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Transitivity, hierarchy and reciprocity of organizational communication network during crisis

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Abstract

Purpose – This paper aims to explore changes in communication networks during organizational crisis. In the literature, various terms such as organizational mortality, organizational death, bankruptcy, decline, retrenchment and failure have been used to characterize different forms and facets of organizational crisis. Communication network studies have typically focussed on nodes (e.g. individuals or organizations), relationships between those nodes and subsequent affects of these relationships upon the network as a whole. Email networks in contemporary organizations are fairly representative of the underlying communication networks.

Design/methodology/approach – The changing communication network structure at Enron Corporation during the crisis period (2000-2001) has been analyzed. The goal is to understand how communication patterns and structures are affected by organizational crisis. Drawing on communication network crisis and group behaviour theory, three propositions are tested: communication network becomes increasingly transitive as organizations experience crisis; communication network becomes less hierarchical as organizations are going through crisis; and communication network becomes more reciprocal as organizations are going through crisis.

Findings – In this research analysis, the support of these three propositions was noticed. The results of tests and their implications are discussed in this paper.

Originality/value – This study builds on an emerging stream of research area that applies social network analysis to organizational interaction data to study various questions related to organizational change and disintegration. These findings could help managers in designing an effective approach to monitor regular functionalities of their organizations.

Keywords Communication network, Organizational crisis, Hierarchy, Transitivity, Reciprocity

Paper type Research paper

1. Introduction

A communication network is either a personal or professional set of relationships between individuals or organizations. It is also described as patterns of contacts which are created due to the flow of messages among participating actors. The word "message" encompasses everything that can flow from one point of contact to another within and between networks including data, information, knowledge, image and symbol. These communication networks could take various forms, such as personal contact networks, work-related contact networks, strategic alliances

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among various firms and global network of organizations (Monge and Contractor, 2003).

Although there is limited consensus among researchers on the precise definition of organizational crisis, there is evidence of shared meaning. Hermann (1963) defined crisis as a situation that threatens goals of an organization, surprises decision-makers by its occurrence, puts them under time pressure for appropriate responses and, consequently, engenders high levels of stress. Milburn *et al.* (1983) identified several important elements of organizational crises such as:

- crisis produces individual crisis;
- crisis can be associated with positive or negative conditions; and
- crises can be situations having been precipitated quickly or suddenly, or situations that have developed over time and are predictable.

Weitzel and Jonsson (1989) defined organizational crisis as a state in which firms fail to anticipate, recognize, avoid, neutralize or adapt to external or internal pressures that threaten the organization's long-term survival. Sheppard (1994) described crisis as "a critical and irreversible loss by the system" and posited that an organization dies when it stops performing functions we would expect from it. A drastic form of critical loss occurs when firms move into bankruptcy as in the case of Enron Corporation, the subject of this study, in the final quarter of 2001.

In this paper, we start with the premise that email networks constitute a useful proxy for the underlying communication network within organizations. A study by Smith *et al.* (2003) investigated how different age groups managed their personal networks and what types of technology-mediated communication tools they used. They found that people around their 30s (i.e. 25-35 years) used email with the most of their social network contacts (81 per cent). In total, 60 per cent of the older age groups (i.e. 50-60 years) also tended to keep in touch with their personal contacts primarily by using email. As a modern and technologically advanced organization, we know that Enron employees used email as a significant medium of communication. Wellman (1996) has argued that computer-supported social networks (CSSNs) sustain strong, intermediate and weak ties that provide information and social support in both specialized and broadly based relationships. CSSNs support and foster both formal and informal workplace communities. Guimera *et al.* (2003) argued that an email network provides an inexpensive but powerful alternative to a traditional survey approach which is expensive and time-consuming. Indeed, they found that the exchange of email between individuals in organizations reveals how people interact and facilitates mapping of the informal networks in a non-intrusive, objective and quantitative way. Tyler *et al.* (2005) also described email communication network as a tantalizing medium for research, which offers a promising resource for tapping into the dynamics of information within organizations and for extracting hidden patterns of collaboration and leadership that are at the heart of informal communities of practice.

Not many studies have been conducted in the area of communication network analysis and organizational crisis. In a study of crisis effects on intra-organizational computer-based communication, Danowski and Edison-Swift (1985) identified that during a crisis:

- the amount of communication increased;
- the number of communicators increased;
- messages became shorter;
- individual-level networks became less interlocking; and
- the macro-level network became more grouped.

The communication network becomes more dynamic (Hamra *et al.*, 2011; Uddin *et al.*, 2012), and the static topology of network analysis cannot capture the complete dynamicity of the network during crisis (Uddin *et al.*, 2011a). Krackhardt and Stern (1988) found evidence that the structure of communication patterns in crisis situations is an important contributor to organizational success. Loosemore and Hughes (2001) argued that there is little understanding of social and communication structures during crisis and studied the appropriate pattern of social ties during crisis. They found that during the crisis period, efficient information flow is important to the reduction of uncertainty, which is important to the reduction of misunderstanding, disagreement, tension and conflict. Some other findings from their study include that during crisis:

- there are strong motives to pursue inappropriate structures;
- parties with similar interests tended to pool information to increase their powerbase; and
- the contraction of responsibility.

