SOCIAL NETWORK ANALYSIS: INTRA-ORGANIZATIONAL COMMUNICATION AND HUMAN RESOURCE MANAGEMENT

By

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To my wife and family

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The purpose of this research is to better understand intra-organizational communication within the social network of employees in a local agribusiness firm, and to investigate the statistical relationship between particular social network variables and human resource management demographics.

The main method of research was an internet based survey that was designed and is supported by the Food and Resource Economics Department at the University of Florida. Respondents of the survey were asked if, and how well they knew the other employees in the firm. They were also asked how often they communicated with the other employees. A social network analysis program was used to evaluate the data once it had been compiled.

This research revealed that XYZ Corporation uses key strategies that allow them to maximize efficiency with regard to communication. One of these strategies is the use of "hybrid" employees throughout various departments. Another is the forging of a unique "communication culture" that is tailored specifically for XYZ. Important results of this research are that demographic variables were not significantly related to centrality

scores, indicating a high level of diversity within the firm. Also, while in-person communication and email communication were positively related to degree centrality, phone communication was the only method that yielded a negative relationship to all centrality scores.

CHAPTER 1
INTRODUCTION

1.1 Social Networks

A social network is a set of socially-relevant nodes connected by one or more relations or ties. Wasserman and Faust describe these 'nodes' as 'actors' in their 1994 paper. Actors are the units that are connected by the relations whose patterns we study. These units are most commonly persons or organizations, but in principle any units that can be connected to other units can be studied as nodes (Marin and Wellman, 2009). Nodes can be connected in various ways, depending on the type of network in question. It is important to note that there are several types of ties that may occur in a social network. There can be dyads or dyadic ties which are simply interactions or established links between two actors (Wasserman and Faust, 1994). There can also be triadic or three way ties among actors. These ties are what make up the social structure of the network.

1.2 Social Network Analysis

What, then, is social network analysis? Breiger (2004) defines social network analysis as "The disciplined inquiry into the patterning of relations among social actors, as well as the patterning of relationships among actors at different levels of analysis (such as persons or groups)." Cross *et al*. (2001) state that social network analysis is a means to systematically assess informational networks by mapping and analyzing relationships among people, teams, departments or even entire organizations. While the application of social network analysis is relatively modern, the actual roots of the basic perspective (on a fundamental level) are as old of sociology itself (Scott,1988). Even though several metaphors have been used over the years, the most prevalent, most

accurate, and seemingly most accepted depiction of a social network has been essentially a net or fabric. Scott (1988) offers the following:

> It was, perhaps, in classical German sociology that this viewpoint was most explicitly allied with the metaphor of a 'network' of sociology that this viewpoint was most explicitly allied with the metaphor of a 'network' of social relations, the social world being depicted as an intertwined mesh of connections through which individuals were bound together. The very language used was redolent of the production of fabrics and textiles, and the works of Toennies, Weber and, above all, Simmel abound with concepts embodying such language: chains of action 'interweave' and 'interlock' to form a tightly 'knit' social 'fabric'. The purpose of metaphor in science is to make the unfamiliar understandable by describing it as if it were analogous to a familiar object or process. The metaphor or a 'social network' served to make the complex and unfamiliar patterns of the social world comprehensible by relating them to well understood everyday concepts drawn from the production and handling of textiles.

At the fundamental level, Wellman (1983) declares that the foremost objective of social network analysis is to determine how the pattern of ties in a network provides significant opportunities and constraints to those in the network. These ties or relationships affect the access of people to resources such as information, wealth and power (Wellman, 1983). This seems to hold with respect to all networks (where there is a clear or supposed hierarchy) regardless of size, in that where one is in the network has great influence on who one knows and what one knows. Aside from determining what knowledge is transferred and how that knowledge is transferred, social network analysis also allows for the measurement of strengths or weaknesses of relationships. This ability to measure relationships helps define the behaviors that exist and the impact they might have on the capability of an individual to function. (Hatala, 2006).

This study proposes that while social network analysis is still a relatively young field of study, it is an important analytical tool which yields important results. Through the use of this analysis, we will have a better understanding of not only the types of

communication used in and between different departments of an agribusiness firm, but also will gain possible insight on the effectiveness of each type of communication. The main hypothesis is that social network analysis variables have a significant impact on centrality. Centrality is the measure of the extent to which a particular node or actor dominates a network (Wellman, 2008), is presented via as a numerical scores.

CHAPTER 2
LITERATURE REVIEW

A review of the literature suggests that the research on networks in a human resources context is still in its early stages. There are relatively few papers on this topic specifically. However, the ones that do exist are relevant. Before reviewing the limited literature on SNA and HR, a brief review of papers regarding SNA in general will be presented.

2.1 Social Network Analysis

A general characterization of SNA is provided by Hatala, (2006) below:

> SNA is a general set of procedures that uses indices of relatedness among individuals, which produces representations of the social structures and social positions that are inherent in dyads and groups. These representations are important for describing the nature of the environment and the impact it has on the individuals who form the relationships.

The general steps to actually conducting SNA are outlined by Hatala,(2006) and are:

- Determining the type of analysis
- Defining relationships in the network using a theoretically relevant measure
- Collecting the network data
- Measuring the relations
- Determining whether to include actor attribute information
- Analyzing the network data
- Creating descriptive indices
- Presenting the network data

A more technical discussion of social networks and how nodes interact is given by Borgatti *et al*. (2009). Here they present theoretical mechanisms that explain consequences of social network variables. The first mechanism is referred to as the adaptation mechanism. "The adaptation mechanism states that nodes become homogeneous as a result of experiencing and adapting to similar social environments…

if two nodes have ties to the same (or equivalent) others, they face the same environmental forces and are likely to adapt by becoming increasingly similar." (Borgatti *et al*. 2009). The second and third mechanisms (binding and exclusion, respectively) are opposites. In the case of binding, several nodes converge around a central node (or group of nodes) and form a cluster. These nodes cooperate together and can seem to act as one. Conversely, any nodes within the immediate area of the network that are not incorporated into the cluster can be effectively excluded and deprived of any resources or information.

2.2 Social Network Analysis within a HR Organizational Context

Over the years, many firms have begun to realize not only the importance, but also the advantages of using social network analysis (SNA). More specifically, in a society where time is equivalent to money, the less time searching for answers to a company's and client's needs and questions, the more efficient one becomes and hence, the more money one makes. In their 2002 paper, Cross, Parker, and Borgatti outline this idea, focusing on knowledge creation and sharing using research conducted by IBM's Institute for Knowledge-Based Organizations. They state the following:

> In short, who you know has a significant impact on what you come to know. Many people we work with have discovered the importance of attending to the human element in knowledge management programs and are initiating various programs to facilitate knowledge creation and use. Although we can design programs to enhance organizational learning, knowledge transfer or innovation, it is often difficult to understand the impact of such interventions. We have found social network analysis (SNA)-a set of tools for mapping important knowledge relationships between people or departments-to be particularly helpful for improving collaboration, knowledge creation and knowledge transfer in organizational settings.

Aside from finding SNA merely helpful, we hold that it is indeed a necessary component in better understanding intra-organizational communication. A similar study was conducted by Cross *et al*. (2001). They were interested in better understanding social and technical means of improving a network's capacity to collectively recognize and act on new opportunities, as well as in discovering what made social relations effective in the creation of knowledge (Cross *et al*., 2001). With respect to the latter area of focus, they identified several features that determined the effectiveness of social relations. These are:

1) Knowledge

2) Access

3) Engagement

4) Safety

Social relations knowledge is defined in two different ways. The first relates to the basic definition of the word (i.e., whether a person has some specific knowledge regarding a particular problem.). The second definition focuses on the person's "ability to help think through a tough issue. These people were tapped for advice in either defining or refining a complex problems and were considered good at identifying and making salient important dimensions of such problems" (Cross *et al*., 2001). Having alternate definitions of knowledge can provide a more accurate and complete scope when attempting to classify and assess an employee's performance. It might be shown that an employee should be relocated to another department in order to fully utilize all of the employee's knowledge and talents.

Access refers to the availability of the knowledgeable employee. More specifically, the employee's wisdom is entirely useless if there are barriers to obtaining it. An example is if an employee constantly out of touch. This is especially important regarding time-sensitive cases (e.g., a client needs an answer to an important question by 1 pm, but the only person capable of answering doesn't arrive until 3 pm. Cross *et al*. (2001) specify how important it is to understand a person's preferred response style and what medium is most effective for establishing contact. They hold that this alone will reduce frustration in the work place as well as allow employees to have more accurate expectations from each other regarding communication.

