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Abstract: Today's dynamic environment illustrates the importance of networking in most industries, but especially critical for technical communities, though there is a gap in current literature of the network of the aerospace industry. This research will discuss the current literature and further the literature by mapping the aerospace southern California network based on an empirical study of mapping these actors within the network, resulting in key advanced measures, such as centrality to understand the implications of such analysis.

INTRODUCTION / BACKGROUND

Government support of diverse research and development activities in relation to the aerospace industry has resulted in substantial improvements in the leading edge of technology and innovative efforts. However, there has been limited attention paid to the patterns of cooperation between institutions in the aerospace network, though there are many organizations that are consortium and provide for networking opportunities. Though this dynamic has recently begun to change, as cooperative agreements and strategic alliance become more common place and as technology increases, making information more accessible, a full understanding of the consequences to such activities is prudent. These partnerships can help to increase synergies of the network based on regional clusters (Littler and Wilson, 1991). These dynamics create a newly formed network and evolved cooperation, leading networks that are a new aspect of such development to continue into the future. Many scholars recognize the importance of networks (Freeman, 1991), but there seems to still be little research on the evolution of such technology structures, especially in regional clusters and the technology driven industries.

Several studies show that the number of inter-firm alliances had risen significantly in the late 1980s to the 1990s (Hagedoorn, 1991). These types of alliances and external cooperation have taken increasing importance because they develop information and push technology forward, which is beneficial because the global market requires an understanding of the diverse marketplace. The strategic cooperation has been discussed extensively (Ohmae, 1985), but the technical industries have a unique environment in that they will integrate capital, knowledge, expertise and techniques in new combinations in order to achieve success for their customers. Specific types of these clusters, including, licensing, R&D projects, joint ventures, of cooperation in technology development between firms have intensified. The result is increased technical interdependencies as one firm will rely heavily on others for resources, knowledge and networking opportunities. Oftentimes, there are direct relationships for technology exchange with other organizations, which can be leveraged within such a network. These specialized technology-driven networks often fall into the strategic planning process for specific resources for innovation and new product development. There has been some research by leading scholars that focuses on the increasing trends of strategic alliances, as well as the similarities and differences in patterns of development (Gersony and Peters, 1997). Networks of inter-organizational relationships do, in fact, spread knowledge across firms within the industries that produce highly technological end-products (Daniel, Hempel, & Srinivasan, 2002). There are various different types of networks, such as informal social structures (Inkpen & Tsang, 2005). Additionally, a social network of contractual and cooperative alliances that links firms can also be analyzed, which allows knowledge to be shared and business transactions to be arranged (Owen-Smith & Powell, 2004). The gap in the literature exists in the establishment of the collaborative networks that enhance and disseminate the knowledge-based structure that many high-technology industries possess. Since very little, if any, network structures have been compiled or analyzed in the aerospace industry, the gap in the literature will play a crucial role for this industry.

NETWORK ANALYSIS

The term 'network' is a term that has been used in many disciplines, including sociology, supply chain management, and organizational theory, for the analysis of different actors within a network. These actors could be employees within the network of a company structure or, more broadly, the actors could be individual companies with an industry network. Scholars analyze the industry network as it is composed of different interrelated groups of actors (firms within the network) and of technological systems (Lundgren, 1995). As this research study will be analyzing the industry, the actors will be individual firms within the network, which is the aerospace industry.

Network analysis enables scholars to more fully understand the influence that each actor has in and among the network with analysis of centrality and densities of interactions and clustering of different types of activity arising from inter-organizational ties.

NETWORKS RELATED TO KNOWLEDGE MANAGEMENT

Knowledge transfer in technical organizations is "the act of moving knowledge from one entity to another in an optimal and reliable manner" (Geraghty & Desouza, 2005). This process creates a result of social learning through the effects of experience (Hansen,1999, 2002). For technology-intensive products, this knowledge transfer can involve the transfer of a wide range of content concerning the amount and level of technological exchange. In the strategy, alliance, and supply chain management literature, knowledge transfer has been conceptualized as both a driver of and an outcome of inter-organizational collaboration (Gulati, 1999). Other scholars will argue that the knowledge is not only driven by knowledge, but more so by the solving of problems within the organizations, such as the creation of new knowledge (Aragon-Correa, Garcıa- Morales, & Cordo'n-Pozo, 2007). When looking at the network from the firm level, it brings the perspective of social capital and its benefits. This analysis will focus on the position of a firm in the network as critical for the benefit of this knowledge exchange (Koka & Prescott, 2002). A firm's position is measured though its centrality, which is the degree among the other actors in the network and how directly and/or indirectly connected they are to other organizations and the degree to which other organizations are connected through it (Hardy et al., 2003).

