



A Report from the University of Vermont Transportation Research Center

# Impact of Information Network Structure on Inter- organizational Partnership Collaboration: A Hierarchical Perspective

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# **Impact of Information Network Structure on Interorganizational Partnership Collaboration: A Hierarchical Perspective**

## **UVM Transportation Research Center**

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## 1. Introduction

Transportation is one of the leading contributors to greenhouse gas emissions, ground based air pollution and pollution in waters and streams.<sup>1</sup> Researchers have also linked the human health issues of obesity and lung disease with automobile use.<sup>2</sup> The solutions to these problems often fall under the umbrella of “sustainable” transportation-- sustainable being defined in the broad sense as meeting the needs of the present without compromising the needs of future generations.<sup>3</sup> Yet, organizations that attempt to address the issue of sustainable transportation face a range of challenges including limited funding and resources.<sup>4</sup> Network and collaborations can increase community and organizational capacity to address social needs.<sup>5</sup>

Previous research has documented the importance of perceived influence as a measure of organizational success in a number of studies.<sup>6</sup> The perceived influence score reflects an organization's ability to pursue its mission because of the ability that influence provides in accessing resources, developing partnerships and building a reputation that the organization can succeed and meet its goals. Due to the significance of perceived influence for an organization, it is important to understand the factors that help predict its perceived influence. Among the many factors that may contribute to an organizations influence is its network position.<sup>7</sup>

While researchers have studied how attributes of network position may relate to an organization's level of success,<sup>8</sup> empirical testing of this relationship at the organizational level is less robust. At the same time, there is limited empirical work that explicitly examines resource dependence theory and its central tenets<sup>9</sup> in the context of an organization's perceived influence. The hierarchical relationship between network structure and alliance formation is an area that has not yet been fully investigated in the literature.

In this report we present findings from the study of the communications patterns of 121 organizations in Maine, Vermont and New Hampshire promoting sustainable transportation. We build on previous research,<sup>10</sup> focusing here on the how the inter-organizational partnerships are formed. In this report we develop a hierarchical path by which social network characteristics impact the formation of partnership through the mediations of perceived influence and service (function) generalism. The latter two represent the factors that mediate the likelihood that network factors lead to partnership opportunities. In this report we examine how network characteristics serve as predictors of perceived influence within the context of sustainable transportation policy networks.

This research suggests that organizations with perceived influence and functional diversity, as a result of their strategic network positions can acquire legitimacy or competence through partnerships and changes in their network position. Strategic network positions within an information network produces two opportunity factors for the focal organizations – perceived influence and function generalism, which facilitate those organizations to form partners with others and increase their capacity.

This report is organized into the following sections. First, we will review previous literature on resource dependency theory and social network related to interorganizational collaboration. This section ends with a set of hypotheses about the hierarchical impacts of social network characteristics on interorganizational partnerships. The next section introduces the methodology of this study, followed by a results section and a discussion of limitations and implications of this study.

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## 2. Background & Methods

### Resource Dependency and Interorganizational Collaboration

According to resource dependence theory, organizations will be more powerful than others because the former controls resources needed by others and can reduce their dependencies on others for resources.<sup>11</sup> The fates of organizations depend upon their access to resources and their dependency relationships with external agencies. The theory stresses the impact of external forces on how organizations operate. Acquiring and maintaining adequate resources requires an organization to interact with other groups that control critical resources.<sup>12</sup> To get access to the resources, organizations must enter into transactions and relations with other organizations that can supply the required resources and services. Resources can include industry-specific knowledge (trade information), capital equipment and funding.<sup>13</sup> A communication network is needed for organizations to gain access to the resource of industry-specific knowledge.

