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Network Structural Equivalence and Public Sectors' Organizational level of Influence in Information Sharing Network: A Social Network Methodology

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Abstract*: Structural equivalence has been a fascinating topic for industry and academia due to its connection with network embeddedness. This study investigates the network assumption that structural equivalence is a major determinant of influence derives largely from the frequent finding that organizations that are embedded with influential connections are at an increased likelihood of becoming influential themselves. It is suggested that the strong and consistent structural equivalence position is at least partially responsible for factors of reputational influence among directors of government agencies. The contribution of this study continues to enrich the literature of the network and provide the solution for the industry since earlier research is neglecting the impact of relations upon the level of influence. Using exploratory social network methodology and statistical evaluation of Exponential Random Graph Modeling, this research found that, directors of government agencies may gain greater influence via its structural equivalence position in an informal network. It is also, argued that social network methodology is an appropriate method for researching influence development use in the context of networked organizations. The contribution of this study to industry and theory are discussed.

***Keywords*: Network management, Organizational behavior, Social network methodology**

I. INTRODUCTION

A. BACKGROUND

In an inter-organizational network structure, the formal authority has relatively little role in determining the selection of actions [1]. In a network underpinned by multiple decision points, most actions and changes are driven by the nuance of influence [2]. The reputation for great influence is a valuable commodity in a network of diverse network members [3]. Because of its value, network and organizational behavior scholars have long sought to capture the essence behind the development of influence among network members and its impacts on network members' performance. One of the particular concerns of managers relates to the understanding of the distribution of influence in inter-organizational network structure. Because network members, embedded in a network, have neither formal power nor formal authority, they rely largely on their level of influence for their goal attainments [4]. As a result, the sharing of information about which network members are more influential often took place. Studies by social network scholars have insisted on the emergence of the more influential network members as a result of information sharing consensus [4, 5]. As a result of the seminal findings, scholars have attempted to model the influential level of network members as a single quantity [6]. According to this school of thought, the degree of influence that a network member may possess would depend on the stability of the network members as well as its position in the network structure.

In a network structure, it is common to find network members who are well known as influential (or at the core), and those who are considered to be irrelevant (or on the periphery), the voluntary nature of the network participation contributed to the influence score. However, it was found that the reputation for influence in a government agencies network is diverse and fragmented throughout the different levels of network structure i.e. bureaucracy [7, 8]. One important explanation for the phenomenon is that participation in the government agencies' network is not voluntary. It is driven by the nature of duties and formal obligations. Duties and formal obligation may create the formal network structure that relies on formal power to execute instructions and tasks. However, network scholars have also found that formality in-network creates informal sub-network structure unbeknownst to the core network member. Scholars have also determined that the informal structure relies more on influence rather than formal power. What this entails is that a network member of a government agency network may be considered to be influential in one sub-network structure, and a weaker level of influence in the formal structure because of the effects of the formality. Is it possible to consider this variation in the network structure? Can the variation of network members' influence degree be assessed?

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In this research, we argue that the embeddedness of government agencies (from here forth is termed as network members) in specific sub-network structure i.e. structural equivalence structure is an important explanation for the differences in the level of influence.

On top of the formal network structure, network members evaluate and involve in selections of actions through their relations and communication for information sharing activities [9]. As network members are involving or embedded in information sharing activities, its multiple roles and the resulting performance will be visible and shared with the other members of the network [10]. Evaluation and judgment of the network member's performance are shared among the network members resulting in the heighten network members' reputation in the network structure [11]. As a result, evaluating the different ways that a network member may be connected or disconnected in a network structure may help to account for how network members evaluate and observe other network member's degree of influence.

This research is based on a network interview with directors of government agencies in the maritime industry in Malaysia. These research models the influence in the network structure as a function of structural equivalence structure using the Social Network method. The findings of this research state that a high level of influence in a network and sub-networks would depend on the pattern of structural equivalence embeddedness of the organizations in the network and sub-network structures. This research concludes by explaining the impact of the research findings upon the industry and by suggesting future research direction on network embeddedness and network dynamics.

II. LITERATURE

B. The NATURE of Network Embeddedness

Reputation as influential frequently converts into the economic payoff. Understanding which organization that is deemed as more influential than the others may increase direct access to economic resources or adjust themselves to organizations that give the resources. In an attempt to remove uncertainty concerning influence, network members continually share and seek information about who is influential [12]. Within a network structure, the network members seek inputs to determine which member of the network those exert influence over others in network decision making. Much of this seeking and sharing activities occur in a network as well as the sub-network setting. From these seeking and sharing activities, reputation for influence will emerge. Other network members will use the shared reputation information as guides in making the decision about which network member in more influential.