In a technology driven organization, firms gain access to valuable knowledge through social ties with other firms (Walter et al., 2007). One reason that a network analysis is critical is that the network itself and clusters within the network can be more powerful than the relationships within that network, which carries benefits by enabling a firm to access information from diverse sources to which a firm is connected only indirectly. Through participation in the network itself, an organization can gain resources, which is appropriate knowledge to benefit the company through the capabilities of other network members that will reduce the risk of failure in core activities of that firm (Bessant, Kaplinsky, & Morris, 2003). The knowledge is not only found within the firms, but is also created outside the firm that can stimulate creativity (Bessant et al., 2003) and stimulate change and organizational improvement (Inkpen & Tsang, 2005).

NETWORK CENTRALITY AND KNOWLEDGE TRANSFER

The position of the company within the network is a key determinant of the knowledge that one will benefit from in the network. Knowledge is oftentimes distributed unevenly within a network, so the criticality of the network position is high. It can enhance a firm's ability to create new value and to achieve economic goals (Coleman,1990; Tsai, 2001). Firms at central positions in a network are more likely to gain desired information, knowledge, and resources from the network by accessing external information and knowledge.

METHODS

The methodology used to conduct the social network analysis of the southern California aerospace industry can be divided into 3 major steps: identifying relevant companies in the industry, compiling relevant data, and analyzing the data. Each of these categories is detailed below.

Identifying Relevant Companies

In selecting the relevant companies in the aerospace industry, the scope was narrowed to include only Tier 1, Tier 2, and Tier 3 southern California aerospace companies. The tiers are generally accepted terms of companies based on location in the supply chain, which also has a correlation to the size of the respective companies. Tier 1 companies are the largest public companies and/or government suppliers. These companies complete large scale projects, for which they receive parts, products, and services from smaller Tier 2 companies. Similarly, these Tier 2 companies outsource certain portions of the deliverable end item to smaller Tier 3 companies. The selection of Tier 3 suppliers were isolated for this study, as little, if any, studies have been conducted for these companies, as they are oftentimes perceived in the industry to be less critical within the network. By understanding the network within this tier, it can be demonstrated of the type of network that has formed. Due to the population size, the search was narrowed to the Southern California region. To identify these companies, an online business directory was consulted, known as manta.com. This website allows for company searches based on industry and location. Thus, a search was conducted based on the aerospace industry in California, which yielded 832 companies as a result. However, the parameters of the search also excluded consultants or sole proprietorships that traditionally provide services, rather than a core relationship based on the supply chain. With these criteria, the results were filtered to include companies that possessed 50 or more employees. This refined search yielded 101 companies in California. From this list, each company was examined based on geographic location so as to include only those companies based in southern California, excluding San Diego-based companies. This narrowed the list to 60 companies, with the only outliers being located in Rancho Cordova and Santa Cruz, which can be considered to be northern California cities. The reason for these two northern companies being included is that they are considered major actors in the network in the California aerospace industry and to fully and accurately depict the network composition, they required inclusion in the analysis. To ensure validity of the population to be analyzed, the American Institute of Aeronautics and Astronautics (AIAA), the leading aerospace professional society, was consulted. This organization recommended a narrowed online search using either manta.com or connectory.com. The current list from manta.com was compared to the list from connectory.com, in which the result was conclusive that Manta provided more thorough search options and a broader list of companies.

Compiling Relevant Data

The population has now been defined for the study, which are the resulting 60 companies. It now became necessary to gather relevant data about each company, which included the location of the headquarters or branch in California, the number of employees at the branch or headquarters, and the annual sales figures of the branch or headquarters. The location is a specific city in California, and the number of employees and annual sales were represented as a range of numbers, since this information is sensitive and sometimes estimated due to frequent changes within the companies or the competitive nature of these figures.

After having this basic company information for each identified actor in the network, each company website was identified and visited to secure public information via press releases of relationships between actors. To do this, the researcher searched through the press archives on each company's website to identify which companies have press releases of partnerships, awards, or alliances with one another. Thus, all of the companies' press releases were examined in order to find contract announcements dating from the present back to 2005. Though this will not be a longitudinal study, it would be prudent to examine a period of time to fully understand the network. Information captured for further analysis included the company that announced the contract award, the company that received the contract award, the contract project details, the date of the award, and the amount of the award.

