the messages. There appears to be high levels of personal familiarity among members of the critical mass with strong associations to each other and the group. Apparently, a core member undergoes surgery during this phase, and many threads are messages of support and news updates about his/her progress. There appears to be a formal WebMD representative hanging around the group, “Chuck,”\* but Chuck has a relatively low profile – typically users will direct technical or spam related issues toward Chuck, but he does not moderate the discussion and is not one of the most active posters. During this phase, turnover is at a moderate level in comparison with other phases, newly attracted members account for about 68 percent of membership size, but the rate of defection (70 percent) is slightly outpacing new member attraction.

\* Actual user names from the data have been changed for privacy reasons.

In terms of external influences, WebMD invested in a Super Bowl ad, although this action did not appear to cause an increase in membership size in February. WebMD was considered at this time an Internet “star,” as this is during the dotcom boom era. During this phase, WebMD was very active in terms of mergers and acquisitions, apparently focusing on a grow big, grow fast strategy. However, there is no apparent discussion of these factors in the group. What did make it into the discussions was the addition of a chat feature in March of 2000. Starting in March, many of the social messages were aimed at informing the group who was on chat and when.

## Phase 2: “Steady Growth” (July 2000 to August 2001, 14 months)

This phase is characterized by steady growth for the group in terms of membership size and communication activities. There are, on average, 259 active members per month, and the proportion of individuals who are seekers, seeker/responders, or only responders remains unchanged from Phase 1. Similarly, Phase 2 has almost the same proportion of information, and social messages as Phase 1, with a little over half of the messages strictly information, and about one third social. The information topics are the typical ones found in all phases, and common topic words are also the same as in Phase 1, indicating that the same issues are generally being discussed. However, the chat function has become more organized, where members designate specific times to meet in chat. Around the end of the year, people wish one another Merry Christmas and Happy New Year, although these social activities are low volume in comparison with informational content. The social content in this phase changes, and there are many posts that indicate new people are joining the group and want to introduce themselves, and these people are welcomed with many replies. In addition, a new social post emerges during this period and continues throughout the rest of the study: the prayer post. In this post, members are asking for others to pray for either themselves or another person in the group. These prayer posts are typically very popular and turn into very long threads. Almost all seeds are replied to, and fewer individuals are left isolated from interactions.

In terms of efforts, the average post per individual increases slightly to 7.2 messages, and the critical mass takes on a more active role, sustaining 78 percent of the communication activities. This phase is notable for its relatively high turnover in the critical mass. By October 2000, there is only one member of the critical mass remaining from Phase 1, and this person drops from the critical mass in February, 2001, at which time the critical mass membership has completely churned. By the end of this phase, there is one person in the critical mass with 11 consecutive months of tenure, one person with 10, but then the rest of the critical mass consists of relative newcomers. As for sustainability, the group is balanced at approximately 71 percent new members and 29 percent retained members, and new member attraction is outpacing member defection (69 percent).

In terms of external events, WebMD is going through severe financial difficulties; the dotcom star is feeling the pressures of the dot gone bust. In January, 2000 WebMD was trading at \$75.19 but by October it reaches a low of \$6.75. WebMD announces lay-offs and decides not to run another Super Bowl ad, although they continue to advertise on television. There is also a mass exodus of the top management team around October of 2000 – both founders, the COO, CMO (marketing), CTO, and the executive vice president of strategic relationships all resign during this phase. Even amidst these events at the corporate level, these issues do not appear to affect the content being discussed. What does end up being discussed on the group is changes in policies around moderating the messages. Phase 2 is notable for the active involvement from official WebMD members. This could be in response to attitudes in 2001 about an increased concern for individual privacy and information accuracy, especially for health-related websites. During the most active month in this period (June 2001) there is an argument on the board, and WebMD is involved in several threads discussing appropriate language on the board. Chuck and other official types actively emerges in the group to discuss policies, Chuck pulls messages from the discussion board and Chuck’s communication activities increase to the extent that he becomes a member of the critical mass. Many of the longest threads deal with the disconnect between the policies that WebMD would like to enforce and the perceived norms of the group. So, this phase is also characterized by some growing pains for both WebMD and the group.