Diesner *et al.* (2005) explored the dynamics of structures and properties of the organizational communication network, as well as the characteristics and patterns of communicative behaviour of employees from different organizational levels. They found that during the crisis period, the network density, centralization and connectedness increased as the crisis deepened. Uddin *et al.* (2011b) noticed that organizational communication networks follow power-law distribution during crisis.

In this paper, we analyze the changing communication network structure to investigate patterns and the communication hierarchy associated with the final stage of an organization in crisis. We draw on theoretical perspectives of organizational crisis proposed by network and other sociologists to test three key propositions related to changes in the network communication structure associated with organizational crisis. We analyzed the Enron corpus which is an email communication log and was released by the Federal Energy Regulatory commission (FERC) in May, 2002. This study provides a meaningful insight into the structural changes of organizational email communication networks during the crisis period. The following questions motivate this research:

RQ1. How do organization communication networks evolve during crisis?

RQ2. What are structural properties of networks associated with crisis?

The rest of the paper is organized as follows. In the next section, we describe the theoretical background of our study and develop three research propositions. Then, we posit research methods followed in this study. After that, we illustrate research findings

of this study. Before making a conclusion of this study, we posit a discussion about the theoretical and practical implication of this research.

2. Theoretical background and research proposition development

Nohria (1992) argued that organizations can be commonly viewed as communication (or social) networks, and these need to be analyzed and addressed as such. The basic definition of social networks, as having a number of nodes (e.g. individuals, departments and organizations) and the recurring relationships within these nodes, closely resembles the basic structure of an organization. He further argued that an organization's environment and its actors can be seen as a network, where environment is a network of other organizations and actors who are embedded into this network, whose continuous interaction with its environment shape and reshape the organization. Wellman (1988) also identified that actor's behaviour within a communication network can be efficiently predicted (or interpreted) in terms of structural characteristics of the network which is defined by relationships in which they are embedded. Unlike the inner forces (e.g. drives, attitudes and demographic characteristics) of the network, these relationships often put constraints on the activities of actors.

The association of structural changes (e.g. clique formation, reciprocity, centralization and transitivity) of communication networks with organizational crisis has been of great interest to researchers in areas of social network analysis and organizational science (Hossain *et al.*, 2013). However, there is a scarcity of substantive empirical research to explore specific theoretical proposition, primarily due to the difficulties in gathering appropriate data. In this study, we consider three communication network structures, namely, transitivity, hierarchy and reciprocity and explore their impact during organizational crisis.

2.1 Transitivity and organizational crisis

Three actors (say *A*, *B* and *C*) are transitive if whenever *A* is linked to *B* and *B* is linked to *C* then *C* is also linked to *A*. This concept of transitivity has a striking resemblance to the concept of the *Balance Theory*. Heider's (1982) *Balance Theory* posited that if two individuals are friends, then they could have similar evaluations of an "object". This concept was extended and mathematically formulated by many authors (Cartwright and Harary, 1956; Harary *et al.*, 1965; and Davis and Leinhardt, 1967). They argued that the third "object" could be a third person in a communication network. If two individuals do not consistently evaluate the third person then there is a possibility of a state of discomfort among them and they would try to reduce this inconsistency by evaluating their evaluation of either the third party or their own friendship. Heider's explanation of the *Balance Theory* was confined to a maximum of three entities. By using the concept of graph theory, many other researchers (Cartwright and Harary, 1956) generalize the *Balance Theory*. This generalized version of the *Balance Theory* contains no such limitation. It can include any finite number of entities and any type of relation.

Holland and Leinhardt (1971) used graph theory to illustrate various organizational patterns which may be generated after the condition of transitivity is satisfied. Their study suggested that transitivity can result in stratification and clustering. They also posited that if transitivity is considered to be a generalization of the *Balance Theory* then balance can lead to the development of hierarchies and cliques. Heider (1982) proposed that, from the psychological perspective, the case of three positive relations may be

considered as transitive. Besides, triads, other than the positive ones, also tend to form a balanced state. Likewise, people also prefer a balanced structure in their day–to-day lives. If the structure is not balanced then people experience various psychological effects such as "strain" and "tension". Heider (1946) argued that these negative psychological cues eventually generate forces towards balanced structures. As the organizations go through the state of crisis, people also experience "strain" and "stress", which will ultimately lead actors to form a balanced state within the communication structure. Crises also lead to increased group cohesion (Staw *et al.*, 1981; Hamra *et al.*, 2011). This increased cohesion will prompt actors to reach a balanced state, thus increasing the network transitivity of the whole network. This leads to our first proposition:

P1. Organizational communication network becomes increasingly transitive as organizations experience crisis.

2.2 Hierarchy and organizational crisis

Traditional functional hierarchy and hierarchy of communication network are affected in different ways during organizational crisis. Hermann (1963) noted that when crises occur, functional authority is affected in one of the three ways:

(1) it moves to a higher level of hierarchy;

(2) fewer people exercise authority; and

(3) there is an increase in the number of occasions when authority is exercised even though the number of units exercising it remains constant.