Subsequent to this analysis, it was determined that most, if not all, of the press releases were limited to the larger Tier 1 and Tier 2 companies. This newly discovered phenomenon mandated further data gathering. It was determined that the smaller companies must be contacted directly to gain greater insight into their supplier network. This would be accomplished via an online survey and email contact, followed with direct phone call when necessary. As the methodology for capturing contact information for each company was via their website, it was recognized that the response rate may not be high enough via the online survey technique, which was the rationale for the possible direct contact of each actor in the network.

The survey was developed via surveymonkey.com, which is an online survey service that allows for survey design, response collection, and analysis. This survey included 9 questions directed at obtaining validated company information and information regarding supplier networks. In the survey, each company is asked demographic information, such as their name, location, number of employees, and annual sales. Next, each company is asked if it has a government designation as a "small business" or "woman or minority-owned business". Lastly, each company is asked to identify if it has offered a contract to, or been offered a contract from, any of the other companies in the list in the last 5 years. The survey was pre-tested to ensure validity and reliability.

Social Network Mapping

Upon the analysis of the survey data, the network information was present, but needed to be structured for the analysis in the social mapping software. **T**he social network analysis took a member of the industry and made them a 'bubble' (Hannemann, 2001). When an interaction was reported by the member of the industry, a measure was reported. Social network mapping begins with the conventional rectangular measurement of actors or players within a selected team (Hannemann, 2001). For this research project, each cell was assigned either a 0 (in which no relationship or data was transferred between actors), or a 1 (in which a relationship or data was transferred between actors). This created a table of comparison of actors and their relationship in binary form. The captured data could further the relationship from binary form to a strength of tie, but due to the timing constraints and the overall objectives, the binary analysis was sufficient to show the necessary data.

This was the foundation data that was used for the mapping portion of the analysis. Network mapping is a special form of conventional data, as it looks at data in a different way. Actors are described by their relations, not by their attributes. This puts an emphasis on the relationships of the actors, not just the individual within the network. "The major difference between conventional and network data is that conventional data focuses on the actor and their attributes, network data focuses on actors and relations. The difference in emphasis is consequential for the choices that a researcher must make in deciding on research design in conducting sampling, developing measurement, and handling the resulting data (Hannemann 2001, pg 3).

N-Cliques can show the relationships in connections with other actors (Hannemann, 2001). For example, one can set a three-clique analysis to determine which members have a distance greater than two away from a chosen actor. This shows the closeness of actors within the context of their environment. The drawback to this analysis is that in larger groups, the analysis will result in "long and stringy groupings, rather than the tight and discrete ones". This negative factor renders this type of analysis undesirable in some cases. Another option is to conduct an N-clan analysis. This analysis will "force all ties among members of an n-clique to occur by way of other members of the n-clique" (Hannemann, 2001). Both of these approaches have the benefit of showing the relationship between actors; even if they do not have direct ties, but have a relationship through another actor in the network. A more relaxed approach is the K-core analysis (Hannemann, 2001). It allows actors to join the group if they are connected by K members. "A K-core is a subgroup in which each node is adjacent to at least a minimum number (k) of the other nodes in the subgroup" (Wassermann & Faust, 1994, p 266). This approach meant the actors defined the population as well as the demographic approach. In this case, the actor was present in the social network map, but did not possess any ties to the remainder of the network, for example, a company that reported that they had no interactions with the groups that were included in the survey. Since no direct interaction or information was exchanged, no tie would be made. This would not be considered an interaction in the social network mapping definition, hence no tie will be present. The scale for measurement was a binary measure, the most commonly used scale, which involved assigning 0 for no relationship or a 1 where a relationship exists. This enabled the network to illustrate whether the relationship existed or not, not the tie between information. This was selected for several reasons. First, it was a starting point for the network analysis. This keeps the illustration simple and will illustrate the network very clearly. The first step of the social network analysis process was to map simply the binary relationship Once the methodology was set, determinations were made on how each step would be conducted. The type of matrix used is a good example to start the explanation. In this research project, the "adjacency" matrix was used; the adjacency matrix is the most common for social network analysis as it simply gathers the inflation between actors in a binary method. This will be the starting point for social network mapping (Hannemann, 2001). The next step of the social network analysis was to determine what to do with the "main diagonal." This is the cell in which the actor is across the matrix from themselves. In this case, to continue the simplistic approach and to make sure the information was not clouded, a dash (-) was placed in those cells. Some analysis needed to be conducted on the fundamentals of the team, so that an accurate selection could be made on how to illustrate the network and what analysis would be conducted. The size of the network was an important aspect to consider, which can enable one to use a substructure analysis. The most common is a clique, which is a "sub-set of actors who are more closely tied to each other than they are to actors who are not a part of the group" (Hannemann, 2001). After the data was coded, edited and entered into the computer, it was then time to tabulate the results. Tabulation is the organized arrangement of data in a table format that is easy for the researcher to read and understand. A simple tabulation, cross tabulation, and frequency distributions were all used, based on hours, function, people, and interaction levels. The simple tabulation results each contained only one variable and were used to inform the researcher how often each response was given. Cross-tabulation is a statistical technique that involves tabulating the results of two or more variables simultaneously to inform the researcher how often each response was given. Frequency distribution shows values grouped into several classes based on quantity and indicates the frequency of the values within each class. The cross-tabulation and frequency distribution results were summarized in their appropriate chapters. The research design is the framework directing research efforts in order to reduce errors. The research design should do the following: 1) provide answers to questions as objectively, accurately, and economically as possible; and 2) identify and control all probable sources of errors.