### **Phase 3: “Turbulence” (September 2001 to May 2002, 9 months)**

Phase 3 is marked by volatility in the size of the membership, with drastic swings from month to month and a general decline in message volume. This is in stark contrast to the relatively steady growth and stability of Phase 2. Membership size peaks in October, 2001, and the proportion of seekers reaches its highest level (34 percent), seekers now outnumber responders, and the proportion of seeker/responders drops to its lowest level across all phases. In terms of content, some of the new most commonly used words are: Dr. “Gilmer”, and question. The common use of a member’s name signals a significant change in the group. In October, 2001, Dr. Gilmer, a WebMD-sponsored back pain physician, joins the group. Dr. Gilmer moves quickly into the critical mass by responding to others’ concerns. He is often asked specifically for advice in the content of the message header, and it appears that he is bombarded with questions. Not only are the infrequent newcomers to the group asking Dr. Gilmer questions, but the veteran members and critical mass are seeking his advice as well.

In this phase the proportion of information messages reaches its peak at 63 percent, which may be driven in part by the presence of the WebMD-sponsored physician. Although social messages are not as common in this phase, they do include wishes to members for “Happy Birthday” and “Happy Mother’s Day.” The members also include textual manifestations of physical emotional support, such as using brackets to hug each other (example: (((((((Bob))))))). In terms of communicative behaviors, the proportion of singletons and isolates increase in this phase, with close to 14 percent of the seeds going unanswered, and members in general are posting fewer messages per person (6 messages). Thus, although there is greater resource availability in this phase, there is less communication activity, less effort, more questions left unanswered, and more members who never receive a response. This apparent lack of effort and attention toward those seeking information may be an underlying cause of turbulence in membership size. The proportion of messages posted by the critical mass is moderate at 77 percent. The critical mass now consists of a group of relative newcomers with only two members in October, 2001 having spent five consecutive months in the critical mass. Three of the members remain in the critical mass throughout this entire phase.

In terms of external events, this phase begins right before the 9/11 terrorist attacks; however, this group seems largely uninterested in discussing these events. Although there were a few messages that were off-topic announcements related to anthrax and bio-terrorism, there was no indication that the increase in membership was related to 9/11 injuries or events. Corporate WebMD is not only experiencing the same financial difficulties that have carried over from the last phase, but many of its corporate mergers fall apart and its president quits. As in prior phases, corporate affairs seem to have little impact on the group’s communication activities. During this phase, however, there are more news articles circulating about “hot spots” to visit on the web as consumers become more Internet savvy, and WebMD is starting to be used as a source for medical information in health-related articles. This sporadic press coverage highlighting WebMD could be one potential cause of the extreme fluctuations in membership size. It is possible that people hear about WebMD through the media, come into the group seeking information, receive a response from Dr. Gilmer or other active members, and then leave with the information they came for. One change in corporate policy that does have an impact on the group’s discussion is the addition of pop-up ads as part of the website experience. This is likely a response to WebMD’s poor financial situation. While members find this disturbing, they discuss that it might be a necessary annoyance in return for free services.

### **Phase 4: “Most Members” (June 2002 to March 2003, 10 months)**

Phase 4 is characterized by a fairly steep increase in membership size through November of 2002, a steep drop for a few months, and another peak at the end of the phase. Since the peak months seemed to coincide with the peaks in Phase 3, we considered that this could be a seasonal pattern in our data: Members may ignore their back problems during the busy summer months and then try and seek help in the fall. However, it is only in these two phases where this pattern is pronounced. The participation proportions are similar to those in Phase 3: The majority of members are seeker/responders, and seekers outnumber responders.

In terms of content, the most commonly used words are similar to those in Phase 3 – back pain, with

many messages directed toward Dr. Gilmer. The proportion of information messages drops slightly and the proportion of social messages increases slightly in this phase. The members also call their social threads "chatter." The social messages introduce another new type of message: a "Roll Call" message, where a member will ask those who access the board that day to reply in a "Roll Call" thread to indicate their presence on the board. These "Roll Call" threads become increasingly popular in the group throughout the rest of the study period.

In terms of coping strategies, these are also similar to those used in Phase 3, although more seeds are being attended to and fewer individuals are left isolated. Members, on average, post 5.8 messages (the lowest across all phases), and the critical mass is sustaining 76 percent of the communication activities (also the lowest level across all phases). Only two members of the critical mass the end of Phase 4 were also active in Phase 3. Dr. Gilmer stops posting in October, 2002 (and WebMD formally posts a farewell from him in November, 2002), but many users in November are still referring their messages to him. This phase appears to be a critical turning point in the social and structural dynamics of the group: a volatile but large membership size expending relatively little effort and better able to attract new members than retain existing ones. This also seems to mark the end of any active participation in the discussion board by WebMD. From November, 2002 forward, there are no WebMD usernames in the critical mass. There is little going on in terms of external events. During this phase corporate WebMD posts its first quarter of profitability, but this does not merit discussion. Member retention is at its lowest level (26 percent) and member attraction is at its highest level (74 percent), slightly outpacing defection (73 percent).