When a crisis occurs, effective leaders take charge, and give functional and policy-related commands that are obeyed by obedient followers. This eventually leads to the harnessing and directing of combined power of many individuals in service for group survival (Kanter, 2003). As a consequence, during crisis, centralization of functional control is significantly increased with leaders, which eventually leads to tightening of reins, concentration of power at the top and minimizing participatory decision-making.

According to crisis theory, which develops from psychoanalytic theory (Greenberg and Mitchell, 1983), during crisis, people participate in two types of activities:

(1) *Action*: Doing something to mitigate crisis consequences.

(2) *Reaction*: Feeling the crisis effects (Parad and Caplan, 1960).

A very small number of people, such as effective leaders and high-ranked officials, take part in the first type of activity (i.e. action). Most of the people feel the effects of crisis. They (i.e. of the second type) also engage in group communications with others to diminish the anxiety resulting from crisis (Seeger *et al.*, 2003). These group communications do not maintain organizational hierarchy. In the end, only a few people play a leadership role and maintain organizational hierarchy in communication network during organizational crisis, whereas most people do not maintain it. Thus, overall communication network becomes less hierarchical during crisis, although the functional structure of the organization tends to be more hierarchical. This leads to our second proposition:

P2. Organizational communication network becomes less hierarchical as organizations are going through crisis.

2.3 Reciprocity and organizational crisis

As one of the very important theoretical concepts of sociology, reciprocity has been widely used in the social network analysis literature since the 1930s. Many earlier sociologists and social-psychologists, such as Thurnwald (1932), Simmel (1950) and Becker and Strauss (1956), tried to define reciprocity in various ways while emphasizing its importance in the contemporary human society. Thurnwald (1932) described reciprocity as almost a primitive principle that encompasses every relation of primeval life and was the basis of entire social and ethical life of all earlier civilizations. Simmel's (1950) comments about reciprocity went further than the primitive society. He argued that social equilibrium and cohesion could not exist without the reciprocity of services. Becker and Strauss (1956) found this concept so fascinating that they named one of their books as "*Man in Reciprocity*" and denoted man as "Homo-Reciprocal". One of the earlier questions researchers asked in network analysis was: how strong is the tendency for an actor to "select" or "choose" another actor, if the later chooses the former (Wasserman and Faust, 2003). Based on this attribute of "select" or "choose", reciprocity can be defined as the extent to which ties between two actors are symmetric (Monge and Contractor, 2003).

We examine Social Exchange Theory to explain the reciprocity within communication network. This theory was originally introduced by Homans (1953, 1958, 1964). Other researchers, such as Thibaut and Kelley (1959), also developed the theory and seek to explain the likelihood of a reciprocal or dyadic relationship based on exchanges of both psychological and economical resources between each member of the dyad. Emerson (1962, 1981) extended the concept of social exchange beyond a mutual dyad and argued that to understand the potential of exchange relationships and power dependence in terms of a social, economical and psychological perspective, we need to examine the larger network in which reciprocal dyads are embedded. Based on Emerson's work, Katz *et al.* (2004) argued that an actor's motivation to forge ties with another actor is not based on maximizing their self-interest (as described by Theory of Self-Interest). Rather, the individual is motivated by minimizing her/his dependence on others from whom they need resources and maximizing dependence of others to whom they can offer both economical and psychological resources.

The social network concept of reciprocity and the theory of social exchange has been used by organizational researchers to explain employee motivations which is the basis of employee behaviour and the formation of positive employee attitude (Settoon *et al.*, 1996). Although organizational literature does not specifically mention the norm of reciprocity as a mechanism of organizational commitment, Scholl (1981) argued that we can clearly see how the norm would hold employees into a system if exchange relationships were dissatisfying or not up to the expectations of individuals. As organizations go through the crisis period, researchers found several negative outcomes:

- decreasing levels of slack resources, morale, trust, upward communication and innovation; and
- increasing levels of conflict, centralization and scapegoating (Cameron *et al.*, 1987).

However, Lanzetta (1955) argued there is also an increase in intra-group cooperative behaviour which is perceived as the source of security during the threat of crisis. Staw

et al. (1981) posited that during crisis period, communication networks display increased cohesiveness, leadership support and pressure for uniformity. Murshed *et al.* (2010) also argued that people seek the company of others when they feel threatened. This implies that during the crisis, more people will be communicating with others within their network. Eventually, this increased level of communications will make many of these communicative ties reciprocal, as the norm of reciprocity (as described earlier) is one of the key elements of our society. This leads to our third and last proposition:

P3. Organizational communication network will be increasingly reciprocal as the organizations experience crisis.

3. Research methods

We first describe the email dataset used for the research in this section. Data cleaning methods are then discussed in this section, which is followed by the description of three network measures used for study.