Effective engagement can be characterized as a process comprised of two steps: “People would first ensure that they understood the other person's problem and then actively shape what they knew to the problem at hand." (Cross *et al*. 2001). This is particularly interesting in the sense that almost everyone encounters this situation on a day-to-day basis. For example, if an employee is in need of help, they must first find the knowledgeable person who is accessible to assist them. In order for there to be an effective engagement and useful flow of information, the knowledgeable person must understand what is being asked of him/her and efficiently as well as successfully disseminate the appropriate information back to the other employee. Cross *et al*. (2001) identify this person as being an "effective teacher".

The fourth and last feature of effective social relations is characterized by Cross *et al*. (2001) as "safety". This is essentially the degree of trust that the person asking for information has in the knowledgeable person. More specifically, the requestor must feel comfortable admitting his or her own ignorance about the issue in question. In

situations/organizations where there is a higher comfort level among relationships, it is clear how there can be a higher flow of information and even a higher quality (e.g., employees that are not afraid of asking each other questions are more likely to ask for help more frequently which can lead to better productivity of the company overall as fewer mistakes are likely to be made). Table 2-1 shows the objectives and interventions associated with these key features and concepts.

Borgatti and Cross delve deeper into the above-mentioned concepts in their 2003 paper. They investigate the reasons behind a person's decision to seek information from other people as well as the positive effects of doing so below:

> Learning someone's level of expertise or determining how to gain timely access to them affects the probability of seeking that person out for information in the future. At a collective level, the structure of these perceptual relations reflects learning and the potential of a network to identify and react to new issues or opportunities requiring coordinated effort or integration of disparate expertise. As members of one region of a network become aware of and [are] able to leverage the expertise of those in other regions, they become individually capable of doing more while the entire network's potential to sense and respond to new opportunities is also enhanced.

They add another concept labeled "value" to the previous ones. This concept is somewhat attached to the "knowledge" concept in that the person seeking the knowledge must positively evaluate the knowledge and skills of the person sought out in relation to the problem that the seeker is attempting to solve (Borgatti and Cross, 2003).

Hansen (1999) focuses on the strength of the ties in the network in relation to how productive and efficient the network is as. He holds that the complexity of the knowledge being transferred is directly proportional to the strength of the tie between the actors. In other words, the weaker the tie between actors, the less complex the knowledge in their information flow. Intuitively, this makes sense within a network

because the more complex an idea being communicated is, the higher the level of understanding between the actors there must be in order to ensure effective engagement. Another effect of the strength of ties is the speed of project completion. According to Hansen (1999), "Findings show that weak inter-unit ties help a project team search for useful knowledge in other subunits but impede the transfer of complex knowledge, which tends to require a strong tie between the two parties to a transfer. Having weak inter-unit ties speeds up projects when knowledge is not complex but slows them down when the knowledge to be transferred is highly complex." Consider, however, removing the complexity variable. It would appear that in a HR context, the above hypothesis still holds. For example, consider a hypothetical factory. Where weaker ties are present among workers, there is a diminished likelihood for prolonged interaction between them. In the case where ties between workers are stronger, there is the increased probability for more frivolous communication and thus, a possibility for decreased production. Since we have removed the complexity factor, it is unlikely that extensive communication will be beneficial to production. The other side of this argument is that stronger ties would mean more cohesion within the firm as a whole and everything would work more smoothly and efficiently. This is mostly determined by the type of firm in question, however.

Table 2-1. Multidimensionality of Knowledge

Aspects	Objectives	Technical interventions	Social interventions
Knowledge	Increase awareness of who knows what and who is working on what within the company	Skill profiling and corporate yellow pages	Communities of practice, thematic help desks manned by knowledge-area specialists and knowledge fairs
Access	Add speed of access to knowledge sharing and target accessibility as a critical behavior	Email and cell phones	Peer feedback forums and periodic SNA
Engagement	Increase ease of interaction, add a dimension to more-conventional communication that engages people. Enhanced performance Increased awareness of skills, abilities and knowledge of co-workers	Synchronous technologies White boarding applications Video conferencing	Peer reviews
Safety	Allow safe relationships to develop over time Increase visibility of relationships that are not safe so they can be discussed by the group	Any form of communication technology used throughout the company	Face-to-face interactions such as working sessions or “brown bag” lunches SNA

Source: Cross, Parker, Borgatti (2002)

CHAPTER 3
METHODS AND THEORY

3.1 Analytical Keywords and Principles

3.1.1 Similarities

Within social network analysis, there are several keywords and phrases that must be understood in order to effectively interpret research results. In their 2009 paper, Marin and Wellman begin with the term ‘similarities’. This is in reference to an event where two nodes share the attributes frequently studied in variable based approaches.

3.1.2 Social Relations

The term ‘social relations’ is defined by Marin and Wellman (2009) to include kinship or other types of commonly-defined role relations (e.g., friend, student); affective ties, which are based on network members' feelings for one another (e.g., liking, disliking); or cognitive awareness (e.g., knowing). This research focuses on the latter in that a major portion of the survey used in the research was dedicated to ascertaining how well the respondents knew each other.

3.1.3 Interactions

Another term commonly used in social network analysis is ‘interaction’. This is any behavior-based tie between nodes such as communicating with, helping, inviting somewhere etc. (Marin and Wellman, 2009). This term was also a major part of the research with respect to the survey. The respondents were questioned about the types of interactions and the frequency of interactions that they had with each other.

3.1.4 Flow

According to Marin and Wellman (2009), flows are relations based on exchanges or transfers between nodes. An example from this research project would be if a dyad were to share some type of information between them.

In addition to the keywords, there are also several principles that are used by social network analysts. The following principles outlined by Wellman (1983) are the most clearly presented ones:

- Ties are often asymmetrically reciprocal, differing in content and intensity.
- Ties link network members directly as well as indirectly; this means that we must analyze ties within the context of larger network structures.
- The structuring of social ties creates nonrandom networks; hence network clusters arise.
- Cross-linkages connect clusters as well as individuals.
- Asymmetric ties and complex networks distribute scarce resources differentially.

An example of what it means for ties to be asymmetrical reciprocal follows: Persons A and B both took a survey and responded to the question "How well do you know this person?" Person A's response in reference to person B was "Very Well" while person B's response to person A was "Slightly". It is reciprocal in the sense that they both indicated that they knew each other, however, it is asymmetrical because of the intensity or degree of knowing (i.e., slightly vs. very well).

Principle two may be explained as follows: While Persons A and B might have a dyadic relationship, person A also knows person C. At the same time, person B knows person D and person D knows person E etc. It is easy to see how several direct ties can lead to many indirect ties in the network. The possibilities for indirect ties are abundant because each direct tie links two individuals and not just two roles (Wellman, 1983).

Principle three introduces the idea of clustering. This happens when a dyad draws others with whom they are linked into a cluster (or group) of ties in which most members are directly linked with each other (Abelson, 1979; Cartwright and Harary, 1979). There can be many clusters in a network or there can be very few. Clusters may be very tight or loose. This wide range of possibilities is due, in part, to the type of network that is in question. For example, two kinds of networks that will share significant differences are a family and a business. For obvious reasons, the ties and clusters in a family will be very different from those in a business.

Principle four is rather self-explanatory in that, if person A is in group A and person B is in group B, their dyadic link also joins their respective groups together. This is what is meant by cross-linkage.

Finally with principle five, we see how networks structure collaborative and competitive activities in order to secure scarce resources. In a system with finite resources; social networks compete for the access to such resources (Mullady, 2008).

3.2 Types of Networks

Following the aforementioned definition of a social network (Wasserman and Faust, 1994) we focus on Hanneman and Riddle (2005) who provide a few examples of some simple networks below, aptly named for the shapes they take on:

Starting with the "star" network (Figure 3-1), we can immediately discern that node "A" is in a particularly interesting position in that it has the highest degree in the network. By highest degree, is meant that A has the highest number of connections within the network (Mullady, 2008). Subsequently, this means that it has the more opportunities and alternatives than the other nodes in the network (Hanneman and Riddle, 2005). The other nodes in the network share the same lower degree in that they

are only tied to "A". An example of a degree measure would be "coreness". Coreness is the measure of how centrally located an actor or node is in a subset of the group (Mullady, 2008). In this particular network "A" would be the most centrally located node.

Consider Figure 3-2 where the line network is displayed. This type of network offers a different structure in that there is not a particular node that is in a more advantageous position than the others. For example, nodes A and G are actually disadvantaged in the sense that they may only have ties with one other node, while nodes F, E D, C and B each have two ties. It is important to note that there is one node with a specific advantage with respect to "closeness". Closeness is the number of links that nodes go through to get to everyone else. Therefore people with a large closeness score are on the inside of the group and have the shortest paths to all others --they are close to everyone else. They are in an excellent position to monitor the information flow in the network --they have the best visibility of what is happening in the network (Beng-Chong and Daniel 2004). In this particular network, D would have the advantage as well as the highest closeness score because it is relatively closer to the rest of the nodes whereas A and G would be have the lowest score and be at the greatest disadvantage.