#### **Phase 5: "Social Interactivity" (April 2003 to December 2003, 9 months)**

In Phase 5, membership declines and actually reaches its lowest level in the study in December 2003, down to 167 members from its start of 363 members in March of 2003 (loses more than half of its members in less than one year). There is a pronounced increase in the proportion of members who are seeker/responders (58 percent), with declines in the proportions of seekers (24 percent) and responders (18 percent) indicating greater amounts of interactivity among members. We are seeing evidence of this increased interactivity in the communication activities. In sharp contrast to the decline in membership size, in this phase, message volume peaks at more than 6,300 messages in October, 2003 (up from just 2,421 messages in March). In terms of content, a new norm has emerged. Commonly used words include: hey, good, morning, roll, call, everyone. This is evidence of the new communication practice, started in Phase 4, where every day people sign-in to a roll call thread. A large shift is seen in the proportion of communication activities with social messages (52 percent) being, for the first time, a larger portion than information messages (33 percent). Many subject headers mention specific user names, with the intention of asking for updates or news, or simply starting a social conversation. Several users are quite popular, and their names appear often in message subject lines. Near the end of this phase, the members started a separate website to post pictures for one another, and there are many conversations about the pictures within the group. The most common off-topic subjects are the weather and the television show "Survivor."

In terms of coping strategies, the norm of responding to all seeds and all members is strengthening, 93 percent of the seeds receive replies and 98.5 percent of members interact with other members. The thread length increases marginally, but the average number of messages per person increases dramatically (16.1 messages). This is largely due to the increased efforts of a critical mass that has become significantly more active (accounting for 84 percent of the total messages) and committed. In December, 2003, 80 percent of the individuals in the critical mass return from the prior month. The most active poster in March, 2003 posts 139 messages. By the end of 2003, 15 individuals are posting more than 100 messages each, with the most active individual posting between 400-500 messages in some months. This indicates that it is harder for different members to enter the critical mass without expending a great deal of effort. Obviously, defection is a key coping strategy in this phase. Additionally, although this heightened level of activity is motivating more people to remain members of the group, fewer new members seem interested in joining. There are no notable external events occurring at corporate WebMD or other world events remarked upon in this phase. It appears that this shift is due largely to internal structural and social dynamics within the group itself.

### Phase 6: “Loyal Members” (January 2004 to December 2004, 12 months)

In Phase 6, membership size decreases steadily, while the proportion of individuals with dual participation behavior of seeking/responding increases to its highest level: 64 percent of the membership is actively engaged in both seeking and responding activities. Although communication activities drop, this group is still significantly more active during the last phase of our study than in Phases 1-4, averaging 3,849 messages per month, requiring a peak effort of 17.7 messages per person. The proportion of information versus social messages remains about the same as it was in Phase 5: about half the messages are social (51 percent) and about one third information (33 percent). In this phase the roll call and “Merry Christmas” and “Happy Easter” messages continue to be prevalent. In addition, there are frequently more mundane greetings such as “Happy Friday” or simply “Hello Everyone” and “Good Evening.” Prayer messages also are common in this period.

The norm of responsiveness has strengthened, ensuring that members who do seek information are rewarded with a response. By Phase 6, 93 percent of the seeds are responded to and 99 percent of members receive a response, even though the group has fewer members overall. Five members of the critical mass from the beginning of this phase still remain by the end of the phase. One member of the critical mass has been in the critical mass for more than 3 years at this point. In January, 2004, two members of the critical mass post more than 400 messages, but this drops in the following months (although it still typically exceeds 200 messages), and the number of individuals posting more than 100 messages drops to an average of around 9. Although the proportion of total messages contributed by the critical mass has declined slightly from Phase 5 (83 percent), fewer new members are entering the critical mass. The mix of these coping strategies has had an even more dramatic effect on member attraction and retention. Defection rates are down (58 percent), as retention rates have increased (42 percent). However, by the end of our study, more members are retained (51 percent) in this group than attracted (49 percent). This is in sharp contrast to Phase 4, only 16 months earlier, where 74 percent of the group consisted of new members.