3.1 Email dataset

In this study, we use Enron email dataset to test our proposed three propositions. To fully understand the context of this corpus, we need to understand Enron's organizational downfall which was mostly instigated by the unethical business practices of its senior management and overall organizational culture (Fox, 2003). Founded in 1985 at Texas, Enron became a global player and a symbol of an innovative and progressive business conglomerate within a decade. It had also been actively involved in areas of metals, pulps and paper, broadband assets, water plants and financial markets internationally (Healy and Palepu, 2003). It became so successful that in 2000, Enron's annual revenue was $101 billion which made it the seventh largest company in the USA, bigger than IBM or Sony (Fox, 2003). However, during the later part of 2001, it became slowly evident that, with the help of Arthur Andersen (Enron's auditor since 1985), Enron had been grossly overstating its profits and understating debts for the previous five years. On October 16, 2001, Enron disclosed that it had lost $618 million in the third quarter earnings. On December 2, 2001, Enron filed for Chapter 11 bankruptcy protection in a New York Bankruptcy court. With $62 billion in assets, this was the largest bankruptcy in the history of the USA up to that time. By January 2002, Enron stock lost 99 per cent of its value. Stockholders lost tens of billions of dollars and many of the company's 20,000 employees lost their retirement savings pensions and jobs (Fox, 2003; Healy and Palepu, 2003; Hamilton, 2006). The US Justice Department conducted an ongoing criminal investigation into the fall of Enron which has resulted in a number of criminal charges (e.g. fraud, conspiracy and insider trading) being filed against several top executives.

In May 2002, the US FERC publicly released a large set of email messages, the Enron corpus. The original corpus contains 619,446 email messages distributed in and around 3,000 user-defined folders over a period of 3.5 years. Shetty and Adibi (2004) of University of Southern California created a MySQL database of this corpus. They also cleaned the database by removing a large number of duplicate emails, computer-generated folders, junk data, invalid email addresses and blank messages. The resulting dataset contains 252,759 messages from 20,294 distinctive users. The basic statistics of this dataset is given in Table I. We use this database to perform our empirical investigations. In the area of organizational science and social networking

Item	Count
Total email communications (year)	
2000	65,995
2001	1,54,616
2002	29,278
No. of emails sent	
By Enron staff	2,00,057
By others	55,578
No. of emails received	
By Enron staff	13,79,506
By others	2,67,718
Average emails sent per user	12.6
Average emails received per user	7,353.6

Table I. Statistics of research dataset (i.e. Enron email corpus)

research, the Enron corpus is of great value because it allows the academic to conduct research on a real-life organization over a number of years.

3.2 Data cleaning

Because the process of creating the MySQL database for the Enron e-mail corpus has been well documented by Shetty and Adibi (2004), we decided to use this dataset. In retrieving data, we imposed the following thresholds on the data:

- First, we only considered 151 Enron employees who sent emails during the year 2001. Even though we had the data of prior to and after the year 2001, we considered the year 2001 only, as the organizational crisis was at its peak during this period, which resulted in the bankruptcy declaration during the first week of December 2001.
- To be considered as a link, we applied a threshold of six or more emails that had to have taken place between two actors over a period of one month. If actor *A* sent six emails to actor *B*, then there would be a link from actor *A* to *B*. We excluded self-addressed emails from our dataset. We also deleted many emails that seemed to contain invalid email addresses such as addresses like "noaddress@enron.com" and system-generated emails.
- Third, for calculating the transitivity of the network, we considered emails sent during each week of year 2001. We use UCINET software (Borgatti *et al.*, 2002) to draw the network diagram and to calculate various measures of this study.

3.3 Measuring transitivity, hierarchy and reciprocity

Transitivity is the total number of transitive triples divided by the number of potential transitive triples. There are a number of different ways in which we could try to norm this count so that it becomes more meaningful. One approach is to divide the number of transitive triads by the total number of triads of all kinds. Another approach is to norm the number of transitive triads by the number of cases where a single link could complete the triad. That is, norm the number of (AB, BC and AC) triads by the number of (AB, BC and ANYTHING) triads (Hanneman and Riddle, 2005). In this study, we have

used the first approach for measuring a transitivity score (i.e. norm the number of transitive triads by the total number of triads of all kinds).

For measuring the *hierarchy* of communication network, we apply the notion of *degree of hierarchy* developed by Krackhardt (1994). A *degree of hierarchy* measure indicates the extent to which relations among individuals in communication networks are *ordered* or *hierarchical*. Krackhardt (1994) defined this measure by the following equation:

$$\text{Degree of Hierarchy} = 1 - \left[\frac{V}{Max(V)}\right] \quad (1)$$

Where, V is the number of *unordered* or *reciprocated* links in the network (i.e. A is linked to B and B is also linked to A) and $Max\ (V)$ is the number of *unordered* pairs of nodes (i.e. A is linked to B or B is also linked to A).

A network that is completely hierarchical will have no *reciprocated* or *symmetrical* link. *Degree of hierarchy* for a completely hierarchical network will be 1, whereas it will be 0 for a completely non-hierarchical network. The extent of the presence or absence of cyclic relation in a network also represents the hierarchical status of that network. A cycle is closed relations among at least three nodes in a network that starts and ends at the same node. This means cycles may represent reciprocated links among nodes in a network. Therefore, like *degree of hierarchy*, for a completely hierarchical network, there will be no cycle, and the frequency of cycle will increase when the network becomes less hierarchical.