Focusing on Figure 3-3 or the "Circle" network, we notice that all actors share the same advantages and disadvantages. Notice how each of the actors are always "between" the other actors in the network. Betweenness is the measure of the extent to which a node lies on the geodesics between each other pair of nodes (Wellman, 2008). Geodesics refer to the shortest, straight-line path between two nodes (Webster's). With respect to Figure 3-1, we can see how node "A" is once again advantaged in that it is the only node between other nodes. This means that if A wants to contact F, A may

simply do so. If F wants to contact B, they must do so through A. This gives actor A the capacity to broker contacts among other actors -- to extract "service charges" and to isolate actors or prevent contacts (Hanneman and Riddle, 2005).

Degree, Coreness, Closeness and Betweenness are all measures of centrality. Centrality is the measure of the extent to which a particular node or actor dominates a network (Wellman, 2008). Measures of centrality are very important properties to social network analysis. Being able to understand and apply these measures of centrality to research allows analysts to effectively compare nodes within their respective networks.

3.3 Freeman Centrality

For the purposes of this research, when referring to degree centrality (or degree closeness and betweenness) we use Freeman's approach. This approach (modeled by Linton Freeman, a co-author of the UCINET© software used in this research) is shown below in Figure 3-4. A brief explanation on the importance of studying degree centrality is provided by Hanneman and Riddle (2005):

> Actors who have more ties to other actors may be advantaged positions. Because they have many ties, they may have alternative ways to satisfy needs, and hence are less dependent on other individuals. Because they have many ties, they may have access to, and be able to call on more of the resources of the network as a whole. Because they have many ties, they are often third-parties and deal makers in exchanges among others, and are able to benefit from this brokerage. So, a very simple, but often very effective measure of an actor's centrality and power potential is their degree.

In this example, the first column (numbers 1 through 10), represent each actor in the network. Hanneman and Riddle (2005) explain briefly how to interpret the Freeman degree centrality in the following:

> Actors #5 and #2 have the greatest out-degrees, and might be regarded as the most influential (though it might matter to whom they are sending information, this measure does not take that into account). Actors #5 and #2

> are joined by #7 when we examine in-degree. In the last two columns of the first panel of results above, all the degree counts have been expressed as percentages of the number of actors in the network, less one (ego).
>
> The next panel of results speaks to the "meso" level of analysis. That is, what does the distribution of the actor's degree centrality scores look like? On the average, actors have a degree of 4.9, which is quite high, given that there are only nine other actors. We see that the range of in-degree is slightly larger (minimum and maximum) than that of out-degree, and that there is more variability across the actors in in-degree than out-degree (standard deviations and variances). By the rules of thumb that are often used to evaluate coefficients of variation, the current values (35 for out-degree and 53 for in-degree) are moderate. Clearly, however, the population is more homogeneous with regard to out-degree (influence) than with regard to in-degree (prominence).
>
> The last bit of information provided by the output above are Freeman's graph centralization measures, which describe the population as a whole -- the macro level. This is how the Freeman graph centralization measures can be understood: they express the degree of inequality or variance in our network as a percentage of that of a perfect star network of the same size. In the current case, the out-degree graph centralization is 51% and the in-degree graph centralization 38% of these theoretical maximums. We would arrive at the conclusion that there is a substantial amount of concentration or centralization in this whole network. That is, the power of individual actors varies rather substantially, and this means that, overall, positional advantages are rather unequally distributed in this network.

Closeness centrality approaches emphasize the distance of an actor to all others in the network by focusing on the distance from each actor to all others (Hanneman and Riddle, 2005). The Freeman Geodesic Path Approach was used in this research and an example of the output is provided below in Figure 3-5.

Hanneman and Riddle (2005), provide a brief interpretation of the centrality closeness measures here:

> We see that actor 6 has the largest sum of geodesic distances from other actors (inFarness of 22) and to other actors (outFarness of 17). The farness figures can be re-expressed as nearness (the reciprocal of far-ness) and normed relative to the greatest nearness observed in the graph (here, the inCloseness of actor 7). Summary statistics on the distribution of the nearness and farness measures are also calculated. We see that the distribution of out-closeness has less variability than in-closeness, for

example. This is also reflected in the graph in-centralization (71.5%) and out-centralization (54.1%) measures; that is, in-distances are more un-equally distributed than are out-distances.

3.4 XYZ Corporation: A Case Study

The following is a brief description and background of the firm that was used in the research specific to this paper.

The study was conducted on XYZ Corporation (the name of the company has been altered to protect their anonymity). It is a bacteriological and chemical research company and was founded in 1976. It is one of the largest full-service laboratories in the U.S. and serves the global food industry. Just a few of their services include: Nutrition labeling solutions, product development and performance solutions, product safety and quality solutions as well as foreign material identification.

XYZ conducts daily chemical, physical, and microbiological analyses for its customer base of over 2000 food companies. This includes mostly large (but also small) fast-food chains, mainstream chain restaurants, food retail and wholesale firms, food-processing firms, packing firms, commercial farms, and some companies in foreign countries (Jaramillo, 2004).

As of mid 2010, XYZ has 54 employees distributed in the following departments:

- Administration
- Food Microbiology
- Research Microbiology
- Food Chemistry
- Research Chemistry
- Product Performance Services
- Administration/Other

The "Administration/Other" category is a not necessarily a department *per se*. Rather, it contains employees that are hybrids between administration and one or more of the other departments.

With so many departments and employees, it is the job of Human Resource management to understand how members of their respective departments interact with those in their departments as well as with those in other departments. This comprehension of social networking by upper management is discussed by John-Paul Hatala in his 2006 paper—"Social Networking Analysis in Human Resource Development: A New Methodology." He states:

> For HRD practitioners and researchers to improve the interactivity between individuals that leads to increased performance and effectiveness, it is necessary to identify techniques that measure the relations between people within a given environment. Social network theory involves a body of methods, measurement concepts, and theories that provide an empirical measure of social structure.

The following outlines the necessary steps taken in order to study the social network structure of XYZ Corporation.

3.5 Procedure

The research began with locating a suitable social network. Since the focus of the research was to be on an agribusiness firm, XYZ Research was the optimal selection. There was already an established relationship between the Food and Resource Economics Department of UF and XYZ. Also, XYZ was in very close proximity to UF campus allowing for the availability and ease of onsite access.

Once a social network was selected for the study, a survey was drafted. XYZ's employee list chemists, microbiologists, sales representatives, and office support staff. These are all very busy people. The survey instrument needed to allow for the collection

of complete and meaningful information, without taking too much time from employees. To accomplish the goals of this survey, Qualtrics Survey Software was used to design, construct, and test the survey. It also provided us an online medium in which to disseminate the survey among XYZ's employees.

In formulating the survey we selected questions that were imperative in analyzing the intra-organizational communication within a firm. The initial question in the survey served to identify the nodes (i.e., determine which employee was taking the survey at the given time) in XYZ Corporation. The survey was designed in such a way that when this question was answered, a specific number would be assigned to the respondent that would be his/her identification number for later data analysis.

The next question was designed to determine social relations between employees, meaning, how well the respondent knows (if he/she knows at all) the other employees. The following Likert scale (House 2008) was used in the survey:

1. Do not know
2. Know slightly
3. Know moderately
4. Know well
5. Know very well

It is important to note that for the purposes of our research, we advised the respondents to select "Do not know" if they were only familiar with someone's name or knew of the person in question but never interacted with them. This was done to ensure that there was at least some form of communication between employees that indicated that they "knew" each other, as in a work situation, they may have been aware of names of other employees, but not interact with them.

The next question focused on the types of communication methods used, as well as how often the methods were used. The respondents were using an average two week period as the guideline for their answers. We specified an "average" two week period because we wanted to know what typical results would be. The respondents were provided with four methods of communication in which to choose from: Email, In person, Phone or other. The 'other' category encompassed more modern methods of communication including: Text messages, Skype™, Instant messaging, Facebook© etc.

The remaining questions in the survey captured demographic information, including age, race/ethnicity, level of education and gender. Other information collected included their work information including what department they worked in, how long they had been employed by XYZ and whether they were full or part time employees. This was done in order to have the most complete profile of the employees.

Once the survey was designed (Figure 3-6), the next step was to get approval from the University of Florida Institutional Review Board. This was to ensure that we were legally allowed to conduct the research and to certify that there would be no risks or benefits to possible respondents for participating. The actual document (IRB Consent Form) had to be signed by the prospective respondents before we could administer the survey.

3.6 Administering the Survey

The survey was administered through two methods. The first method (the more common method) involved an onsite interview with XYZ employees. The interviews took place in a closed conference room where the principal investigator ensured all IRB forms were signed and dated. The principal investigator administered the survey to each employee one at a time while recording answers in the online survey software.