The next analysis conducted was for network centrality. Network centrality for each participant was operationalized as that individual's betweenness score, which represents the degree to which the individual can broker relationships among all other participants (Freeman, 1979). In short, betweenness captures the extent to which one individual is on the shortest network pathway between other pairs of individuals. High betweenness centrality makes a network member an obligatory passage point for the information flowing through a network structure. Betweenness represents a firm's ability to absorb (or interrupt) information flow (Owen-Smith & Powell, 2004).

At the group level we calculate a measure of relational density and a centralization index. The density is a count of the number of edges actually present in a graph, divided by the maximum possible number of edges in a graph of the same size. It provides information about the group relational intensity and the cohesion of a graph, but does not include information about the variability among actor degrees. In vertically-related industries, density measures the relational intensity among customers and suppliers in the network. A change in density essentially depends on the relational activity of suppliers and on the sourcing strategies of customers. Specifically, density increases because of new relations by incumbents, exit of firms with a number of relations below the average, or entry of firms with a number of relations above the average. Density decreases because of interruption of relations by incumbents, exit of firms with a number of relations above the average, and entry of firms with a number of relations below the average. As entry and exit are more likely to occur with a small number of relations, more generally density increases because of increasing relational intensity and decreases because of entry. We also identify the existence of cohesive subgroups, which are subsets of actors among whom there are relatively intense ties.

RESULTS AND ANALYSIS

For final statistical analysis, the original list of 66 companies was narrowed to 45 companies, as 21 companies reported not being involved in the aerospace industry at all. From this list of 45 companies, statistical techniques were used to analyze the data, which will be detailed later. However, before statistical analysis software was used, certain pertinent statistics were identified from the data we had already collected. First was a location analysis based on county location. Of the 45 companies, only one (NASA) was located in Kern County, meaning that 2.22% of the companies were located in Kern county. 20 of the 45 companies were located in Los Angeles, meaning that 44.44% of the population was located in Los Angeles County. 20% of the companies, or 9 out of 45, were located in Orange County. Riverside County housed 2 out of the 45 companies, or 4.44%, while San Bernardino County was home to 6.66% of the companies, or 3 out of 45. One company was located in Sacramento County, giving that county 2.22% of our list. Six of the 45 companies were located in San Diego County, which equates to 13.33% of the list. Lastly, Santa Barbara County, Santa Cruz County, and Ventura County were each home to one company on the list, meaning each county contained 2.22% of the list. These statistics show that the largest segment of the population, or 44.44%, was located in Los Angeles County.

Next, the list of companies was analyzed according to their number of employees. Since these numbers change frequently, many of the companies reported them as a range of numbers. Also, our research was concerned with only larger companies, rather than sole proprietorships or up-start companies, which is why our list was narrowed to companies employing at least 50 people. With these specifications in mind, the data was analyzed based on percentages. 33.33% of the responding companies reported having between 50 and 99 employees, 15.55% reported having between 100 and 249 employees, 22.22% reported having between 250 and 499 employees, 13.33 % of the companies reported having between 500 and 999 employees, 6.66% reported having between 1,000 and 4,999 employees, 4.44% of the companies reported having between 5,000 and 9,999 employees, and another 4.44% reported to have over 10,000 employees. These statistics show that the largest segment of the population, 33.33%, had between 50 and 99 employees.