In terms of external events, Vioxx, a popular drug for treating osteoarthritis symptoms and pain, is recalled on September 30, 2004, but we do not see an increase in Vioxx-related messages. Members do make note of the tsunami that devastates the shores of Indonesia, Sri Lanka, India, Thailand, and other countries. Members also engage in some discussion of the 2004 Presidential election. However, as in Phase 5, it is not apparent that any of these external events have a significant impact on communication activities, coping strategies, or sustainability of the group.

## 7. Discussion

The objective of our study was to investigate online discussion group sustainability by taking a logics of opposition approach. We predicted that rather than following a pattern of linear relationships, sustainability depends upon the interplay between the social and structural dynamics over time. As a result of this study, we are better able to explain *why* we see the opposing impacts noted by Butler (2001). We find support for our first hypothesis that shifts in resource availability lead to changes in communication activities. Changes in communication activities were not driven by membership size, but seemed to have a stronger correlation with how members participate – higher proportions of single-purpose seekers and responders resulted in lower levels of message volume that were more focused on information content. As a higher proportion of members became more interactive, taking on seeker/responder roles, members produced higher message volume and contributed more social content; information content seemed to become a secondary benefit to members in the final phases of our study. This suggests that more resources do not always result in more communication activities. Changes in how people participate – whether this participation is primarily informational seek and respond or interactive and social in nature, leads to different levels and types of communication activities. Our results also suggest that online discussion group moderators have some control over this dynamic. Designating a formal expert in the group to answer questions seems to promote seeking and responding over social activity.

We also find support for our second hypothesis that shifts in communication activities lead to changes in coping strategies. As communication activities increased, members of the critical mass increased

their efforts, and levels of retention in the group actually increased. Contrary to prior predictions suggesting that members would cope with increased information load by leaving the group, members in our group coped by staying active over longer periods of time and putting forth more effort. This appears to be a response to message content becoming more social. While across the five years communication activities appeared to have little impact on communicative behaviors in terms of thread length, as message content became more social, norms of responsiveness intensified. Thus, this group has decided to adopt coping strategies that focus on increased efforts and increased interactivity among all members, developing a strong norm and appreciation for social exchange over information content. One implication of these findings is that if retaining existing members in an online discussion group is perceived as important, this could be achieved by allowing more social and off-topic interactions among members.

We also find support for our third hypothesis that changes in the coping strategies will affect resource availability. While adopting coping strategies focused on increased efforts and interactivity among members appears to have made a significant impact on the group's ability to retain existing members, this has come at a high cost – the group is far less able to attract new members. It may be that newcomers are not interested in the social chatter that appears to be somewhat of a “closed club” of people who know each other well. In order for members to provide personalized support to each other, in the form of “hugs” and prayer threads, this requires a certain level of intimacy and familiarity that may simply not be felt by newcomers to the group. Alternatively, new individuals may come to the group in seeker roles, looking for specific information. If this information is not readily available by scanning existing threads, these individuals may decide not to become active members and seek answers to their questions through other online resources. Although the higher interactivity ensured that more seeds were answered and fewer members were isolated by not receiving a response, this is only a benefit if individuals actively participate and post questions. If this trend continues, this group may keep losing resources if the proportion of social content continues to increase, demanding ever increasing efforts and intimacy.

Although we did not hypothesize about the influence of external events and how these could impact internal online discussion group dynamics, we found that external shocks had a significant impact on the structural and social dynamics of the group. The addition of just one person, Dr. Gilmer, as a medical expert and spokesperson for the WebMD website, coincided with substantial volatility in membership size and had a direct impact on message content. Adding new features (chat and pop-up ads), introducing moderation, and changing the underlying technology were all disruptive events to this group. What is particularly interesting to note is how the timing of the withdrawal of formal WebMD participation in the group coincided with the shift in structural and social dynamics – when WebMD leaves, membership size drops, message content becomes more social, and individuals are willing to expend more effort. This finding extends prior research to suggest that examinations of online group sustainability should include investigations of external influences on intra-group interactions.