About 95% of respondents were surveyed using this method. The other 5% (who were not available for the onsite interview) were called and the survey was administered over the phone. One employee took the survey on their own through the online site after discussing the instructions with the principal investigator.

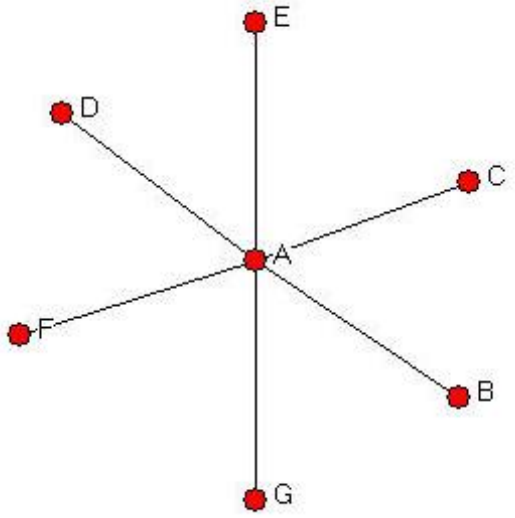

Figure 3-1. Star Network

Figure 3-2. Line Network

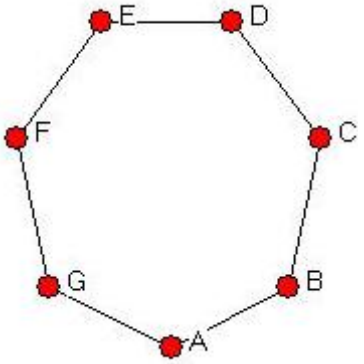

Figure 3-3. Circle Network

Closeness Centrality Measures

	1 inFarness	2 outFarness	3 inCloseness	4 outCloseness
7	9.000	16.000	100.000	56.250
5	10.000	10.000	90.000	90.000
2	10.000	11.000	90.000	81.818
4	13.000	15.000	69.231	60.000
9	13.000	16.000	69.231	56.250
1	14.000	15.000	64.286	60.000
3	14.000	12.000	64.286	75.000
10	16.000	13.000	56.250	69.231
8	17.000	13.000	52.941	69.231
6	22.000	17.000	40.909	52.941

Statistics

		1 inFarness	2 outFarness	3 inCloseness	4 outCloseness
1	Mean	13.800	13.800	69.713	67.072
2	Std Dev	3.682	2.227	17.584	11.616
3	Sum	138.000	138.000	697.133	670.721
4	Variance	13.560	4.960	309.201	134.925
5	SSQ	2040.000	1954.000	51691.488	46335.906
6	MCSSQ	135.600	49.600	3092.015	1349.255
7	Euc Norm	45.166	44.204	227.358	215.258
8	Minimum	9.000	10.000	40.909	52.941
9	Maximum	22.000	17.000	100.000	90.000

Network in-Centralization = 71.51%
Network out-Centralization = 54.14%

Figure 3-4. Geodesic path closeness centrality for Knoke information network

Source: Hanneman and Riddle, 2005

	1 OutDegree	2 InDegree	3 NrmOutDeg	4 NrmInDeg
1	4.000	5.000	44.444	55.556
2	7.000	8.000	77.778	88.889
3	6.000	4.000	66.667	44.444
4	4.000	5.000	44.444	55.556
5	8.000	8.000	88.889	88.889
6	3.000	1.000	33.333	11.111
7	3.000	9.000	33.333	100.000
8	6.000	2.000	66.667	22.222
9	3.000	5.000	33.333	55.556
10	5.000	2.000	55.556	22.222

DESCRIPTIVE STATISTICS

		1 OutDegree	2 InDegree	3 NrmOutDeg	4 NrmInDeg
1	Mean	4.900	4.900	54.444	54.444
2	Std Dev	1.700	2.625	18.889	29.165
3	Sum	49.000	49.000	544.444	544.444
4	Variance	2.890	6.890	356.790	850.617
5	SSQ	269.000	309.000	33209.875	38148.148
6	MCSSQ	28.900	68.900	3567.901	8506.173
7	Euc Norm	16.401	17.578	182.236	195.316
8	Minimum	3.000	1.000	33.333	11.111
9	Maximum	8.000	9.000	88.889	100.000

Network Centralization (Outdegree) = 38.272%
Network Centralization (Indegree) = 50.617%

Figure 3-5. Freeman degree centrality and graph centralization of Knoke information network.

Source: Hanneman and Riddle, 2005.

1. What is your name?
2. Please indicate how well you know the following people (names omitted for confidentiality).

Evaluation Scale: (5) Very Well (4) Know Well (3) Moderately (2) Slightly (1) Don't Know

(List of Names) 5 4 3 2 1

3. Please indicate how many times in a typical 2 week period you have used the following methods of communication with the following people:

Email	In-person	Phone	Other

4. What department do you work in primarily?

Administration
Food Chemistry
Research Chemistry
Food Microbiology
Research Microbiology
Product Performance
Other

5. What is your age?

6. Which of the following describes your racial and ethnic background? (Select all that apply)

White
African American/Black
Hispanic
Asian or Pacific Islander
American Indian or Alaskan Native
Other

7. What is the highest level of education you have completed?

High School Diploma (or equivalent or less)
Some college or 2-year degree

Figure 3-6. XYZ Communication Survey

CHAPTER 4
EMPIRICAL RESULTS

4.1 Initial Analysis

Once the data was collected, it was analyzed through the use of several software programs including Microsoft Excel®, UCINET© for Windows, NetDraw© and SAS®. All of the responses to the survey were tabulated in Excel® . In particular, the responses to the second question (how well the other employees were known) were ordered into an asymmetric full matrix (Figure 4-1). The use of a symmetric matrix would have rendered our results useless (it would have falsely shown that all employees reported knowing each other equally well, which is clearly not the case).

The responses to question three (how often each method of communication was used) were compiled into Table 4-1. This table summarizes the frequency of use of each method (email, in-person, phone or other) within a typical two-week period for each employee. Demographic information from the last question was compiled into Table 4-2, and the values in this table can be interpreted using the accompanying Table 4-3.

4.2 Network Structure and Analysis

With UCINET© and Netdraw©, we used the values Figure 4-1 in conjunction with the values in Table 4-2 to construct a visual representation of the company and its employees that is consistent with the "fabric-like" model so commonly referred to in social network analysis (Figure 4-2).

We can see how each department is its own cluster and that all of the departments are focused around one central area-Administration. While it is interesting to actually visualize this, it is what we would expect within any company: that administration is the

center of the social network structure. It is from this position where administration can most efficiently and effectively operate and manage the company. As we will see later in the paper, this is the reason for the higher centrality scores reported for those employees within administration.

It is important to note that this Figure 4-2 only includes responses indicating that employees knew each other "very well". As we included more responses (i.e., take into account those who reported "knowing slightly", "knowing moderately", "knowing well" etc.), the figure has increasingly more ties, making it difficult to determine what connections are actually present. For this reason, all but the following figure (Figure 4-3) will feature only the "know very well" ties.

Figure 4-3 has ties included for "know moderately", "know well" and "know very well". This can be interpreted to mean how many employees indicated knowing each at least moderately.

To visualize the impact of how long a person has worked at XYZ on their position within the network, the node sizes were adjusted based on the "time employed" variable (Figure 4-4).

Again, with the exception of a few, the employees in administration tend to have the larger nodes, indicating that they have been employed the longest.

4.3 Centrality Scores

The centrality scores of the employees were calculated using UCINET© (focusing on degree, closeness and betweenness). These scores were consolidated into Table 4-4. For the purposes of this paper, we will be focusing on the "in" measures (where applicable), the indication of how other people rated how well they knew the subject in the measure.

The degree scores ranged from 59 to 168 with a mean of 111.57 over the 42 observations. The degree network centralization contains insight on how the network is structured. While a high network centralization percentage (e.g., the star network depicted in Figure 3-1) signifies a very centralized network, it is not always optimal. In fact, Krebs (2010) describes this case of a very centralized network:

> A very centralized network is dominated by one or a few very central nodes. If these nodes are removed or damaged, the network quickly fragments into unconnected sub-networks. A highly central node can become a single point of failure. A network centralized around a well connected hub can fail abruptly if that hub is disabled or removed. Hubs are nodes with high degree and betweenness centrality. A less centralized network has no single points of failure. It is resilient in the face of many intentional attacks or random failures -- many nodes or links can fail while allowing the remaining nodes to still reach each other over other network paths. Networks of low centralization fail gracefully.

In XYZ's case network degree centralization was 28.2%. The degree centrality scores for those in administration are higher when compared to the other employees. Out of all of the administration employees, 75% had scores above the mean for the company.

Closeness measures how connected each employee is to all other employees a higher score means that the employee has many avenues within the company to send and receive information. This is regarded as having a high "flow". The closeness scores ranged from 56.16 to 100 with a mean of 75.99. Once again, 75% of employees in administration had scores higher than the company average and there was a network centralization score of 49.81%.