In a manner similar to the analysis of the number of employees, the annual sales figures for each of the companies were analyzed. Again, these figures were represented as ranges of numbers. First, 11 of the 45 companies, or 24.44% of the respondents, did not report annual sales figures out of confidentiality.

One company, or 2.22%, reported making between $5 million and $10 million annually. Six companies, or 13.33%, reported making between $10 million and $20 million per year. Another 24.44% of the companies reported making between $20 million and $50 million annually. Five of the companies, or 11.11%, reported making between $50 million and $100 million per year. 15.55% of the responding companies, or 9 out of the 45, reported annual sales between $100 million and $500 million. Lastly, one company, or 2.22%, reported annual sales between $1 billion and $5 billion, with one other company (2.22%) reporting annual sales in excess of $5 billion. Thus, the majority of the population, with the largest segment being 24.44%, did not report annual sales figures while another 24.44% reported annual sales between $20 million and $50 million.

After analysis of these simple statistics, gathered from various sources, the results of the survey that was sent to each company were analyzed with greater detail. The survey was sent to, and included lists of, the original 66 companies compiled in our population set, as it was created when our population set was still this large. The population set was not narrowed to 45 companies until after the results of the survey were analyzed, as 21 companies reported not being involved in the aerospace industry upon being contacted to take the survey. Surevymonkey.com, which was used to conduct the survey, offers several ways to view and analyze the survey response data. This response data was placed in a spreadsheet for easier viewing and analysis.

Out of the 66 companies, 19 responded to the survey, resulting in a 28.78% response rate. The first two survey questions were simple identification questions, asking for company name and location, to which all 19 respondents gave answers. When asked to report their annual sales figures, one company skipped the question (leaving 18 total respondents), 5.6% reported less than $1 million annually, 16.7% reported between $1 million and $10 million, 11.1% reported between $10 million and $20 million, 27.8% reported between $20 million and $50 million, and 38.9% reported annual sales in excess of $100 million. The majority of this population of 18 companies (38.9%) showed annual sales of over $100 million.

Next, the survey asked the companies to identify the number of employees at their branch. Out of the 19 that responded, 10.5% reported having 25 of fewer employees, 5.3% reported having between 25 and 50 employees, 15.8% had between 50 and 100 employees, 26.3% had between 100 and 200 employees, 10.5% had between 500 and 1,000 employees, and 31.6% reported having more than 1,000 employees. The largest segment of this population (31.6%) showed to have more than 1,000 employees.

The next question in the survey asked the respondents to identify whether or not their company is designated as a "small" or "women or minority-owned" business, as designated by the Federal Government of Small Business Administration. One company skipped this question, 44.4% answered "yes", 44.4% answered "no", and 11.1% responded "don't know". This showed an even split between companies that identified themselves as "small" or "women or minority-owned" and those that did not.

Next, the companies were presented a list of the 15 larger companies that we identified in our original 66 company population set, and were asked to identify which, if any, of the companies they had offered a contract to in the last five years. While the statistics on this question vary widely, only the most significant statistics will be presented here. 33.3% of the respondents reported offering a contract to ATK Space, 38.9% reported an offer to Boeing Company, 27.8% reported an offer to Lockheed Martin Corporation, 27.8% reported an offer to Northrop Grumman Corporation, 27.8% reported an offer to Northrop Grumman Systems Corporation, and 33.3% reported doing business with Raytheon Corporation. Also, 38.9% reported having made no contract offers to any of the companies on the list in the last five years. The largest segment of the respondents (38.9%) reported either doing business with Boeing Company or none of the companies on the list.

The next question in the survey presented the remaining 51 companies in our original population set (the smaller companies) and, again, asked if the respondents had offered a contract to any of the companies on the list in the past five years. Of the 19 respondents, 4 skipped this question, leaving a total of 15 respondents. Again, the statistics widely vary, but only the most significant will be presented here. 46.7% of the respondents reported having made no contract offers to any of the companies on the list in the last five years. This represents the largest segment of the responding population. The other largest reporting segments included 26.7% of the respondents reporting offering a contract to Curtiss-Wright Controls Integrated Sensing Incorporated, and 20% reporting an offer to Parker-Hannifin Control Systems.