Generalizing our results to other online discussion groups, it is possible that future research will find similar trends that socially — oriented online discussion groups have fewer members that are more interactive and engage in more communication activities of a predominately social nature, relying on a critical mass of active members willing to expend a great deal of effort to maintain this high volume. It would be interesting to see if our findings are replicated in other online discussion groups, where high levels of interactivity are important for retention yet create a barrier excluding new members. Another important finding of this study is that an online discussion group that is predominately information-oriented at one point in time can shift to become a social group. Thus, it does not appear that the actual topic of discussion determines whether a group is primarily informational or social, rather it is how this group evolves over time, and the interplay between its unique structural and social dynamics, that determines whether it is informational or social. Potentially, if the membership in the Back Pain Group decides to increase its proportion of information-based communication activities, it may be able to once again attract a higher proportion of new members. Alternatively, WebMD could attempt to bring back a medical expert and spokesperson as a catalyst to making this shift.

Also worth discussion, our findings and interpretations of events are based on how we chose to operationalize the theoretical constructs. For instance, we assess membership size in terms of the number of active members (those that post messages). Butler (2001) assessed membership size as the number of registered users (all members of a listserv). Measures of membership size could also include the number of lurkers, as a “truer” indicator of both the amount of audience resources and the potential to generate new members. Lurkers present another category of how people participate as well – reading without responding. Additionally, we only examine two primary coping strategies: changes in communicative behaviors and changes in effort. Jones et al. (2004) discuss seven possible coping strategies that members can adopt; (1) increasing their effort, (2) learning new techniques to deal with the increased information, (3) not responding to some of the messages, (4) making simpler responses, (5) storing inputs and responding later, (6) making more errors in responses, and (7) leaving the group (Jones et al., 2004). In their study, they assess changes in message length as a key coping strategy. One potential alternative explanation for our findings is that individuals have not truly increased their efforts, they are simply posting shorter messages more frequently. It may take significantly less effort to post relatively short support messages than information messages that require a great deal of explanation. Our dataset did not include message length, so we are unable to test this assertion. Future research should investigate how individuals adopt a wider range of coping strategies to further our understanding of how a wider portfolio of coping strategies influences sustainability.

### **7.1. Limitations and Future Research**

While this researcher presents many new additional insights into the sustainability of online discussion groups, we should note that it has some important limitations. The most significant limitation is the examination of only one group. While the selection of one group afforded a more in depth study over a longer period of time and allowed us to examine the opposing forces and social dynamics within this group, our analysis is limited to the interpretation of the dynamics underlying this one group. Additionally, this group is a health-related support group, and its topic area may influence sustainability. For example, because health-related support groups may have the dual need to provide both information (medical-related news) and support (helping members cope with ailments), this may affect the interplay among structural and social dynamics. Although our main theoretical assertion is that findings from one online discussion group may not be generalizable across all discussion groups, and that findings from online groups at a specific point in time may not be generalizable across time due to the opposing forces at play, future studies that examine different groups, and across technological platforms, would greatly enhance our understanding of online discussion group sustainability. Another limitation of our study is that we were only able to track the structural changes in sustainability, attraction, retention, and defection across different points in time. We do not assess the social dynamics related to sustainability. In other words, we cannot explain exactly why members decide to leave the group, or why fewer members are deciding to join. Studies that include interviews or survey responses from members are needed to assess the underlying reasons for joining or leaving the group, how certain benefits of group participation are perceived, and why members adopt the coping strategies that they do. A final limitation of our study is that we cannot provide evidence of causation. Our study only examines shifts in the theoretical constructs over time. We cannot conclude with certainty that higher proportions of a predictor variable caused an increase or decrease in a dependent variable. Other methods are needed in order to test causation, such as surveys of group members in combination with objective participation data to determine whether individuals, in fact, decided to change their coping strategies in response to changes in communication activities and how.

Rather than serve as the final answer to online discussion group sustainability, this research points to many exciting areas of future research. For instance, this research focuses on the dynamics at the group level of analysis. However, online discussion group sustainability is rooted in individual differences and the choices members make about how to participate and cope with information load. Additional research is needed at the individual level of analysis to get a better idea about why individuals make certain choices regarding participation. For instance, the heterogeneity of the individuals within an online discussion group is an important factor in determining the motivation to

contribute (Fulk et al., 1996; Monge et al., 1998; Oliver et al., 1985). Additionally, differences among other characteristics of individuals, such as preferences for posting information or support-related content and individual centrality (the number of connections an individual has with others in the network) may affect how individuals contribute to the sustainability of the group (Monge et al., 1998).