The last centrality score identified is betweenness. The betweenness scores ranged from 0.49 to 54.76 with an average of 14.5. Roughly 70% of administration

employees scored above the average company score. The network centralization percentage was 2.41.

The centrality results for degree, closeness and betweenness are shown graphically in Figures 4-5, 4-6 and 4-7 respectively. In each of these figures, the node size is adjusted to represent the relative size of their network scores.

4.4 Regression Results

Regression analysis was used to determine the effect of several social network variables on the centrality scores of the employees in XYZ. In particular, an ordinary least squares model was used and the following equation was estimated:

$y = \beta_1 x_1 + \beta_2 x_2 + \beta_k x_{k...}$, where y is the dependent variable, x's are dependent variables and β's are the model parameters to be estimated.

Table 4-5 shows the results of the regression when the dependent variable was the degree score and independent variables were the following:

- Hybrid
- Administration
- Time employed
- Email sum
- Phone sum
- In-person sum
- Away (accounting for offsite employees)

The hybrid variable represents a department in XYZ where employees are a combination of administration and some other department. Time employed represents how long the employees worked for XYZ in terms of months. Email, phone and In-person sums represent the total amount of interactions for each respective method of communication. The away variable represents if employees worked on site or not.

The hybrid, time employed and email sum variables were all significant at the 1% level and all positively related to degree scores. The away variable was significant at the 1% level but, as expected, was negatively related to degree scores. The phone sum variable was significant at the 5% level and was negatively related to degree scores. The in-person sum variable was significant at the 5% level and was only slightly positively related to degree scores. The administration variable was not significant.

Table 4-6 depicts results for the case when the dependent variable was changed to closeness, *ceteris paribus*.

The hybrid, time employed and email sum variables were all significant around the 1% level and all positively related to centrality scores. The away variable was significant at the 1% level but, as expected, was negatively related to centrality scores. The phone sum variable was significant at the 10% level and was slightly negatively related to centrality scores. The in-person sum variable was significant at the 10% level and was only slightly positively related to centrality scores. The administration variable was not significant. Table 4-7 has the dependent variable as betweenness, *ceteris paribus*.

The hybrid variable was significant at the 1% level and was positively related to betweenness scores, Time employed and email sum variables were significant at 5 and 10 %t levels respectively, and positively related to centrality scores. The away variable was significant at the 5% level and was negatively related to centrality scores. The phone sum variable was not significant. The in-person sum variable was significant at the 5% level and was only slightly positively related to centrality scores. The administration variable was not significant.

Table 4-8 features the dependent variable as degree once again; however, this time the independent variables only include the gender and ethnicity variables which were not significant.

Figure 4-8 depicts a scatter-plot and a best-fit line correlating degree score by time employed.

	A1	FMB1	FMB2	PP1	A2	A3	A4	FMB3	FC1	RC1	FC2	FC3	FMB4	FC4	A5	A6	A7	RM1	RC2	A8	A9	FMB5	A10	FMB6	FMB7	PP2	FC5	A11	A12	PP3	A13	PP4	A14	FMB8	A15	FC6	FMB9	RM2	A16	FC7	FC8	RM3
A1		1	3	1	2	4	5	1	1	1	1	1	1	1	4	1	2	1	1	1	4	1	2	3	1	1	1	2	2	1	1	2	2	1	3	1	1	2	3	1	1	1
FMB1	1		5	1	2	5	5	4	2	1	1	3	5	1	4	3	1	1	1	2	1	5	5	5	1	1	2	5	5	1	5	4	5	5	5	1	5	3	1	1	1	5
FMB2	1	5		1	5	4	4	3	4	2	1	5	5	1	3	4	2	3	2	3	2	5	3	5	3	1	2	4	4	1	5	4	4	4	4	1	3	5	2	2	1	4
PP1	1	1	3		2	4	4	1	1	1	1	4	1	1	4	1	1	1	1	1	1	1	1	1	1	5	3	4	4	4	4	5	1	1	3	3	1	1	3	1	1	1
A2	3	1	5	2		5	5	1	3	2	1	3	3	1	5	5	5	5	4	5	3	1	4	5	1	2	4	5	1	1	4	4	5	1	5	1	1	3	4	2	1	2
A3	5	4	5	3	5		5	1	5	2	3	4	3	3	5	5	3	4	4	5	5	2	5	5	2	2	5	5	5	2	5	4	5	2	5	2	1	4	5	2	2	3
A4	5	2	3	3	3	5		1	2	2	1	2	1	2	5	3	2	3	3	2	3	1	3	4	1	3	4	5	5	3	4	5	5	1	5	1	1	4	2	2	1	2
FMB3	1	4	4	1	1	1	1		1	1	1	1	4	1	1	1	1	1	1	1	1	4	4	4	3	1	1	2	4	1	3	1	1	4	2	1	4	1	1	1	1	4
FC1	1	2	3	1	3	3	3	1		3	1	5	1	5	3	5	2	2	3	4	1	1	4	2	1	3	5	4	4	1	3	3	3	1	4	5	1	2	2	5	5	3
RC1	2	1	4	1	3	5	4	1	5		1	5	1	5	3	5	5	4	5	1	2	1	1	4	1	2	5	5	5	2	5	5	4	1	5	5	1	4	1	5	4	1
FC2	1	1	2	1	2	2	2	1	5	3		4	2	4	2	2	1	1	4	2	1	1	2	2	1	1	4	3	4	1	2	2	2	1	3	3	1	2	1	5	3	2
FC3	1	1	5	4	3	4	4	1	4	3	1		1	5	4	5	1	2	4	4	1	1	5	3	1	4	4	4	4	1	4	4	4	1	4	5	1	1	1	5	3	4
FMB4	1	5	5	1	2	2	2	2	1	1	1	2		1	2	2	1	1	1	2	1	4	1	5	1	1	1	4	5	1	3	2	1	5	4	1	2	4	2	1	1	5
FC4	1	1	2	1	2	2	2	1	5	3	1	5	1		4	4	2	1	3	3	1	1	2	2	1	3	5	3	1	1	2	3	2	1	3	4	1	2	1	4	4	2
A5	5	2	5	2	5	5	5	2	5	3	3	5	4	4		5	3	5	5	5	5	2	5	5	2	2	5	5	5	2	5	5	5	3	5	3	2	5	5	3	3	3
A6	3	1	4	1	4	4	4	1	5	2	3	5	2	3	4		2	4	3	4	4	2	5	4	1	1	4	4	4	3	3	3	4	1	4	3	1	3	4	3	2	4
A7	3	1	4	1	5	3	3	1	2	1	1	1	1	1	3	3		1	1	3	1	1	3	4	1	1	2	4	1	1	4	4	5	1	4	1	1	3	2	1	1	1
RM1	2	1	4	1	4	4	4	1	1	2	1	1	1	1	4	4	1		1	4	1	1	3	5	1	1	3	4	3	1	4	3	4	1	4	1	1	5	2	1	1	4
RC2	1	2	3	2	3	4	4	1	4	5	1	4	1	4	4	4	1	1		3	2	1	2	1	1	1	3	3	3	1	2	2	2	1	3	1	1	1	2	5	2	1
A8	1	1	5	1	5	5	5	1	5	1	1	5	4	5	5	5	4	5	5		3	1	5	5	1	1	5	5	5	1	5	5	5	3	5	1	1	5	5	4	1	5
A9	4	1	5	1	4	5	5	1	1	1	1	2	1	1	5	3	1	3	1	3		2	4	4	1	2	4	4	3	1	1	3	5	2	4	1	2	3	3	2	1	2
FMB5	1	4	5	1	2	4	4	5	1	1	1	2	5	1	4	3	1	1	1	3	1		1	5	4	1	2	4	5	1	5	4	2	5	4	1	4	4	1	1	1	4
A10	2	2	3	1	4	5	3	1	4	1	1	3	1	1	3	5	3	1	1	5	3	1		3	1	1	4	3	5	1	5	2	5	1	2	1	1	2	2	3	5	5
FMB6	4	5	5	2	5	5	5	5	4	3	2	4	5	1	5	5	3	5	2	5	5	5	4		5	2	4	5	5	1	5	5	5	5	5	1	5	5	5	1	1	5
FMB7	1	4	4	1	1	1	1	1	1	1	1	1	4	1	1	1	1	1	1	1	1	1	4	4		1	1	2	3	1	1	1	1	4	1	1	4	3	1	1	1	3
PP2	1	1	2	4	1	1	2	1	3	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1		2	3	3	3	3	4	1	1	1	2	1	1	1	1	1	1
FC5	1	1	4	1	4	5	5	1	5	3	1	5	1	5	3	4	1	3	3	3	2	1	4	3	1	1		5	5	1	3	4	4	1	4	4	1	2	3	5	3	3
A11	2	3	5	2	4	5	5	1	4	2	1	4	3	3	5	3	2	4	4	5	2	3	4	5	1	3	5		5	2	5	5	5	3	5	3	1	5	3	3	1	3
A12	1	5	5	4	5	5	5	3	5	3	3	5	5	4	5	5	4	1	3	5	4	5	5	5	4	5	5	5		3	5	5	5	5	5	5	3	5	4	5	1	5
PP3	1	1	3	5	2	2	5	1	1	2	1	4	1	1	3	2	1	1	1	2	1	1	1	2	1	5	2	5	5		5	5	1	1	4	3	1	2	3	1	1	1
A13	1	3	4	1	3	4	4	1	3	5	1	3	3	1	4	4	1	5	1	2	1	2	2	4	2	3	3	5	4	2		4	4	3	4	1	1	4	1	1	1	3
PP4	2	3	4	5	4	4	5	1	3	3	1	5	3	1	5	4	1	3	1	3	2	2	2	4	2	5	4	5	5	5	4		4	3	4	3	2	4	3	1	1	1
A14	2	3	5	1	5	1	5	1	5	2	2	5	2	3	5	5	3	5	2	5	3	1	5	5	1	2	5	5	5	2	5	4		2	5	1	1	4	4	3	1	4
FMB8	1	5	5	1	2	3	3	3	1	1	1	2	5	1	2	2	1	1	1	2	1	5	1	4	3	1	2	4	4	1	5	3	2		2	1	3	4	1	1	1	5
A15	2	4	5	2	4	4	4	2	5	3	4	4	3	3	5	5	2	4	3	5	3	2	5	4	2	2	4	5	5	2	5	3	5	2		2	2	3	3	3	2	4
FC6	1	1	3	1	2	3	3	1	5	5	1	5	1	5	3	4	1	1	4	1	1	1	2	1	1	4	5	4	4	1	1	5	1	1	4		1	2	2	5	5	1
FMB9	2	4	5	2	1	3	3	4	1	1	2	2	5	1	1	1	1	1	1	1	1	5	4	5	5	1	1	3	5	3	5	3	1	4	2	1		3	1	1	1	3
RM2	1	4	5	1	4	4	5	3	2	3	1	3	4	1	4	3	3	5	2	3	2	4	2	5	4	2	2	5	5	1	5	4	4	4	4	1	3		3	1	1	5
A16	4	2	5	1	4	5	5	1	3	1	1	4	1	1	5	5	3	4	2	5	5	1	5	5	1	1	5	5	4	1	5	5	5	1	5	1	1	5		1	1	1
FC7	1	1	3	2	2	3	3	1	5	4	5	5	1	5	4	4	1	1	5	1	1	1	2	2	1	2	5	4	1	2	1	3	3	1	4	4	1	1	1		4	3
FC8	1	1	1	1	1	1	1	1	4	2	1	4	1	1	1	3	1	1	2	2	1	1	4	1	1	2	3	3	1	1	1	1	1	1	2	3	1	1	1	3		1
RM3	1	2	5	1	2	2	2	2	2	1	1	2	3	1	3	5	1	5	1	3	1	1	3	5	2	1	1	4	1	1	4	2	5	5	5	1	1	5	1	1	1	