Organizations are resource-sharing entities embedded in complex network relations. Organizations form linkages with each other to obtain access to needed assets. Collaborative strategy is the result of organizational efforts to manage external dependencies and uncertainties in their resource environment.<sup>14</sup> Collaboration networks benefit organizations because inter-organizational linkages provide access to partner resources. The attractiveness of an organization on the inter-organizational linkage market depends on what the organization can provide to its partners. Organizations with a history of collaboration, high technological strength, and commercial assets enjoy greater facility in obtaining partners (Valuable resources, such as information, may be inherent in the networks within which organizations are situated that, in turn, provide strategic advantage to the organizations with access to the resources.<sup>15</sup>

### Social Network and Interorganizational Collaboration

Scholars often view interorganizational partnerships or collaborations through the conceptual lens of social network theory. Interorganizational relationships should be conceptualized as networks rather than markets or hierarchies.<sup>16</sup> Organizational behavior in general, and interorganizational cooperation in particular, is affected by the context in which strategic choices are made. Conduct and performance of organizations can be more fully understood by examining the network of relationships in which they are embedded.<sup>17</sup> A network of embedded ties accumulated over time can become the basis of a rich information exchange network that enables organizations to learn about new alliance opportunities with reliable partners.<sup>18</sup> The existing social structures that surround potential partner organizations, and the history of prior ties between them can further our understanding of inter-organizational partnership formation.<sup>19</sup> Networks of existing ties between organizations can facilitate the formation of subsequent linkages by providing both information and reputation benefits to well-connected organizations. Organizations that are centrally located in an alliance network (as measured by cliques and closeness) are more likely to form new alliances. The number of inter-organizational alliances is positively related to several networking properties (propensity to network, strength of ties, and network prestige). An organization is more likely to increase the degree of formality of its collaborative activities when it has more board linkages with other nonprofit organizations). Centrality-based network capabilities and the efficiency with which organizations choose their partners, facilitate the formation of new partnerships.<sup>20</sup>

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Organizations that become well-embedded in these networks accumulate informational advantages that increase their propensity to engage in new partnerships. Embeddedness in the network positively impacts an organization's opportunities to form linkages through at least three mechanisms. First, highly embedded organizations can obtain information about linkage formation opportunities from their partners and their partner's partners. Second, the embeddedness of organizations itself serves as a signal of their reliability. Partnering with many organizations reinforces their reputation as desirable collaborators. Further, their partners can serve as sources of information about their capabilities and behavior. For other organizations, transacting with highly embedded organizations on whom information is available is less risky than transacting with organizations whose collaborative behavior is unknown. Third, the embeddedness of organizations serves as a signal of their access to other highly embedded actors.<sup>21</sup> Highly embedded organizations are resources not just in themselves but also as a means to link with other prominent actors. Thus, embeddedness by itself adds to an organization's attractiveness as a partner.

In our study, we propose that the above three mechanisms of interorganizational linkage formation work through a hierarchical process. That is, access to information (Mechanism 1) impacts perceived reliability (Mechanism 2) and access to other major network actors (Mechanism 3), which in turn affect the formation of partnerships. To reflect the proposition, we develop a set of specific hypotheses in which an organization's information network positions (akin to Mechanism 1) affect its perceived reliability and influence (akin to Mechanism 2) and function generalism (the extent of functions/roles assumed by an organization, an attribute that should signal access to more diverse and other highly embedded actors, akin to Mechanism 3), which in turn affect the amount of partnerships.

#### Effects of Network Structure on Perceived Influence

Organizations in the center of a network may not only be best suited for locating and garnering resources, but may also have the privilege of influencing the network by shaping its actions and priorities. For example, Diani's study of environmental organizations in Milan found that although central groups did not dominate the network per se, they were regarded as more influential in setting the environmental movement's agenda and were perceived as "de facto representatives" of the network from the outside.<sup>22</sup> Organizations may use a network of interorganizational relationships to gain power and access resources. Network ties were convenient conduits through which resources flow to an organization.<sup>23</sup> A network's central actors have greater access to resources which may include trade information (e.g., new practices), personnel and client referral (case management activities). Highly ranked focal organizations within the network are better able to attract skilled professionals. Networks can serve as an indicator of an organization's social status. Organizations that are more prominent in interorganizational networks are more likely to enhance their status in the community over time.<sup>24</sup> Based on the discussions above, we propose the following hypothesis:

H<sub>1</sub>: An organization's network position is positively related to its perceived influence in the network.