Because the reputation for influence spread in network structural voluntarily in network structure, some network members embedded in a network become already known as being more powerful than others. For example, the Green Peace, EcoKnights and Grameen Bank are widely known to be influential sustainability proponents even by other organizations or individuals who are not a close observer of sustainability. Nevertheless, there are network members of a network structure who build their influence in a much informal, smaller and close-knit of a network of relations. In a social network setting, the continuum of influence development from one end of close-knit relations to another of a universally known reputation is a commonly observed outcome of network embeddedness. Hence, is it fair to make claims that one network member is truly influential because it portrays possession of a high level of power while another network member is not because its degree of reputation for influence is not visible? The main concern is that, at times, power can be a misleading judgment of network embeddedness or involvement. This is because, a powerful network member in a formal network structure can be easily identified influential vis its coreness, but the true influential network members may be undetected as there are embedded in the informal sub-network. Thus, at a minimum, there is loose connectivity between what is reputed as influential and the actual influence. As long as the loose connectivity persists, network members of the network will continue to make an inconclusive judgment about influence, based on the noise of reputation. This gap between the reputation for influence and actual influence of the embedded network members presents itself as a worthy subject of research.

C. A Theory of Structural Equivalence

In order to determine the impact of network embeddedness in shaping network member level of influence, it is also important to account for an alternative reason for how network members foresee influence. In this article, we argue that an important alternative explanation is network structural equivalence. In theory, structural equivalence is a network position when two actors are said to be actually fundamentally comparable in the event that they have similar connections to every other actor. Structural equivalence is anything but difficult to get a handle on (however it tends to be operationalized in various ways) since it is quite certain: two actors must be actually substitutable so as to be basically equal.

Actors that are structurally equivalent are in indistinguishable "positions" in the structure of the graph. Whatever changes and limitations work on one individual from a class are likewise present for the others. The actors in a structural equivalence class are, as it were, a similar position with respect to every other actor.

The principle debate of this research is that network members embedded in-network, values structural equivalence in a network as a key tool to remove the uncertainty of influence. Two premises form the basis of this debate. First, network members use structural equivalence as guides to remove uncertainty in its decision making of which network member is more influential. This is because structural equivalence members are more likely to pay attention to information obtained from the similarly connected network members rather than the disconnected ones. Thus network members are more likely to think of their structural equivalence network members (directly and indirectly connected network members) as influential as that the isolates (disconnected network members).

In the network, in the event that a network member receives numerous ties, they are regularly said to be prominent.

That is, numerous network members try to make connections to them, and this may demonstrate their level of importance.

Network members who have uncommonly high structural equivalence can trade with numerous others, or make numerous others mindful of their perspectives. Network members who show high structural equivalence are frequently said to be highly influential.

Thus, this research will test the hypothesis that as network members become connected in structural equivalence structure with the network core members within the network structure, its other network members would perceive the network member as influential. Thus the likelihood that the network members' reputation influence increases as the strength of the structural equivalence ties with the core network members in the network relation increases.

III. RESEARCH METHOD

The focus of this research is situated on structural equivalence embeddedness in a network structure. The standard statistical method is not adroit at estimating relations. This is since typical measurable examination repudiates the presence of connections between organizations in a network through its supposition of autonomy of perception. Be that as it may, the network methodology, all the more explicitly the Social Network method, centers around the relations between organizations, as well as the relations and the ramifications of the connections. Thusly, in this examination, the researcher embraces the SNA methodology for network information accumulations, research, and presentation of the discoveries. In-network research, all the network members who are situated inside the naturally-occurring boundaries are incorporated for examination. Therefore network studies don't utilize samples as in the conventional sense; rather, it tries to incorporate all the network members in some populace or populaces.

Aligning with the objectives of this research, the design and methodology are based on the theoretical and analytical framework of the network method. The network framework is applied to capture how the network structure of relationships is influenced by the dynamic of network embeddedness.

To test the effects of the organizations' embeddedness variables i.e. structural equivalence impact on influence in the information-sharing network, two methods were applied. First, the researcher used the visual evaluation of the connectivity to explain the pattern of connection. The visual evaluation was performed using the SN program UCINET. Second, this research applied the statistical network modeling algorithm, Exponential Random Graph Modeling (ERGM).

In ERGM, networks, even a small one, the number of possible configurations of ties is rather large. For example, a network with only n=20 actors will require a configuration model involving up to n (n–1) or 380 possible ties. Because of these large possible configurations, the probability distribution of the network structural elements must be estimated. The estimation is done using the Markov Chain Monte Carlo Maximum Likelihood Estimate (MCMCMLE) method to sample the distribution of the structural features of interest among the networks having the same number of nodes as the observed network.