Figure 4-1. Knowledge Matrix

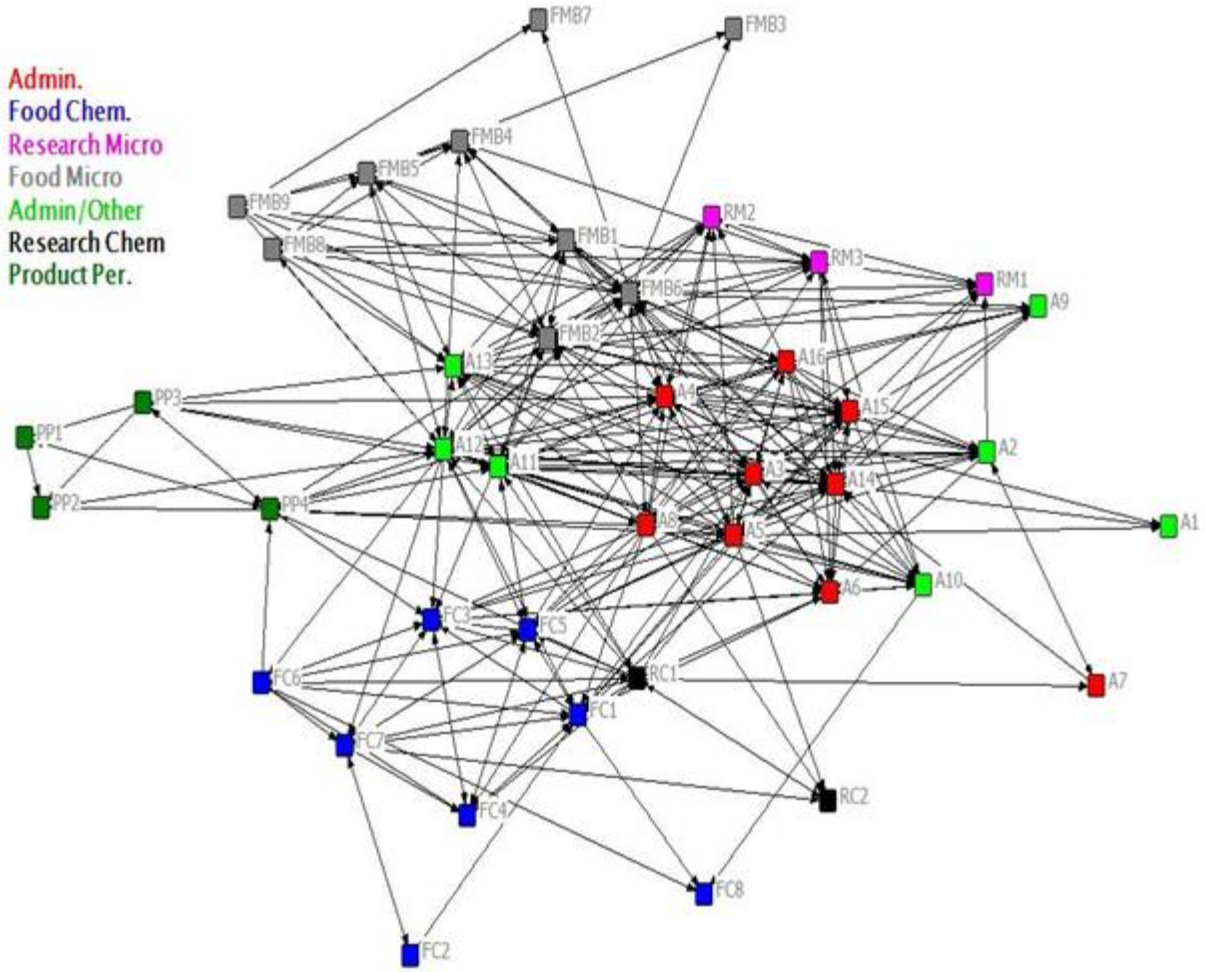

Figure 4.2. Know Very Well

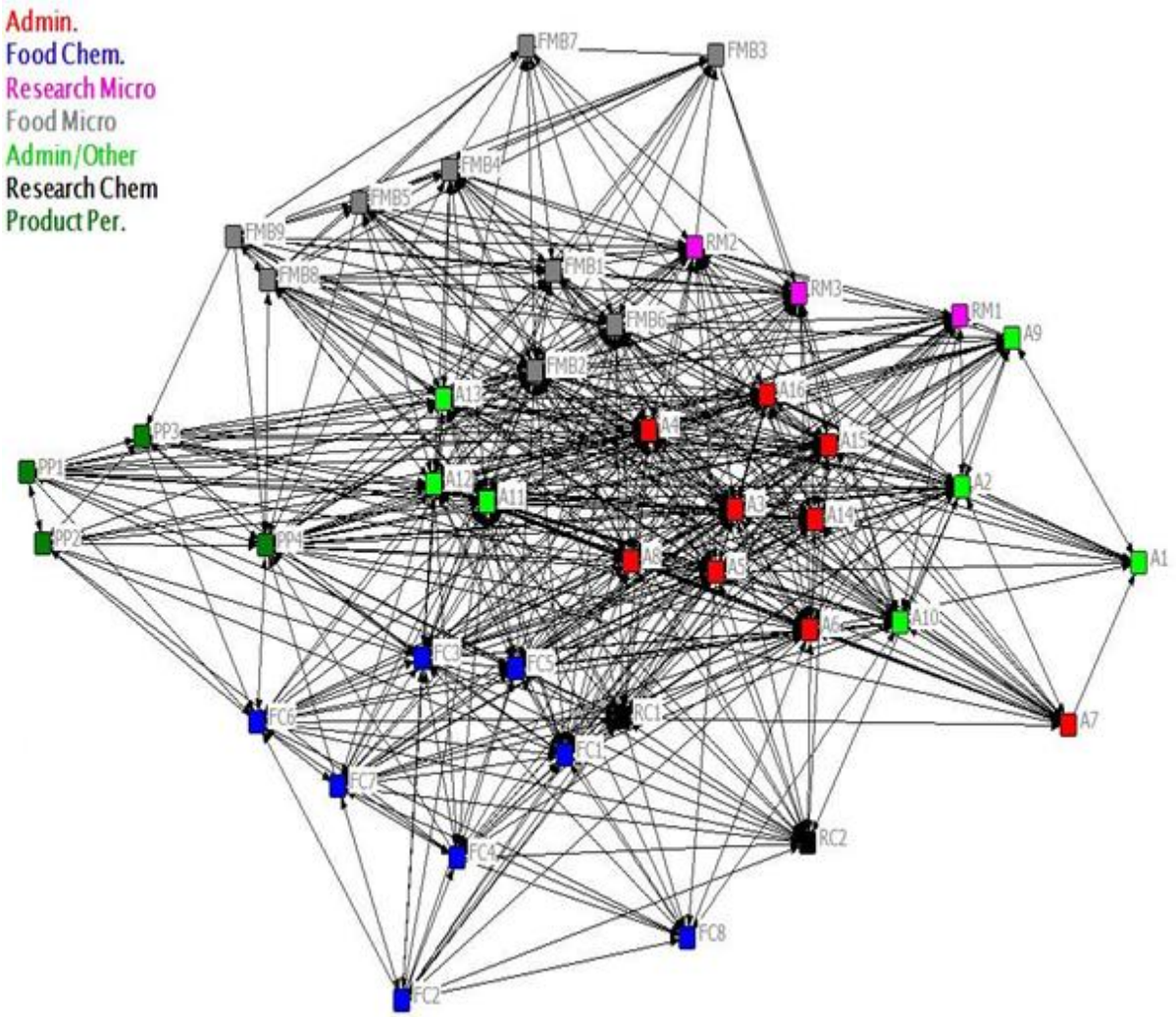

Figure 4-3. Know Moderately