There are several ways of measuring an organization's network position, such as centrality measures (e.g., degree, closeness or betweenness) and structural holes.<sup>25</sup> Degree consists of the number of ties an actor has to other actors in a network. Closeness

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measures the relative proximity of an actor to all the other actors in the network. Betweenness is about the extent to which an actor serves as a bridge between other actors whose communication with each other is otherwise limited.<sup>26</sup> Structural hole represents the ability to bridge disconnections among actors in a network. Organizations that span structural holes will be able to connect with others in different market niches that typically employ staff with a variety of skills. Funding gains from affiliation are likely to be higher where partner organizations have dissimilar resources, as they are able to provide wide-ranging services to their client population. Specifically, we have the following hypotheses:

H<sub>1a</sub>: An organization's degree centrality is positively related to its perceived influence in the network.

H<sub>1b</sub>: An organization's betweenness centrality is positively related to its perceived influence in the network.

H<sub>1c</sub>: An organization's closeness centrality is positively related to its perceived influence in the network.

H<sub>1d</sub>: An organization's structural holes is positively related to its perceived influence in the network.

#### Effects of Network Centrality on Function Generalism

An organization can benefit from its central position within an information network by learning about new practices and services, and then expanding and diversifying their services based on the addition of new information resources, to better meet multiple client needs (e.g., education, research). An organization's strategic position within an information network may have important consequences for an organization with respect to the depth of services provided. It may allow an organization to expand its services based on its easier access to knowledge, and its ability to attract funds. There is an association between an organization's ability to attract funds and its service breadth.<sup>27</sup> Thus we hypothesize:

H<sub>2</sub>: An organization's network position is positively related to its service/function generalism.

H<sub>2a</sub>: An organization's degree centrality is positively related to its function generalism.

H<sub>2b</sub>: An organization's betweenness centrality is positively related to its function generalism.

H<sub>2c</sub>: An organization's closeness centrality is positively related to function generalism.

H<sub>2d</sub>: An organization's structural hole is positively related to its function generalism.



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### Effects of Perceived Influence on Partnership

Group linkage formation inherently requires that not only must an organization be desirous of forming a linkage, it should also be attractive to potential partners. An existing network can influence an organization's available set of choices of feasible partners and its attractiveness to other organizations as a partner. A central network position shapes a company's reputation as a skilled and knowledgeable partner that makes it an attractive partner for other companies in the network.<sup>28</sup> The proclivity of organizations to enter new alliances is influenced by the amount of network resources available to them.<sup>29</sup> The greater an organization's stock of resources, the greater the organization's attractiveness to partners, and the greater the organization's collaboration opportunities. A network resource can be intangible or nonmaterial like one's status or reputation (perceived influence). On the one hand, one's structural position in a network can generate status that can be used to procure resources from network partners and the broader environment. On the other hand, an organization's own status is a function of being tied to actors with high status.<sup>30</sup> For the latter, it is about achieving and maintaining institutional legitimacy (a justification and endorsement of one's strategic actions) and stability/longevity within a network,<sup>31</sup> through associating itself with other reputable, influential and legitimate organizations. An actor's association with network members of high status is reflective of the actor's image and credibility, and of the actor's easy access to resources, which both facilitate establishing inter-organizational alliances.<sup>32</sup> An organization's ability to form new relationships is determined by the set of opportunities provided by its position in the prior network structure. Organizations that strategically position themselves in between a lot of other organizations may benefit from such a central position as they are being invited to participate in future partnering activities.<sup>33</sup> A focal organization's reputation and prestige as an effective, reliable, and influential partner may be a valuable resource that other organizations can depend on, and can attract others to propose or enter partnerships. The focal organization may provide other organizations with opportunities of resource (e.g., funding) and risk sharing. There is a strong association between an organization's reputation and ability to attract funds. Reputation influenced both the initiation and nature of alliances.<sup>34</sup>As a result of the above discussion, we have the following hypothesis:

H<sub>3</sub>: An organization's perceived influence is positively related to its number of partners.

### Effects of Function Generalism on Partnership

Service (or function) generalism has been found to have a significantly positive impact on collaboration outcomes. For organizations to build alliances that effectively address their needs while minimizing the risks posed by moral hazard concerns, they must first be aware of the existence of potential partners and have an idea of their needs and requirements and, second, have information about the reliability of those partners.<sup>35</sup> An organization that houses various functions within its boundary is in such an advantageous position to survey the availability, feasibility, reliability/trustworthiness, and objectives of its potential partners, as it has an opportunity to connect with and get familiar with organizations with different roles or functions. The diversity of ties an organization has can enhance the breadth of perspectives, cognitive resources, and overall problem-solving capacity of the group. The focal organization can also have an opportunity to get indirect referrals from organizations in different function/role tracks. An organization that takes on multiple roles or functions may also develop diverse needs for resources. Thus

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from the perspective of resource dependency, a focal organization may need to form alliances with diverse partners. This invites the following hypothesis:

H<sub>4</sub>: An organization's function generalism is positively related to its number of partners.