Next, the respondents were presented the same list of the 15 larger companies from the population, but were asked if they had received a contract from (rather than offering a contract to) any of the companies on the list in the last five years. Six of the respondents skipped this question, leaving a total of 13 respondents. The most significant of the statistics reported included 61.5% reporting having received a contract from Boeing Company, 46.2% reporting having received a contract from Lockheed Martin Corporation, 23.1% reporting an offer from Northrop Grumman Corporation, and 38.5% reporting an offer from Raytheon Corporation. This shows that Boeing Company was the major company offering contracts to this population of respondents.

This question was followed by a list of the remaining 51 smaller companies from our population set. The respondents were asked to identify if they had received a contract offer from (rather than offered a contract to) any of the companies on the list. Of the 19 respondents, 11 skipped this question, leaving a total of 8 respondents. Of these 8 respondents, 3 (or 37.5%) reported receiving a contract offer from Boeing North American Incorporated, one (or 12.5%) reported receiving an offer from Pacific Scientific Company, and 5 (or 62.5%) reported having not received a contract offer from any of the companies on the list in the last five years. This last segment of 62.5% of the respondents represented the largest segment, meaning the majority of the respondents did not receive contract offers from any of the companies on this list.

This completed the first step in the statistical analysis, using spreadsheet analysis tools made available by surveymonkey.com and Microsoft Excel. However, further statistical analysis was necessary in order to test certain variables for significance. In order to analyze the statistics and attributes that were obtained through our research, the survey, and the UCINet software, SPSS statistical software would have to be used to test the variables for significance against one another. In other words, as reported above, certain percentages can easily be observed regarding annual sales figures and numbers of employees for each company, but SPSS software would allow us to run statistical tests to find out if variables, such as annual sales figures and numbers of employees, affect each other and affect other variables. As such, SPSS statistical software was used to test the variables for correlation significance.

SPSS computes the Pearson correlation coefficient, an index of effect size. This value ranges between -1 and +1. Indicating the degree to which low scores or high scores on one variable tend to go with low scores or high scores on another variable (from book). “A score on a variable is a low (or high) score to the extent that it falls below (or above) the mean score on that variable” (from book). For example, a correlation of +1 means that an increase (or decrease) in one variable will cause a precise increase (or decrease) in another variable at a constant rate. Similarly, if the coefficient is positive, a high score (or low score) for one variable tends to be associated with a high score (or low score) for another variable. If the coefficient is zero, than increases or decreases in one variable have no effect on changes in the other variable. If the coefficient is negative, then high scores for one variable tend to be associated with low scores for another variable, and vice versa. A correlation of -1 indicates that increases in the score for one variable lead to precise and constant decreases in another variable.

Another measure of correlation is the measure of error significance between two variables. Generally, an error significance (in a two-tailed test) measurement that is less than 0.05 indicates a strong correlation, while an error significance measurement that is greater than 0.05 indicates a weak, insignificant, or lack of correlation.

SPSS was utilized to run a bivariate Pearson correlation test between different variables from our data, which yielded the following results. The Kcore attribute and the Density attribute yielded a Pearson correlation coefficient of 0.270 and an error significance of 0.073, indicating a very weak correlation or no correlation at all. The Kcore attribute and the Degree attribute yielded a Pearson coefficient of 0.771 and an error significance of 0.000, indicating a strong positive correlation. The Kcore attribute and the Employees attribute (indicating number of employees) yielded a Pearson coefficient of -0.073 and error significance or 0.634, indicating no correlation. The Kcore attribute and the Annual Sales attribute yielded a Pearson coefficient of -0.297 and an error significance of 0.088, indicating a very weak negative correlation or no correlation at all. However, the two attributes yielded a Spearman's rho coefficient of -0.377 and an error significance of 0.028, indicating a negative correlation. Lastly, the Annual Sales and the Employees attributes yielded a Pearson correlation coefficient of 0.886 and an error significance of 0.000, which indicates a very strong positive correlation between the two attributes.