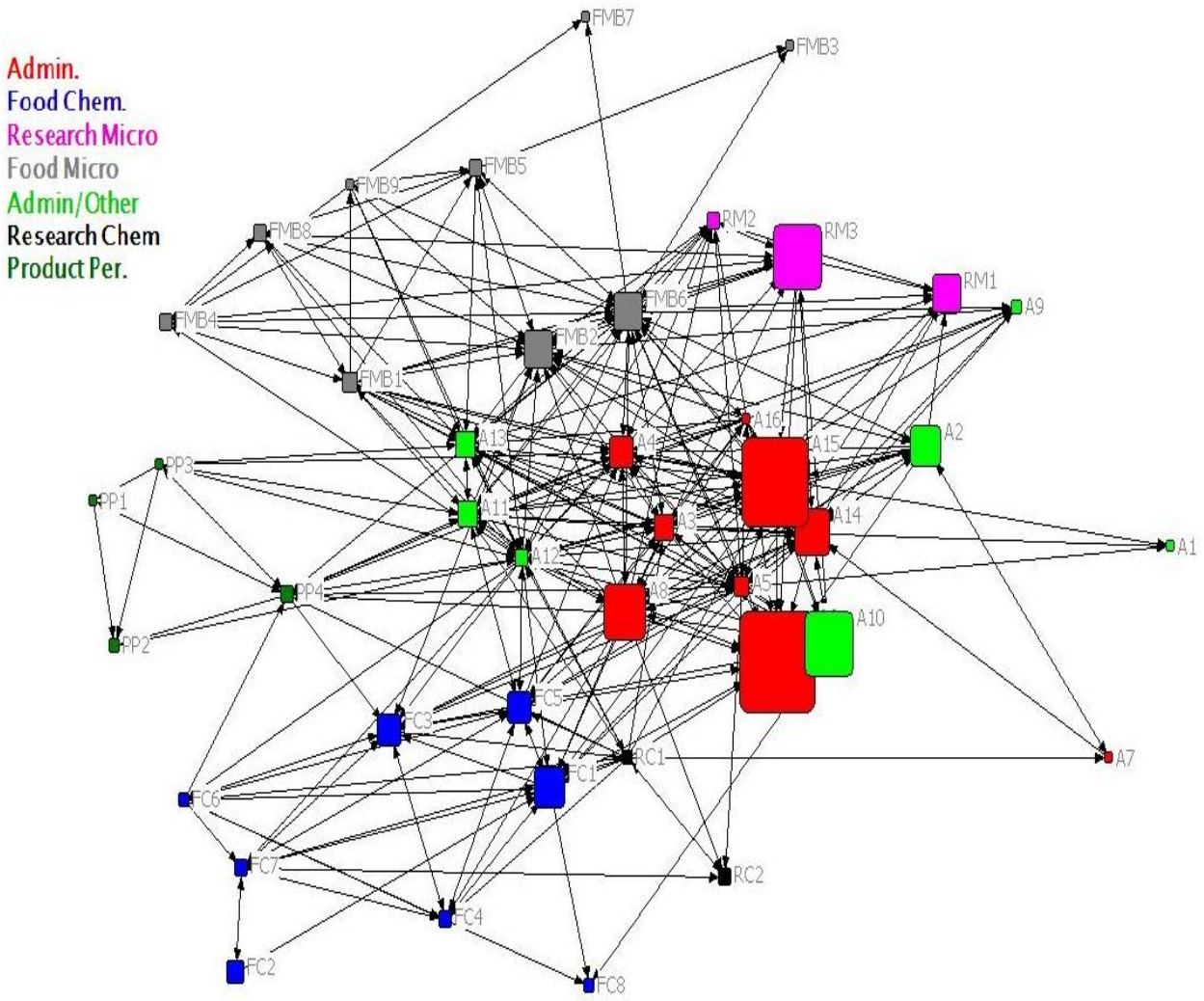

Figure 4-4. Time Employed

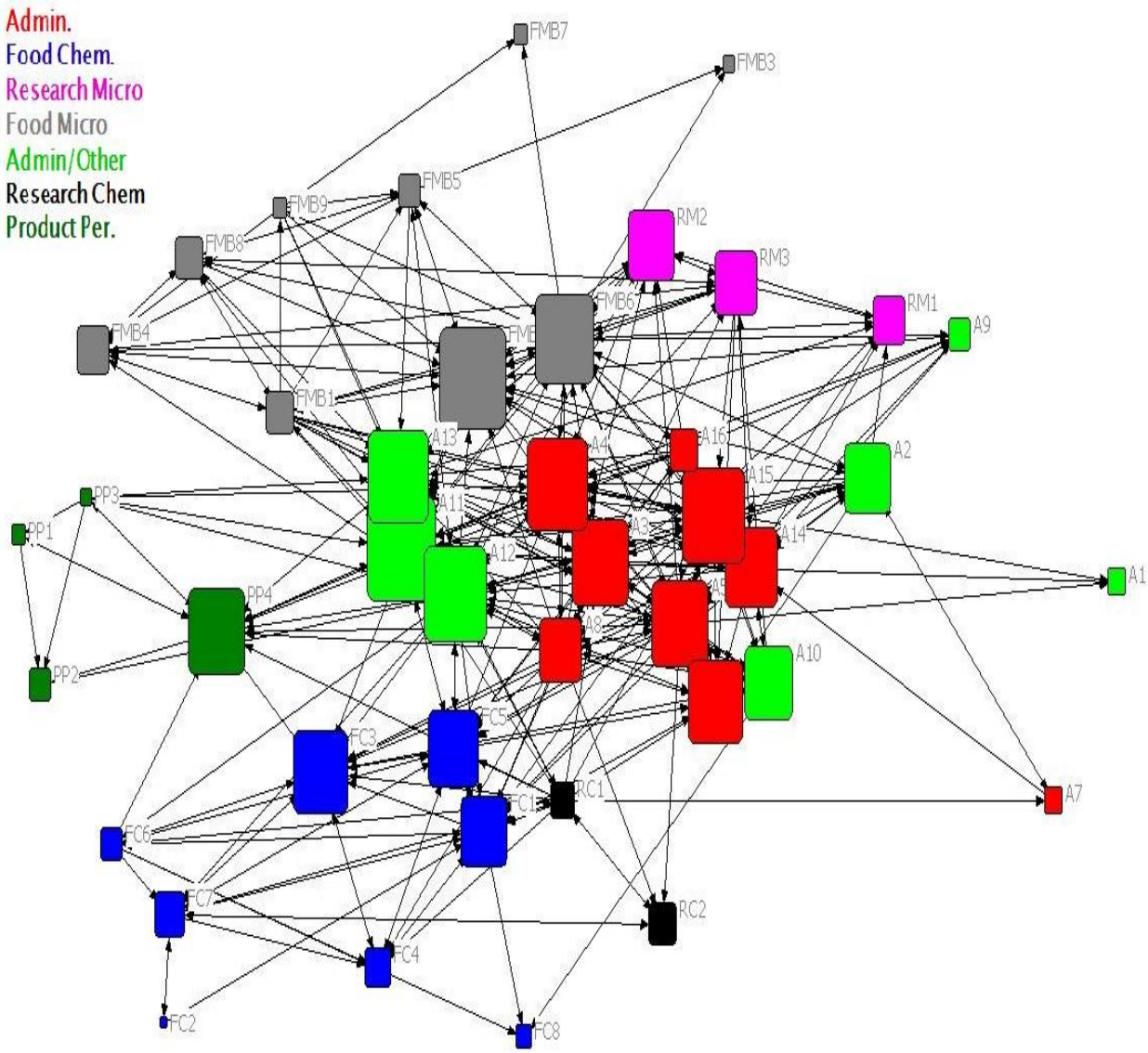

Figure 4-5. Centrality Graph (Degree)