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## 2.1 Data Collection

The study consisted of three separate surveys of sustainable transportation organizations in Maine, New Hampshire, and Vermont. The surveys covered the same questions, differing only in the names of the organizations identified in each state. These three states were chosen because of their geographical proximity, and their similarities in terms of population densities and demographics climates and transportation challenges.<sup>36</sup> The survey, designed in SurveyMonkey, was sent out by emails to all the organizations involved in sustainable transportation policy, which was defined as "being related to environmental themes, such as alternatives to private automobiles, walking, biking, public transit, passenger rail, smart-growth, funding that promotes alternatives, position on gas taxes, VMT fees, or feebates."<sup>37</sup> The organizations also had to be a nonprofit, business, or government agency, have a physical office within the state under study, and have at least one dedicated staff-person. We developed a comprehensive list of organizations meeting these criteria through Internet searches, through reviewing state organizational lists and through a snowball sampling approach,<sup>38</sup> in which we asked organizations to name other organizations that are in the network. Each state-wide chamber of commerce and each state's chamber of commerce associated with its largest city were also included. Even though the chambers of commerce are not usually strong proponents of sustainable transportation policy, they were included in order to account for the general interests of private industry, because few businesses met the criteria to be included. Some organizations were eliminated because they had recently become obsolete or became obsolete during the study period of August 2010 to November 2010.

All organizations that fit the study's criteria were emailed the survey. Assured of confidentiality, communication officers of each organization were asked to participate, as they are believed to be more knowledgeable about the information exchange network. If organizations did not respond in the first round, a follow-up email was then sent. If there was still no response, then a superior such as a director was emailed. If there was still no further response, two follow-up phone calls were attempted, followed by two emails. 121 of the 122 identified organizations responded to the survey for a response rate of 99%.

Survey participants were asked whether or not they send information related to sustainable transportation policy to each of the others included within each state network, and whether they receive information related to sustainable transportation policy from each of the others included in the network. Questions regarding organizational characteristics were also asked (e.g., the year in which the organization was founded, number of staff members, annual operating budget). The data on whom organizations send information to, rather than receive information from were used as the basis for building social network models in UCINET (a type of social network analysis software). Sending was chosen over receiving because less of an incentive exists for over-reporting sent information than over-reporting received information due to the notion of prestige associated with receiving ties from others.<sup>39</sup> The network models were

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based on all organizations included in the survey (i.e. government agencies, planning commissions, transit services, and businesses). An additional survey which was used to design the further analysis here was completed in the summer of 2013. In that survey, the previously surveyed organizations were asked for key measures of success, those answers were then used to further inform the research design described here.

### **Measures**

*Network Centrality.* Through UCINET, we calculated each organization's centrality scores, including Freeman degree, closeness, and Freeman betweenness, based on the network of sending information in each of the three states. Each centrality measure was normalized within each state so that our samples could be pooled across three states.

*Structural Holes.* We also measured structural holes through UCINET, in which we first calculated the constraint score that calculates an organization's lack of access to structural holes.<sup>40</sup> Then we used Zaheer and Bell's (2005) approach by subtracting the constraint score from 1 as the measure of structural holes. The measure was normalized within each state as our samples were pooled across three states.

*Perceived Influence.* On a 5-point scale, each organization was asked to rank how influential each other organization was in the field of sustainable transportation policy, with 1= not influential at all, and 5= very influential. The perceived influence score for each organization was calculated by arriving at the mean of the scores given to each organization by the other organizations within each state network. Provan, Beyer and Kruytbosch (1980) used a similar measure of perceived power in a study of human service agencies formally affiliated with the United Way. The researchers asked United Way staff members' perceptions of the influence of each agency with which they worked over United Way's allocation decision to that agency.<sup>41</sup> Each influence score was normalized within each of the three states in the sample.