## 7.2. Conclusion

We propose that the study of online discussion groups must take into account that there are opposing forces consisting of both structural and social dynamics that interact over time to sustain online social networks. Rather than affirm evidence of consistently positive or negative relationships among these constructs, this study provides additional evidence to deny the common assumptions and expectations about how more of one thing (size) always leads to either more or less of another (sustainability). Results provide support for our main assertion: Each online discussion group is a product of its structural and social dynamics in combination, and the influence of these factors on sustainability is best understood when they are examined in relation to each other over time

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## Appendix 1 – Measurement Procedures

*Size of Membership.* To assess the structural dynamics of resource availability, we calculate size of the membership. The size of membership is an aggregate measure of the overall resources available to the group (Butler, 2001b). The size of the membership was assessed by summing the total number of unique usernames from the message headings for each month.

*Type of Participation.* To assess the social dynamics underlying availability, we assess type of participation, indicating the specific type of resources an individual contributes to the group. In order to assess type of participation, the dyadic message exchanges (the pattern of posts and replies) were recorded in a square social network matrix on a month by month basis reflecting how members interacted with each other. We calculated the number of messages coming to an individual (indegree) and the number of messages originating from an individual going to another member (outdegree) using UCINET 6 (Borgatti et al., 1999). Seekers are calculated as the sum of individuals who only received replies (indegree $\geq$ 1), but did not respond to others (outdegree=0) for each month. Seeker/Responders are calculated as the sum of individuals who received replies (indegree $\geq$ 1) and responded to others (outdegree $\geq$ 1). Responders are calculated as the sum of individuals who received no replies (indegree=0), but only responded to others (outdegree $\geq$ 1).

*Message Volume.* To assess the structural dynamics of communication activities, we calculate message volume. Message volume is the total number of messages posted to the group during the month. For threads that spanned across months, we counted all messages within a thread as occurring in the month the seed was posted. In the WebMD online discussion group, the vast majority of conversations are short-lived, lasting only one or two days.

*Content of Messages.* To assess the social dynamics underlying communication activities, we examine the subject line of the messages. A set of coding instructions including examples was developed by the authors for the categories of (1) information, (2) emotional/social/personal, (3) off-topic, and (4) other (too vague or coder cannot understand the message). The authors also developed a list of acronyms commonly used in the community as well as medical terms germane to the back pain topic. The two authors independently coded 100 cases. Straight agreement was calculated and discrepancies discussed and resolved, and the coding categories and accompanying instructions updated as necessary. The same two judges independently coded another 250 cases. Intercoder reliability on this dataset was assessed with Krippendorff's alpha at .8779 (Hayes and Krippendorff, 2007). Krippendorff's alpha is considered an appropriate measure of intercoder reliability because it accounts for chance agreement, can be used for any number of coders, and is explicitly designed to be used for nominal variables (Lombard et al., 2002). A third coder was added to the project and trained verbally by one of the authors and provided with written instructions. A sample of 250 cases was double coded by this third coder and one of the authors, resulting in a Krippendorff's alpha reliability of .8221. Both alphas were .80 or greater, meeting a minimum acceptable level of reliability, given that we have chosen a very conservative reliability index (Lombard et al., 2002). Once reliability across coders was established, all message headers were coded by one of the authors. Examples of subjects in each category are given below.

### Example Information Discussions

epidural/cortisone injection scheduled! comments please  
Help... herniated disk c5 and c6 just diagnosed  
Results from Seeing Neurosurgeon  
Spinal Fusion of L5- S1 - Please Help!!!!!!  
Does Oxycontin cause insomnia?  
degenerative disc disease  
Herniated & Protruding disc  
I finally found a good pain Dr.  
Doctors Just Don't Understand Pain

methadone?????  
new med for back pain?????????  
Neck Pain is worse and Nothing shows on the MRI  
Back Pain relieved by urination!!  
spondylolisthesis  
MY BACK HURTS WORSE THAN IT DID WHEN I WAS.....  
Meds/Treatment ideas for lower back pain?  
SURGERY. HOW MUCH IS ENOUGH??