A tie between two actors A and B is *reciprocated* if there is a tie from A to B and there is also a tie from B to A. *Reciprocity* is defined as the extent to which ties between two participating actors are symmetric (Monge and Contractor, 2003). In other words, reciprocity indicates "how strong the tendency is for one actor to "choose" another, if the second actor chooses the first" (Wasserman and Faust, 2003, p. 507). We used UCINET (Borgatti *et al.*, 2002) to measure reciprocity of a network. Dyad-based reciprocity is used for our research analysis. It simply represents the number of reciprocated dyads divided by the number of adjacent dyads.

4. Findings of this study

Findings of this study are discussed in this section.

4.1 Transitivity (P1)

Figure 1 plots a graph of the transitivity score of the network during the period of January-December, 2001. This graph does not show a consistent pattern of transitivity scores throughout the year 2001. However, if we look at some of the significant events that generated crises within the organization, we observe some similarities in patterns. One of the chief executive officers (CEOs) of Enron resigned on 15 August 2001 (Week 33), leading to some sort of crises. If we look at transitivity scores during that period, we see that there is a sharp decrease in transitivity on the Week 34, immediately after the resignation of the CEO (in Week 33). However, transitivity increased significantly in Week 35 again. Another example of decreased transitivity scores is related to the final crisis period which eventually leads to the disintegration of the organization. During Week 48 (early December, 2001), Enron declared bankruptcy. In the following week (i.e. Week 49), transitivity scores decreased significantly. Although, the score increased

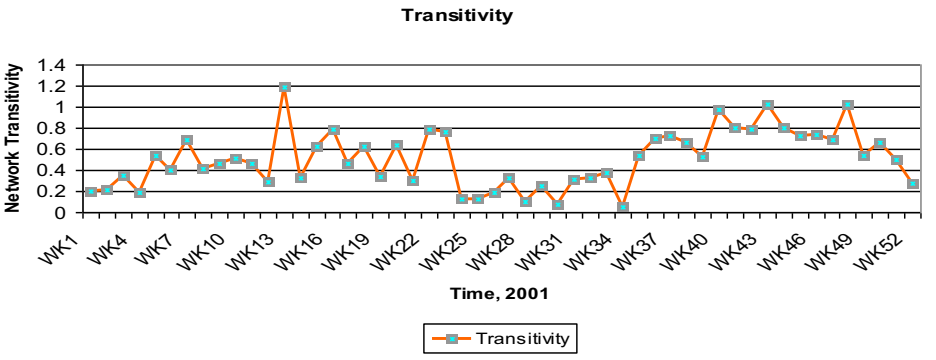

Figure 1. Transitivity scores for different weeks of the year 2001

slightly during the Week 50, it decreased again in subsequent weeks. So, there seems to be a consistent pattern of decreased transitivity during the organizational crisis period. However, it is not possible to make any definitive conclusion. As an example, if we look at the transitivity score of Week 42, during which period Enron announced (for the first time) a net loss of $618 million and people became aware of accounting irregularities practised within Enron. Immediately after this crisis broke out, in Week 43, transitivity score, actually, increased prompting us not to have any definitive conclusion about the correlation of crisis and transitivity scores.

As our research dataset spans over a period of one year, there could be the effect of seasonality on our measured transitivity scores. A seasonal effect is a systematic and calendar-related effect. To get rid of the seasonal effect, we also conducted a time series analysis of transitivity scores for the year 2001. The result, which is depicted in Figure 2, shows a slow increasing pattern of transitive scores as Enron went through its crisis period.

4.2 Hierarchy (P2)

We first measured *degree of hierarchy* values for each week of the year 2001. As illustrated in Figure 3, we can see that there is a decrease in the *degree of hierarchy*

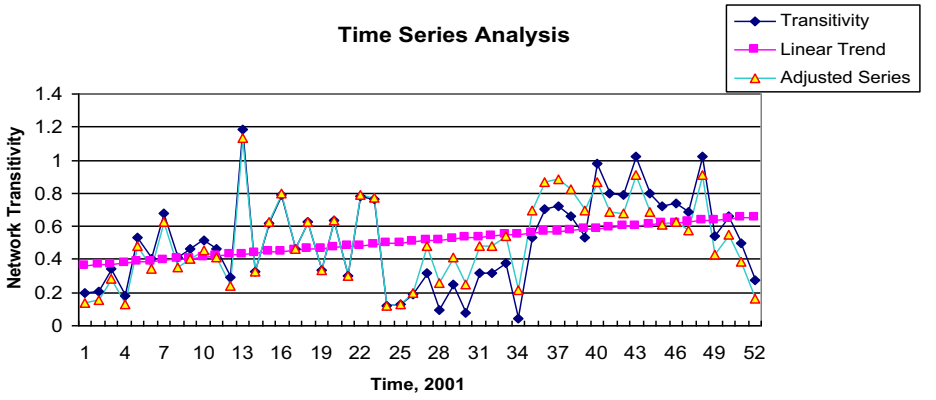

Figure 2. Time series analysis (January 2001-December 2001) for transitivity scores of Figure 1

values as the organization moved towards the peak crisis period. Although this trend is not monotonic the decrease of *degree of hierarchy values*, which starts in Week 37, is significant. It is important to note that this was the time during which Enron was in complete turmoil. After some time, during mid-October, the company revealed that it lost $618 Million dollars in the third-quarter earnings, which eventually led to the bankruptcy declaration on 2 December 2001. The observed pattern of decreasing trend of *degree of hierarchy* values supports our second proposition even though we cannot make any causal claims.