*Number of Functions.* The number of functions is measured by the following question: "Please indicate the type(s) of functions or roles within sustainable transportation policy." Respondents can choose from a total of 11 functions, including advocacy/organizing, building partnerships/collaborations, consulting, delivery of services, drafting and promoting policy, education, funding projects/programs/organizations, legal, lobbying/testifying in the Legislature, research and training. This measure was constructed by manually counting the total number of functions mentioned by an organization.

*Number of Partnerships.* In the survey, we provided the definition of "partnership" as an organized relationship with other organizations around specific issues or activities. They can be contractual or less formal. After the definition, we asked the following question, "How many partnerships do you have with other organizations or groups?" Respondents can answer both the number of partnerships related to sustainable transportation policy, and the number of other transportation-related partnerships. For this study, we focus on the partnerships related to sustainable transportation policy. In other words, the dependent variable is operationalized as the count of partnerships (related to sustainable transportation) an organization forms with others (not limited to those from within the information network).

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## Statistical Approach

To test the hypotheses, we used the structural equation modeling (SEM) approach. We used AMOS 20 to test the hierarchical model, which has four network measures (degreeness, closeness, betweenness and structural holes) as the exogenous variables, perceived influence and function generalism as the mediating variables, and the number of partners as the endogenous variable.

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## 2.2 Data Analysis

### Descriptive Results

Among the 121 organizations, 45 were from Vermont, 40 from Maine and 36 from New Hampshire. Fifty-five percent of these organizations were non-profits. Among the type(s) of functions or roles within sustainable transportation policy promotion that an organization fulfills, about two-thirds selected building partnerships/collaborations (65%), with 64% for education and 55% for advocacy/organizing. Across the three states, the average number of paid staff was about 31, while the average number of partners related to sustainable transportation was about 9. On average about 30% of each organizations activities were related to sustainable transportation.

### Path Model Results

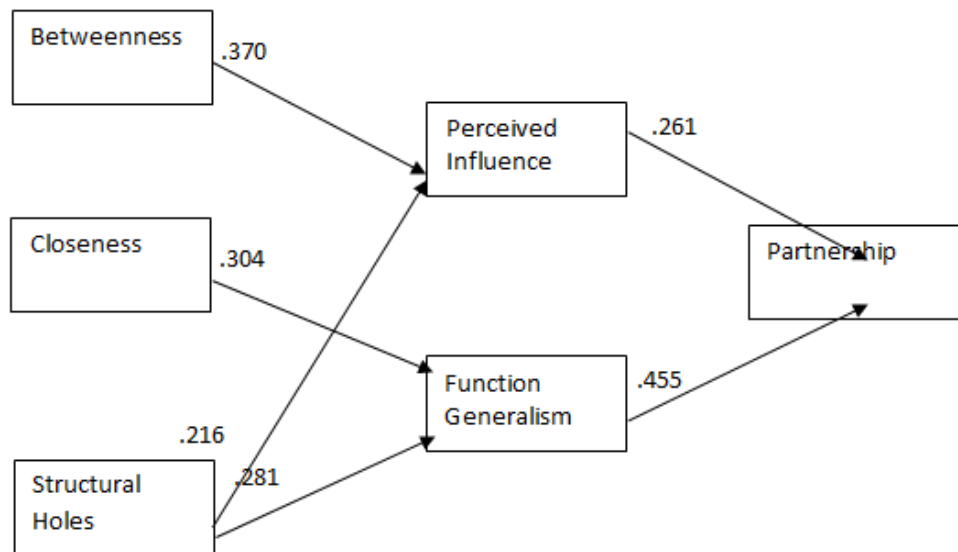
Our initial model (with the error terms of perceived influence and function generalism correlated) did not produce very satisfactory fit indices (Chi-square = 7.661,  $df = 4$ ,  $p = .105$ , CFI = 0.99, NFI = .98, RMSEA = 0.087), mainly due to the relatively high RMSEA number, as it is higher than .06, the cutoff point for a good model fit (Hu and Bentler, 1998). The results failed to support H<sub>1a</sub>, H<sub>1c</sub>, H<sub>2a</sub> and H<sub>2b</sub>, while supporting the other hypotheses. That is, degreeness was not found to be significantly related to either perceived influence (H<sub>1a</sub>) or function generalism (H<sub>2a</sub>). Closeness was not related to perceived influence (H<sub>1c</sub>), while betweenness was not related to function generalism (H<sub>2b</sub>). Structural holes was found to be significantly related to both perceived influence (at .05 level, H<sub>1d</sub>) and function generalism (at .01 level, H<sub>2d</sub>). Betweenness was significantly related to perceived influence (at .01 level, H<sub>1b</sub>), while closeness was significantly related to function generalism (at .05 level, H<sub>2c</sub>). Both perceived influence (H<sub>3</sub>) and function generalism (H<sub>4</sub>) were positively related to the number of partners (both significant at .01 level).