**Example Social/Personal/Emotional Discussions**

SCARED TO DEATH  
Update If anyone wants to know  
Thank you Thank You Thank You  
Thank You All  
Response from 9/11 to shar46  
Prayers for Garrett.....again  
Thank You For Your Help  
Just need to vent and still confused  
GROUP HUG AND PRAYER  
To: carol632-Depot66-granny6154 and everyone else  
Dyana - Jenny - Shar  
Thanks Rosalini and SweetC61  
Let's focus on HOPE... like Garrett is back!!  
I need prayers please, I'm scared!  
Burden to family - feeling desperate

**Example Off-Topics Discussions**

Snow  
redheads  
what is with the website malfunctioning?  
ack! sorry about the duplicate posting!!  
OT: The crazy flying ant in my office...  
OT - Got my first rejection letter  
OT - Uno at work??  
New board at WebMD re the tsunami and aftermath

*Coping Strategies – Changes in Communicative Behaviors.* To examine the structural dynamics of communicative behaviors, we calculated the average thread length per month. The average thread length is calculated as the total number of messages posted to the group for the month, divided by the number of seed messages posted that month. To assess the social dynamics underlying communicative behaviors we examine norms of responsiveness. Norms of responsiveness were measured in terms of the proportion of seeds message without replies (singletons), and the proportion of members who post seeds, but do not receive a response (isolates).

*Coping Strategies – Changes in Effort.* To measure the structural dynamics reflecting changes in efforts, we calculate the average message postings per person for each month. To assess the social dynamics underlying changes in efforts of the critical mass, we use the concept of the Pareto principle to identify the 20 percent of members who are the most active posters. The phenomenon of a few contributors associated with a large distribution of an outcome is widely accredited to the Italian economist Vilfredo Pareto, who noted that 80 percent of a country's wealth was distributed among 20 percent of its population. Juran (1950, 1954) named this the "Pareto Principle". While the Pareto Principle suggests that, for online discussion groups, the most active 20 percent of the membership

produces 80 percent of message volume, there is no empirical evidence that 20 percent of members necessarily contribute 80 percent of the message volume. We then calculated the proportion of message volume generated by the critical mass for each month. The average commitment of the critical mass was also assessed as an indicator of effort. To calculate critical mass commitment, we first tracked the participation history of each individual in the critical mass from month to month. For example, the 20 percent most active posters in the month of June, 2001 were identified. These usernames were compared to the list of usernames in the critical mass in May, 2001. If an individual had two consecutive months in the critical mass, this individual was coded as having 1 consecutive month of commitment. If another individual had been a member of the critical mass since January, 2001, this individual was coded as having 5 consecutive months. Commitment was then assessed as the average commitment of members in the critical mass for each month critical mass.

*Coping Strategies – Defection.* To assess the social dynamics underlying the coping strategy of leaving the group, we calculated the proportion of members who defect from month to month. For example, the rate of defection for February, 2001 was calculated by comparing the usernames of active members who posted in January, 2001 with the usernames of active members in February, 2001 to identify the number of individuals who did not return. This was then divided by membership size in January, 2001 to indicate the proportion of membership that was lost from the prior month.

*Sustainability.* The structural dynamics reflecting sustainability were assessed by examining the proportion of membership size that was retained from the prior month (retention), and the proportion attributed to new members (attraction). For example, the rate of retention for February, 2001 was calculated by comparing the usernames of active members who posted in January, 2001 with the usernames of active members in February, 2001 to identify the number of individuals who returned. This sum was then divided by membership size in February, 2001 to indicate the proportion of membership in the current month that was retained from the prior month. Similarly, usernames were compared to identify the total number of members that were not active in the prior month (January, 2001), but active in the current month (February, 2001). This sum was then divided by membership size in February, 2001 to assess the proportion of membership in the current month that consisted of new members.

*External Events.* One potential alternative explanation for changes in the structural and social dynamics of an online discussion group is due to events that occur outside of the group. For instance, the terrorist attacks on 9/11, changes in the WebMD website (e.g., structural or policy related), the release of new drugs or safety concerns about existing drugs, and identification of new medical procedures, may be external events that cause changes in the structural and social dynamics of the group, but are beyond the boundaries of our theoretical focus. Therefore, we attempt to account for these effects by including in our study an analysis of external events. First, we performed a wide-based search using both the Internet and Lexis-Nexis to identify news articles related to WebMD, back pain medicines and medical procedures. There were 482 general news articles in major publications between 2000-2004. Then, we performed text analysis of the message headers to identify word frequencies for each month (using NVivo 7). We examined the frequently used words and terms to refine our news-related search to ensure that we had identified important topics of interest to the group. Finally, we matched external events from the wider news media to message content in the group.