We then observed the frequency of cyclic relations for the year 2001. As plotted in Figure 4, we can see that there is a sharp increase of cyclic relations in our email communication dataset during the organizational crisis period. This further supports our second research proposition.

4.3 Reciprocity (P3)

Figure 5 illustrates weekly reciprocity scores of the network throughout the year 2001. Reciprocity suddenly decreased from Week 33 to Week 34. Enron's CEO resigned on Week 33, which has resulted in crisis across the organization. It seems that reciprocity decreased in the following week (i.e. Week 34). However, it increased again in Week 35 and kept increasing until Week 39, and remained relatively steady during next few weeks. Reciprocity suddenly decreased in Week 49, followed by the bankruptcy declaration in Week 48. But, it increased again on the Week 50 before decreasing for the rest of the year. Overall, increasing reciprocity during the crisis is generally consistent

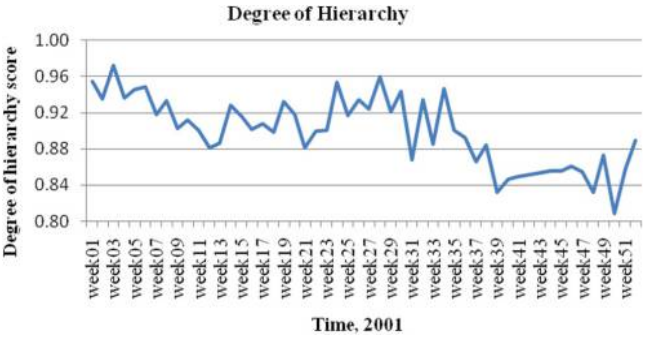

Figure 3.
Degree of Hierarchy scores for the year 2001

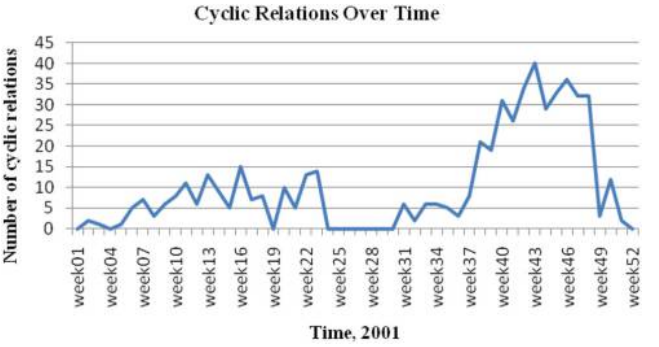

Figure 4.
Frequency of cyclic relations during the year 2001

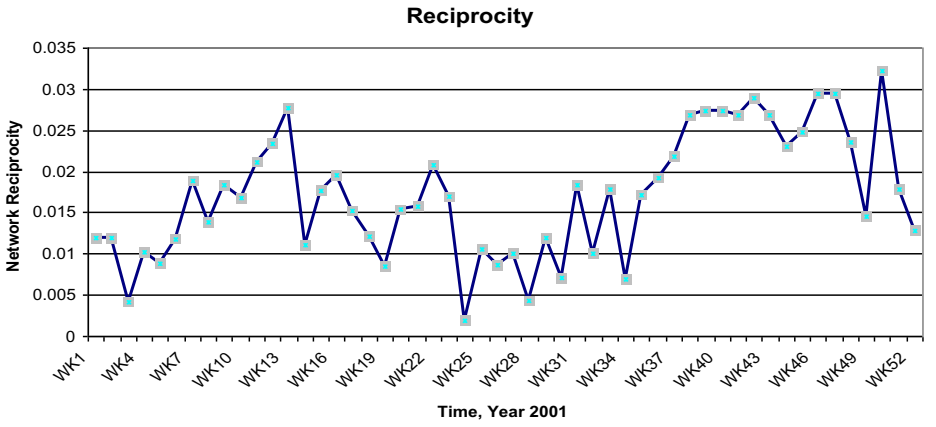

Figure 5.
Reciprocity scores for different weeks of the year 2001

with our third proposition. We also plot the graph of the number of dyads found in Enron's email network throughout the year 2001. We can clearly see from the Figure 6 that number of dyads increased during the peak crisis period.

5. Discussion

In this section, we discuss implications of the result obtained from our research analysis in relation to transitivity, hierarchy and reciprocity during organizational crisis.

5.1 Transitivity and organizational crisis

We noticed that during crisis organizational communication network becomes more transitive. Tutzauer (1985) posited that transitivity exerted the most profound influence and was totally deleterious in terms of the network's cohesion. He argued that it might initially seem that transitivity will decrease system dissolution because one way to achieving transitivity is by adding links to the existing network (transitive closure). But more subtle situations can also result due to transitivity. Even though links may (or may not) be added, transitivity implies a roping-off of groups. It tends to eliminate bridges and liaisons, creating completely isolated factions and totally stratifies the network.