To develop a model that fits the data better, we decided to only keep the significant relationships identified in the original model. Our revised model revealed very good fit statistics (Chi-square = 5.956,  $df = 5$ ,  $p = .310$ , CFI = 0.994, NFI = .969, RMSEA = 0.04). The model explained 37% of the variance in the endogenous variable (number of partners) (see Figure 1). It is therefore possible that perceived influence and function generalism may precede network positions. As an alternative, we treated perceived influence and function generalism as the exogenous variables (independent variables), closeness, betweenness and structural holes the mediating variables and the number of partners the endogenous variable. The fit indices for the alterenative model were not satisfactory (Chi-square = 20.972,  $df = 4$ ,  $p = .00$ , CFI = 0.902, NFI = .892, RMSEA = 0.188, explaining 23% of the variance in the endogenous variable). The structural modeling analysis of the directionality of the effects suggested that the revised model fit the data better than the alternative model. In other words, it seemed to be more plausible for network positions to

affect perceived influence and function generalism than for perceived influence and function generalism to affect network positions.

**Figure 1.** Model of Hierarchical Predictors of Inter-organizational Partnership

The Revised Model of Hierarchical Predictors of Inter-organizational Partnership ( $\chi^2 = 5.956$ ,  $df = 5$ ,  $p = .310$ ,  $CFI = .994$ ,  $NFI = .969$ ,  $RMSEA = .04$ ). The number above each line indicates standardized regression weight (all significant at .05 level). All error terms are omitted for the sake of clarity of presentation. Degreeeness was not included as it was not a significant predictor of either perceived influence or function generalism in the initial model.



### 3. Results & Discussion

From the perspectives of resource dependency and social network, this study models the process by which network structural factors create an environment that enables (or encourages) the other actors to search for and partner with the focal actor. As this study suggested, organizations with higher perceived influence and functional diversity, as a result of their strategic network positions, are more likely to attract other organizations who have limited access to social capital (e.g., information network relationship) and hope to acquire legitimacy or competence through partnerships. Our findings added empirical support to the argument by Ahuja (2000) that the linkage-formation propensity of organizations is explained by simultaneously examining both inducement (e.g., need for resources) and opportunity factors.<sup>42</sup>

Adapting a social structural theory of alliance formation from Burt (1982), Gulati (1995) proposed a social structural model that depicts the important role of social networks in guiding organizations' actions. In this model (which was not tested in a hierarchical way), Gulati (1995) proposed that social structure as the context of action predicts organizational interests and external opportunities, which lead to alliance formation. Both Gulati (1995) and Ahuja (2000) emphasized the role of opportunity factors in the

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organizational linkage formation.<sup>43</sup> Our model suggested that strategic network positions within an information network produces two opportunity factors for the focal organization – perceived influence and function generalism, which facilitate those organizations to form partners with others. An organization's observed linkage behavior reflects linkage opportunities open to it (Ahuja, 2000). An organization that sits on a strategic position in an information network will develop specific strategic network capabilities (e.g., knowing the positioning/functionality of other organizations in the network and their information flows), that enable them to choose new partners (Hagedoorn, Roijackers, & Van Kranenburg, 2006).<sup>44</sup> An active network of information exchange can also help organizations learn about the reliability (or prestige/status) and specific capabilities of current and potential partners. This exchange reveals to organizations alliance opportunities they would be unaware of otherwise.