In general, the exponential random graph models (ERGM) have the following form:

$$P_r (Y=y) = (1/(k) \exp (\sum nA (g) A(y))) \quad (1)$$

Where:

(i) The summation is over all configurations A;

(ii) ηA is the parameter corresponding to the configuration A (and is nonzero only if all pairs of variables in A are assumed to be conditionally dependent)

(iii) gA(y) is the network statistic corresponding to configuration A; gA(y) = 1 if the configuration is observed in the network y, and is 0 otherwise

All ERGM models are of the form of equation (1), which describes a general probability distribution of graphs on n nodes. The probability of observing any particular graph y in this distribution is given by the equation, and this probability is dependent both on the statistics gA(y) in the network y and on the various non-zero parameters ηA for all configurations A in the model. Configurations might include reciprocated ties, transitive triads and so on, so the model enables us to examine a variety of possible structural regularities (Handcock et al. 2004). The probability of observing the graph is dependent on the presence of various structural characteristics introduced in the model. It is worth stressing that a model for the network y, consists of n(n–1) possible network ties. In this research, it would involve 37 nodes implying 37 x 36 = 1332 observations on the presence or absence of ties.

The model specification was as follows. For all organization-level variables (i.e. organization network embeddedness) the researcher included node-attribute effects of the Sum of Continuous Attributes as well as the Difference of Continuous Attributes effects (positive and significant Sum of Continuous Attributes denotes that organizations that have high embeddedness are likely to forge ties with other organizations while positive and significant Difference of Continuous Attribute parameters indicate that organizations that have differences in their embeddedness are likely to forge ties together). Therefore separate effects for the Sum of Continuous Attributes and the Difference of Continuous Attributes were each included for organization network embeddedness degree centrality (FNEDC) which is the continuous variables.

This research analyzed the network data using the Exponential Random Graph Modeling (ERGM) via the statistical program, PNet.

IV. RESULTS AND DISCUSSION

To make assess the importance of power (coreness) versus influence (structural equivalence) in government agencies network,

the researcher first developed the formal network structure of the MMEA network. Using the network program i.e. UCINET and the spring embedding algorithm, the following results were found regarding structural equivalence and influence in network structure.

Figure 1 shows the detail structural equivalence structure of the influence network. In the context of the information-sharing ties, this research found that two main network members which are the APMMHQ-1 and the MTUKCHG-30 are connected to all other network members based on information sharing ties. Both APMMHQ-1 and MTUKCHG-30 is a tie to 10 other clusters in the influence network via at least one cluster member of the information sharing tie. Both APMMHQ-1 and MTUKCHG-30 are structurally equivalence. It is important to note that APMMHQ-1 is the core organization in the formal network structure while MTUKCHG-30 is rather a periphery in nature.