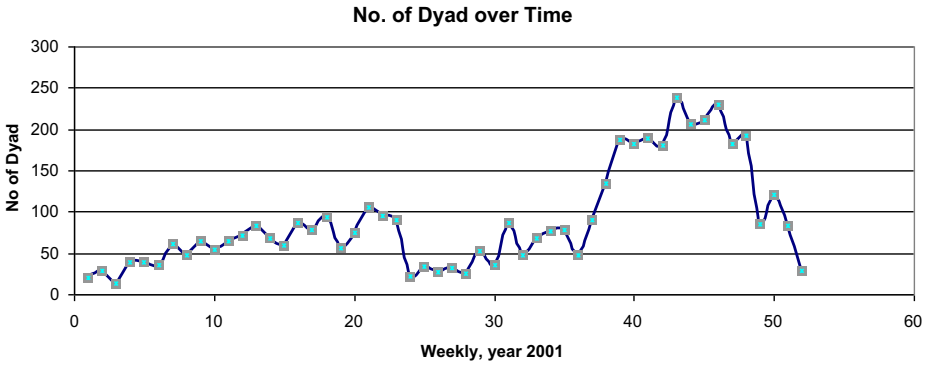

Figure 6.
Number of dyads during the year 2001

Transitivity creates two or more completely separated but highly cohesive social subgroups. He also suggested that in the advanced stages of crisis, communications among group members increases within subgroups but decreases between subgroups.

The most interesting phenomenon we observe in relation to transitivity is that, overall, the transitivity score of the network is quite low. This relatively lower transitivity of the Enron email communication network may be attributed to the fact that the organization went through a period of unethical business practices exercised by some of its senior management employees (the dataset we studied encompasses many of the senior management staff including CEO, chief financial officers, various vice presidents and directors). Brass *et al.* (1998) argued that the need for balance among three people can influence the likelihood of unethical behaviour. According to the Balance Theory, when two strong ties exist in a triad, the possibility of a third strong tie is much greater than when two strong ties do not exist. When all three parties are connected by strong ties, it is referred to as Simmelian triad (Krackhardt, 1992). Brass *et al.* (1998) provided two examples, where there are three strong ties of the Simmelian triad, and the two weak ties and a missing third link of a structural hole, that represents extreme but frequent interaction patterns within a communication network. According to Granovetter (1973), various other combinations of strong and weak ties are less frequent. Brass *et al.* (1998) suggested that as the overall strength of the triad increases (from weak-tie structural hole to strong-tie Simmelian triad) the likelihood of unethical behaviour will decrease. This is due to the fact that there is a potential loss of "reputation" and relationship within the triad if it is affected by unethical behaviour. One of the main reasons of Enron's spectacular demise was due to a number of senior managers' unethical conduct in relation to its accounting practices.

5.2 Hierarchy and organizational crisis

Organizational communication networks become less hierarchical during crisis. Authoritarian leadership is likely to be encouraged during crisis period at a functional level of hierarchy (Weick, 2000). Stronger hierarchy emerges among people who serve as leadership and policy-making roles during crisis. Communication exchanges among these people change and become more formalized and top–down. On the other hand, those people who are not playing any leadership role during crisis are left alone in organization decision-making. These non-influential people, who are much larger in numbers than the leader group, create small sub-groups in communication networks to mitigate their anxiety and to allow self-evaluation comparison with others (Stein, 1976). All these people, both leaders and non-influential individuals, use communication networks to communicate with others. Eventually, communication networks split into small sub-groups (Figure 7), overall communications networks become less hierarchical, and it becomes difficult to locate hierarchical communication maintained by very few leaders.

5.3 Reciprocity and organizational crisis

The increasing patterns of network reciprocity during organizational crisis are consistent with extant theory and the third proposition. However, we also observe overall low reciprocity scores throughout the crisis period.

Settoon *et al.* (1996) noted that the concepts of reciprocity and Social Exchange Theory have been used to explain why individuals express loyalty to the organization