The role of interorganizational networks as conduits of information, learning, and knowledge is of concern to both managers and scholars. Networks are effective because they can provide access to information that can help organizations overcome uncertainty and gain control over their environment (Burt, 1983). Our results showed that network structural characteristics tend to have differential impacts on perceived influence and function generalism. Degree centrality is more about the quantity of information network relationship, while the others tend to imply the quality of the network tie. In our findings, the “quantity” network variable (degree centrality) was not a significant predictor of either perceived influence or function generalism. Among the “quality” network measures, the variable “structural holes” significantly predicted both perceived influence and function generalism. Betweenness was significantly related to perceived influence, but not to function generalism. Betweenness centrality views an actor as being in a favored position to the extent that the actor falls on the geodesic paths between other pairs of actors in the network.<sup>45</sup> Our model seemed to suggest that this strategic position is important for an organization to build its reputation and status in the network, but not functional diversity. Closeness was significantly related to function generalism, but not to perceived influence. Closeness centrality emphasize the distance of an actor to all others in the network by focusing on the distance from each actor to all others.<sup>46</sup> Our results seemed to suggest that the number of functions can be partially explained by how “close” an organization is with other actors in the network, not by how the organization “goes between” other pairs of organizations within the network.

### Theoretical Implications

Previous organizational research has explored the correlates of collaboration. For example, Arya and Lin (2007) examined how collaboration outcomes (organizational ability to acquire monetary and nonmonetary resources through collaborations) were affected simultaneously by such factors as service generalism, own status, network centrality, and structural holes, among others.<sup>47</sup> Hagedoorn and Frankort (2008) found that organizations well-embedded in networks accumulate informational advantages that increase their propensity to engage in new partnerships.<sup>48</sup> Surprisingly, little research has explored the hierarchical process of linkage formation. This study went one step further by taking a process-oriented approach and examining the hierarchical and nonlinear predictors of partnership formation. Our study extends the literature of organizational partnership in twofold. First, it is among the first efforts to investigate the network correlates of partnership in the field of sustainable transportation. Second, our study shows how the network resources (particularly structural holes) derived from an information exchange network, along with the reputation and functions that accrue from the network structure, may contribute to the partnership formation.

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### Practical Implications

A mapping of information exchange networks of organizations engaged in sustainable transportation carries practical implications, as it can help identify opportunities for better interorganizational communication, especially for those who occupy more peripheral positions in the networks. To the extent that brokerage reflects a bridging of structural holes, organizations may be in a superior position over their peers for accessing this information. These structural holes may provide entrepreneurial opportunities for organizations willing to bridge the holes, or in other words, occupy the flow of information between opposite sides of a hole. Organizations serving as a bridge may also be in a privileged position of hearing about impending threats and opportunities more quickly than others in the network.<sup>49</sup> If a peripheral organization is determined to increase its influence within the network, it is important for them to establish ties with those with higher scores in structural holes, or better still, try to identify the structural holes within a network and then put itself in a position to bridge those structural holes. More research is needed on the network factors that contribute to collaborative relationships both in the field of sustainable transportation policy and in the other fields.

### Limitation and Future Research

While the way we measure our dependent variable has its precedents (e.g., Ahuja, 2000), the extent or diversity of the partnership was not fully explored in this study. Future research can further differentiate the network impacts on different forms of partnerships. They can be classified in type/form, intensity, complexity and scope.<sup>50</sup> This study explored the hierarchical antecedents of interorganizational partnership. Future research can integrate the antecedents and consequences of interorganizational partnering in one hierarchical model. Finally, the cross-sectional nature of this study precludes us from making a definitive causal inference, which would be better arrived at in a future longitudinal before-and-after design.

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## 4. Conclusion

From the perspectives of resource dependency and social network, this study investigates the hierarchical impacts of network positions (network centralities and structural roles) on inter-organizational partnership in the context of sustainable transportation. As predicted by the theories, the influence of network position (closeness, betweenness and structural holes) on interorganizational partnership was mediated by such network-derived resources as perceived influence and function generalism. As this study suggested, organizations with perceived influence and functional diversity, as a result of their strategic network positions, tend to attract other organizations who have limited access to social capital (e.g., information network relationship) and hope to acquire legitimacy or competence through partnerships. Our model suggested that strategic network positions within an information network produces two opportunity factors for the focal organizations – perceived influence and function generalism, which further facilitate those organizations to form partners with others. An organization's observed linkage behavior reflects linkage opportunities open to it. An organization that sits on a strategic position in an information network can develop specific strategic network capabilities that can enable them to choose new partners).<sup>51</sup>



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