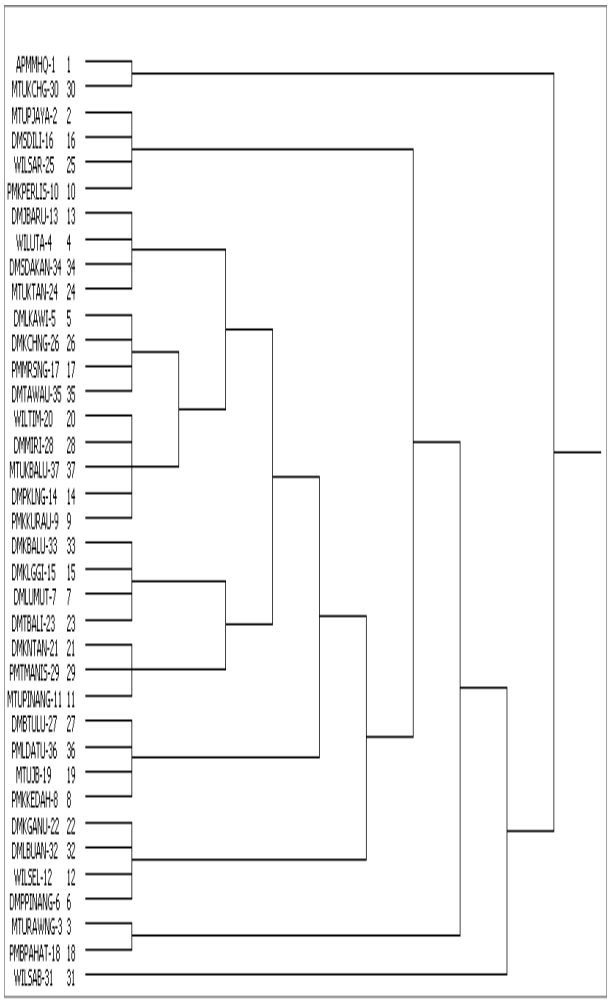

Fig.1. Cluster diagram of Influence Network in Information Sharing Ties

The following section discusses the results of the ERGM. In this research, the researcher controlled for the influence of network attributes. Instead, the specific hypothesis developed, involving the social interactions and structural parameters of the actors (i.e. actor-attributes effects model), are the focus of this research. As mentioned in the earlier section, two types of attribute effects were considered in this research. First, the Sum of Continuous Attribute Effects indicates whether an actor of the network with high levels of certain characteristics is more likely to receive ties. Second, a Difference of Continuous Attribute Effects refers to the propensity of ties between actors when there is a different level of characteristics score. Importantly, the researcher used the actor-attribute effects parameters to explore the local-level theoretical assertion made for trust relations. If a parameter estimate representing particular network configurations is significant (a parameter estimate that is more than twice its standard error can be considered significant) and positive, this is evidence that the configuration is more prevalent in the network than would be expected by chance (given the other effects in the model). In other words, a significant and positive parameter estimate is evidence for an underlying social process (Lusher & Robins, 2010). All models achieved convergence, indicating stable parameter estimates.

In Table 1, the first attribute parameter shows the results for embeddedness measure based on degree centrality in contract ties.

Table - I: Embeddedness Measured Based on Structural Equivalence Parameter

Organizations Network Embeddedness	*Trust Network*
Sum of Continuous Attribute FNESE	0.071(0.026)*
Difference of Continuous Attribute FNESE	0.028(0.014)*

Parameter estimates (MLE), Standard Error (SE) in parentheses

(Asterisk indicates effects where the absolute value of estimates exceed twice the standard error)

The Sum of Continuous Attributes, Firms Network Embeddedness Structural Equivalence (FNESE), is significant and positive (MLE = 0.07, SE = 0.026). This shows that organizations that have a high embeddedness level score (measured based on structural equivalence score) in information sharing ties receive more ties from the organizations in the network structure. Because the embeddedness score is related to the number of connections that an organization has in the network, we could also relate this parameter to the location of these organizations in the network structure. Structurally, we would find these organizations to be located in the center of the network, as these are the nodes that have the most connections or ties to other nodes in the informal network.

The Difference of Continuous Attributes, FNEDC, in information sharing ties is significant and positive (MLE = 0.028, SE = 0.014) indicating that there is a strong tendency for organizations in the observed network to forge ties or trust other network members when their embeddedness difference is small.

What can be taken from the findings of the ERGM outcome is that, the structural equivalence level of organizations in the information-sharing network influences the propensity for influence ties to be forged between the embedded organizations. Taken together, organizations tend to forge ties with others that are highly embedded based on structural equivalence in information sharing ties.

Thus, organizations with a high level of embeddedness measure based on their structural equivalence positions appear more influential to other network members. Thus, the ERGM showed that the relationship between embeddedness based on structural equivalence is related to influence.

The principle debate of this research is that network members embedded in structural equivalence positions obtain overlapping connections that provide visibility to other network members' actions which impact the influence reputation of the network member. Such potential is not visible in the government agencies' network due to the existence of the formality governing the efficiency of the network.

Consequently, these findings mean the existence of low-key yet highly influential network members in the network structure. This is because, even though the formal network and informal sub-network are different, it is essentially an overlapping network structure that creates different characteristics of organizations when attending to the matter of the network. Different characteristics of evaluation in the network and sub-network resulted in a different classification of network members. This is indicated by the different scores of the cluster of structural equivalence of network members. Consequently, if an organization is evaluated as being low in the influential level in a network structure, one cannot claim the same evaluation result in other sub-network structure

Thus the managerial contribution of this research lies in the good management of government agencies network relationships. What this means is that combining the results of the network statistical results and network structural measures, it indicates that different network structure creates different powerful and influential network members. What this also means is that, in any one network relation, a heterogeneous network structure exists which consists of both formal and informal form. It begins with the formal structure which eventually creates its own sub-network of informal relations.

In conclusion, while addressing the research question of this research, the researcher found that, in inter-organizational network relations, the organization level of influence is dependent upon the type of network relations that it is embedded or involved in. Moreover, the network results indicate that the level of influence matters differently in the formal and informal network's structure.

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