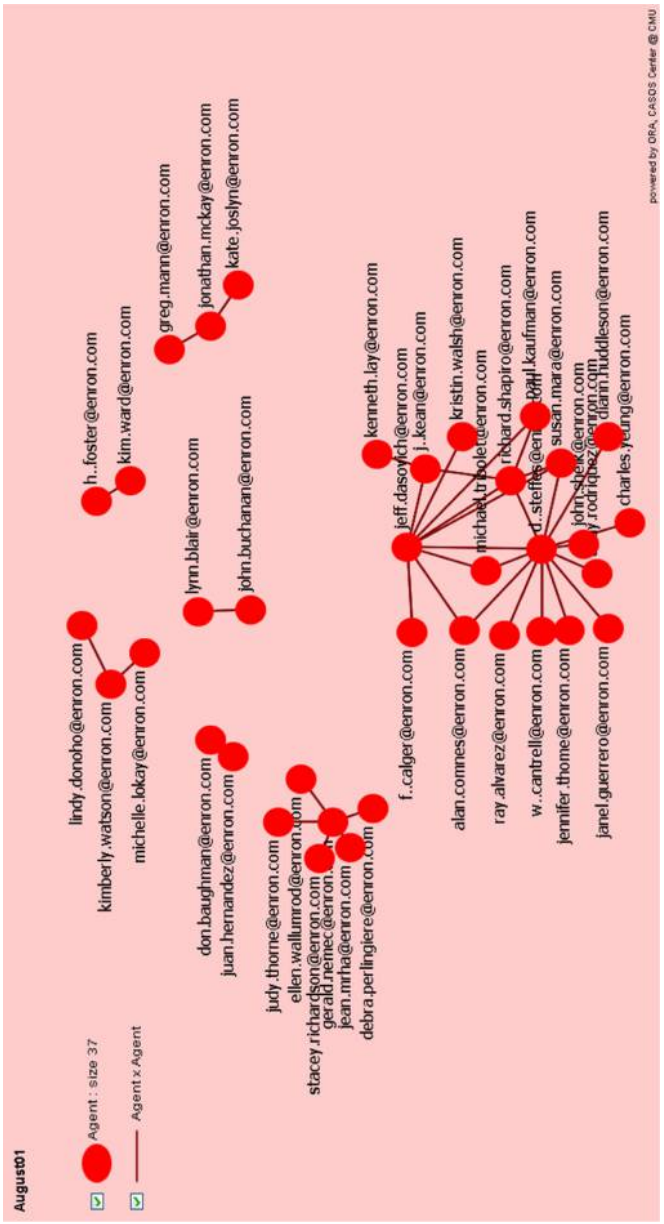

Figure 7.
Visualization of communication network for August 2001

and demonstrate behaviour that typically is neither formally rewarded nor contractually enforceable.

Leng (1993) argued that increasing reciprocity during crisis may lead to two opposing types of behaviour: either more conflictive or more cooperative. He further noted that two parties who are involved in crisis may exhibit an upward trend of rising hostility. Even though this trend can be described as reciprocal in type, it might not be in magnitude. One party might exhibit a higher level of hostility over the entire period of crisis compared to the other. From the structural analysis of Enron email dataset, we do not really know what type of reciprocity employees were experiencing during the period of their phenomenal level of crisis, especially towards the end of year 2001. Although network reciprocity went up during the crisis period, it is possible that there was an element of conflictive behaviour as mentioned by Leng (1993). This interpersonal conflict between reciprocal dyads may have resulted in the further disintegration of Enron's communication network.

Gouldner (1960) discussed the norm of reciprocity and its contribution to the stability of the social systems. He argued that:

> […] sometimes there may be occasions when questions, as to whether the individuals return is appropriate or sufficient (apart from whether it is equivalent), that arise by virtue of the absence of common yardsticks in terms of which giving and returning may be compared (Gouldner, 1960).

He further argued that the norm of reciprocity may lead individuals to establish contacts with only those who are able to reciprocate. This will ultimately lead to neglecting relationships of those who are unable to do so. This highly individualized nature of interpersonal behaviour could well be the reason of very low reciprocity score within Enron employees.

6. Conclusion

We found weak support for the proposition that transitivity will increase as the organization is going through crisis. This anomalous result could be an artefact of the particular nature of the crisis that was unfolded at Enron. From a theoretical standpoint, this suggests that this proposition needs to be reconsidered by taking into account specific contingencies associated with the crisis. The results of our study of the Enron crisis using the email communication corpus clearly point to less hierarchical communication in response to the enveloping crisis during the final months of 2001. This finding further reinforces a tendency that has been predicted based on theory and empirically observed in previous research. We finally notice that organizational communication networks become less hierarchical and increasingly reciprocal during the crisis period.

There has been strong evidence that, recently, many sociologists, organizational researchers and social scientists are using network analysis tools and techniques to increase their understandings of various organizational phenomena. This study also highlights the importance of studying (or exploring) organizational communication network structure during acute crisis period. As organizations are complex and cooperative systems, the network structure that exists within it may either hinder or facilitate cooperation during crisis period. Managers should pay more attention in developing and nurturing informal subunits that concentrates on exchanging communications between subunits, in opposition to within subunits, during crisis

period. Managers can also take targeted actions to encourage and promote connectivity. So, an effective communication structure should be designed consciously. On the other side, managers can get an overview about how regular functionalities of their organizations are going by analyzing the informal underlying communication networks among staff.

This research was conducted using email communication data from a single organization. Hence, any claim of generalizability is problematic. Field studies involving data from more organizations are needed before we can arrive at more definitive conclusions. Further research should compare actual face-to-face communications, telephone communications, letters and memoranda along with electronic mail.

The methodological contribution of this study is worthy of note. This study builds on an emerging stream of research area that applies social network analysis to organizational interaction data to study various questions related to organizational change and disintegration. With increasing popularity of email as an interaction medium and increased popularity of social network analysis methods and tools, it is expected that we will be able to develop a deeper understanding of the various social and organizational phenomena, specially, interaction and communication patterns (both formal and informal) that are widely observed within contemporary organizations.

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