Word Frequencies for each Phase (top 25 words only)

Phase 1	use	Phase 2	use	Phase 3	use	Phase 4	use	Phase 5	use	Phase 6	use
pain	258	pain	676	pain	587	pain	681	i	539	I	751
back	187	back	515	dr	457	back	534	pain	504	Pain	577
i	105	i	319	back	447	i	370	all	490	Back	539
you	92	you	286	gilmer	406	dr	315	back	462	You	468
from	66	help	219	i	268	gilmer	245	you	377	All	467
what	63	surgery	216	question	232	my	228	morning	301	My	448
my	57	my	191	help	228	you	227	my	293	morning	292
surgery	52	what	191	you	192	help	205	hey	232	From	273
help	50	anyone	166	my	179	please	180	good	222	Call	265
anyone	46	all	153	please	166	surgery	154	help	221	Roll	259
disc	44	need	146	anyone	142	anyone	146	call	205	Good	257
all	42	please	135	need	142	need	146	roll	204	Help	251
chat	42	fusion	132	surgery	136	all	142	everyone	198	Need	224
fusion	41	new	123	what	118	question	133	question	190	question	221
need	41	post	117	have	100	what	131	new	176	everyone	218
please	35	do	112	all	90	about	116	need	168	Me	213
about	34	from	112	me	90	new	113	what	166	New	211
have	34	have	111	can	85	me	105	about	163	What	211
do	30	me	106	post	85	have	101	just	162	About	210
good	30	question	100	about	83	disc	98	from	160	Have	209
post	30	i'm	96	fusion	83	from	89	me	157	update	209
thanks	29	after	92	lower	80	lower	86	have	155	surgery	198
today	29	disc	90	from	79	hey	75	anyone	154	anyone	194
herniated	28	just	89	your	76	some	75	hi	150	please	193
new	28	update	88	disc	66	can	74	here	147	Today	185

**Means, Standard Deviations and Correlations among Constructs**

	Mean	Std. Dev	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1 Size of membership	256	.52																
2 Proportion of participants seeking information	.25	.07	.28*															
3 Proportion of participants seeking and responding	.53	.08	-.51*	-.52*														
4 Proportion of participants responding only	.22	.07	.30*	-.34*	-.63*													
5 Message Volume	2504	1339	.00	-.35*	.65*	-.40*												
6 Proportion Information Messages	.50	.14	.36*	.40*	-.79*	.51*	-.82*											
7 Proportion Social Messages	.38	.11	-.27*	-.35*	.75*	-.50*	.81*	-.98*										
8 Proportion Off-Topic Messages	.05	.03	-.46*	-.42*	.63*	-.31*	.63*	-.71*	.60*									
9 Thread Length	5.32	.78	-.41*	-.67*	.66*	-.12	.53*	-.61*	.54*	.56*								
10 Proportion of Singletons (seeds without responses)	.10	.04	.37*	.56*	-.65*	.21	-.50*	.61*	-.57*	-.57*	-.66*							
11 Proportion of Isolates (individuals never responded to)	.03	.04	.16	.65*	-.46*	-.09	-.35*	.38*	-.38*	-.27*	-.48*	.55*						
12 Average messages per person	10.18	5.86	-.34*	-.42*	.83*	-.53*	.92*	-.89*	.85*	.75*	.62*	-.60*	-.37*					
13 Proportion of total messages posted by the critical mass	.79	.05	-.01	-.20*	.55*	-.43*	.88*	-.82*	.83*	.57*	.50*	-.44*	-.29*	.79*				
14 Average commitment of critical mass in months	2.37	1.41	-.54*	-.29*	.81*	-.65*	.63*	-.76*	.73*	.59*	.45*	-.58*	-.36*	.83*	.53*			
15 Rate of Defection	.10	.04	.29*	.41*	-.72*	.43*	-.74*	.75*	-.73*	-.63*	-.57*	.62*	-.80*	-.80*	-.62*	-.74*		
16 Proportion of new member attraction	.68	.08	.69*	.40*	-.84*	.58*	-.54*	.75*	-.68*	-.68*	-.59*	.60*	-.80*	-.80*	-.49*	-.83*	.67*	
17 Proportion of member retention	.32	.08	-.69*	-.40*	.84*	-.58*	.54*	-.75*	.68*	.68*	.59*	-.60*	-.28*	.80*	.49*	.83*	-.67*	-.1

\*p≤.05 (two-tailed); correlations > .34 have p≤.01

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