These correlation measurements can be interpreted to mean several things. First, it can be assumed that any increase or decrease in the Kcore score does not significantly affect the Density score, and vice versa. However, the Kcore score and the Degree score have a strong positive correlation, meaning increases (or decreases) in one of the variables will lead to increases (or decreases) in the other. The Kcore score and the number of employees display no correlation, meaning a high Kcore score is not influenced by a high (or low) number of employees. The Kcore score and the Annual Sales attribute display no signs of significant correlation. Yet, surprisingly, the Spearman rho coefficient signifies a negative correlation, meaning that a high Kcore score is influenced by lower annual sales numbers, and vice versa. Lastly, the Pearson coefficient signifies a strong positive correlation between the number of employees and annual sales, meaning that the companies with more employees tend to have the higher annual sales.

CITATIONS

Aragon-Correa, J. A., Garcıa-Morales, V. J., & Cordo'n-Pozo, E. (2007). Leadership and organizational learning's role on innovation and performance: Lessons from Spain. Industrial Marketing Management, 36, 249–359.

Bessant, J., Kaplinsky, R., & Morris, M., 2003. Developing capability through learning networks. International Journal of Technology Management & Sustainable Development, 2(1), 19–38.

Borgatti, S. P., Everett, M. G., & Freeman, L. C. (2002). UCINET for Windows: Software for social network analysis. Harvard, MA: Analytic Technologies.

Coleman, J. S., 1990. Foundations of social theory. Cambridge, MA: Havard University Press

Daniel, H. Z., Hempel, D. J., & Srinivasan, N. (2002, November). A model of value assessment in collaborative R&D programs. Industrial Marketing Management, 31, 653–664.

Freeman, C., 1991. Networks of innovators: a synthesis of research issues. Research Policy 20, 499–514.

Geraghty, K., & Desouza, K. C., 2005. Optimizing knowledge networks. Industrial Management, 47(6), 25–30.

Gersony, N., Peters, L.S., 1997. A strategic alliance typology for new technological ventures. American Business Review 15, 63–70.

Gulati, R., 1999. Network location and learning: The influence of network resources and firm capabilities on alliance formation. Strategic Management Journal, 20(5), 397–420.

Hagedoorn, J., 1991. Global Strategies in Innovation: Networks in Research and Production. International Journal of Management, 81–94.

Hagedoorn, J., Schakenraad, J., 1991. Interfirm partnerships for generic technologies—The case of new materials. Technovation 11, 429–444.

Hannemann 2001

Hansen, M. T., 1999, March. The search-transfer problem: The role of weak ties in sharing knowledge across organization subunits. Administrative Science Quarterly, 44, 82–111.

Hansen, M. T., 2002, May/June. Knowledge networks: Explaining effective knowledge sharing in multiunit companies. Organization Science, 13, 232–248.

Hardy, C., Phillips, E., & Lawrence, T. B. (2003). Resources, knowledge and influence: The organizational effects of interorganizational collaboration. Journal of Management Studies, 40(2), 321–347.

Inkpen, A. C., & Tsang, E.W. K. 2005. Social capital, networks, and knowledge transfer. Academy of Management Review, 30(1), 146–165.

Koka, B. R., & Prescott, J. E. 2002, September. Strategic alliances as social capital: A multidimensional view. Strategic Management Journal, 23, 795–816

Littler, D., Wilson, D., 1991. Strategic alliancing in computerized business systems. Technovation 11, 457–472.

Lundgren, A., 1995. Technological Innovation and Network Evolution. Routledge, London.

Ohmae, K., 1985. Triad Power: The Coming Shape of Global Competition. McKinsey, London.

Owen-Smith, J., & Powell, W. W. 2004, January–February. Knowledge networks as channels and conduits: The effects of spillovers in the Boston Biotechnology Community. Organization Science, 15, 5–21.

Tajfel, H., & Turner, J. C. 1979. An integrative theory of intergroup conflict. In W. G. Austin & S. Worchel (Eds.), The social psychology of intergroup relations (pp. 33–47). Monterey, CA: Brooks-Cole.

Tsai,W. 2001. Knowledge transfer in intraorganizational networks: Effects of network position and absorptive capacity on business unit innovation and performance. Academy of Management Journal, 44(5), 996–1004.

Walter, J., Lechner, C., & Kellermanns, F. W. (2007, July). Knowledge transfer between and within alliance partners: Private versus collective benefits of social capital. Journal of Business Research, 60, 698–710.

Wasserman, S., Faust, K., 1995. Social Network Analysis: Methods and Applications. Cambridge University Press, Cambridge.