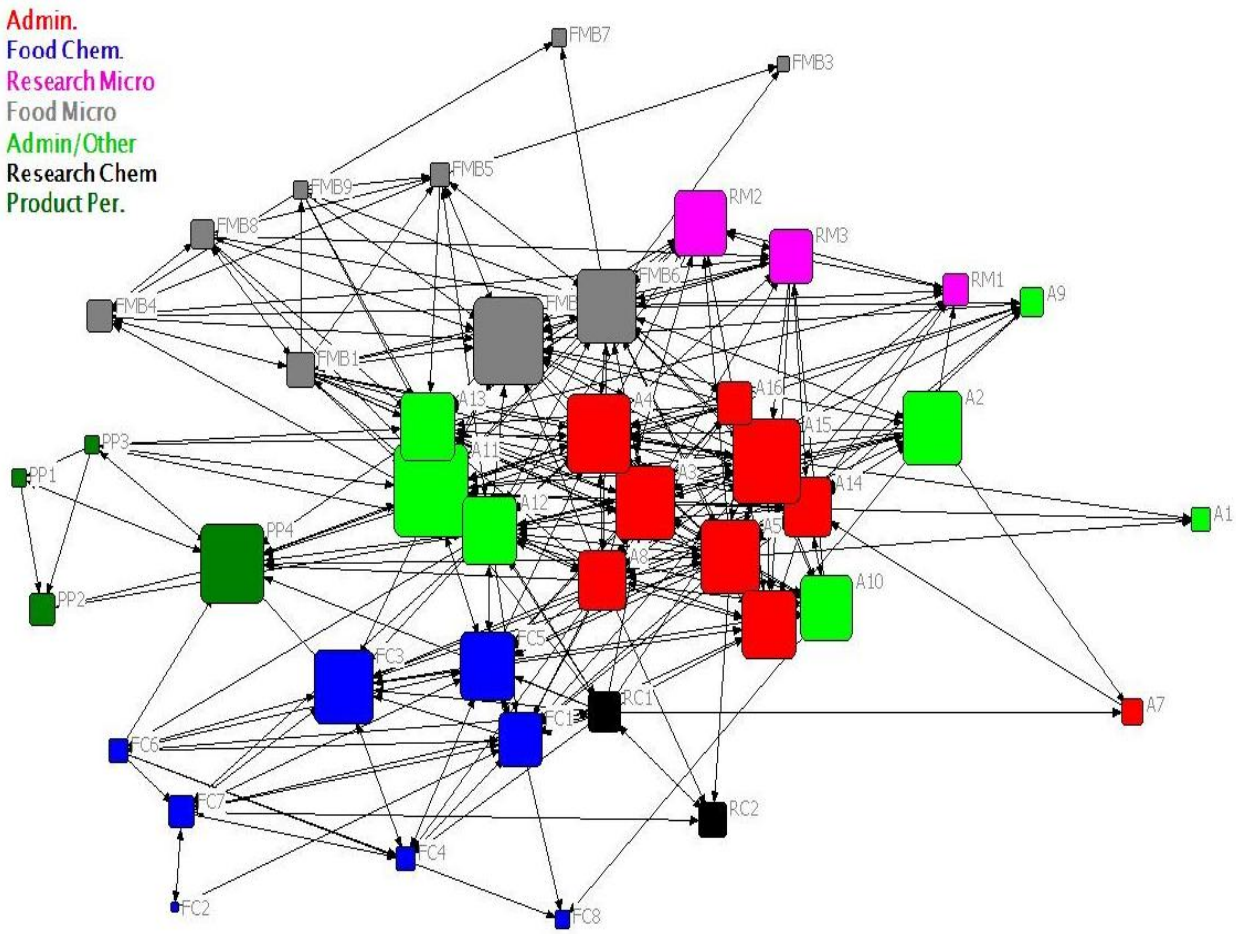

Figure 4-6. Centrality Graph (Closeness)

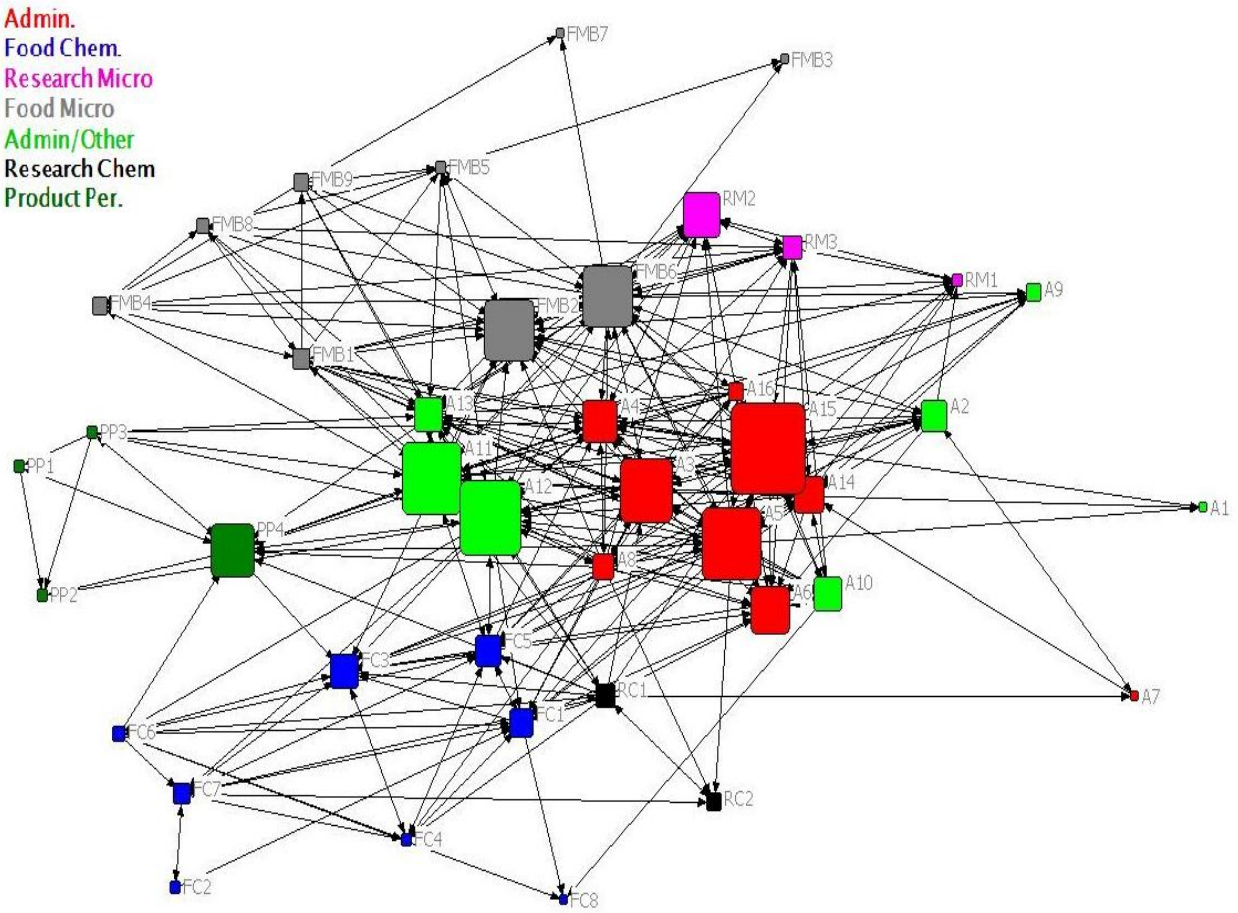

Figure 4-7. Centrality Graph (Betweenness)

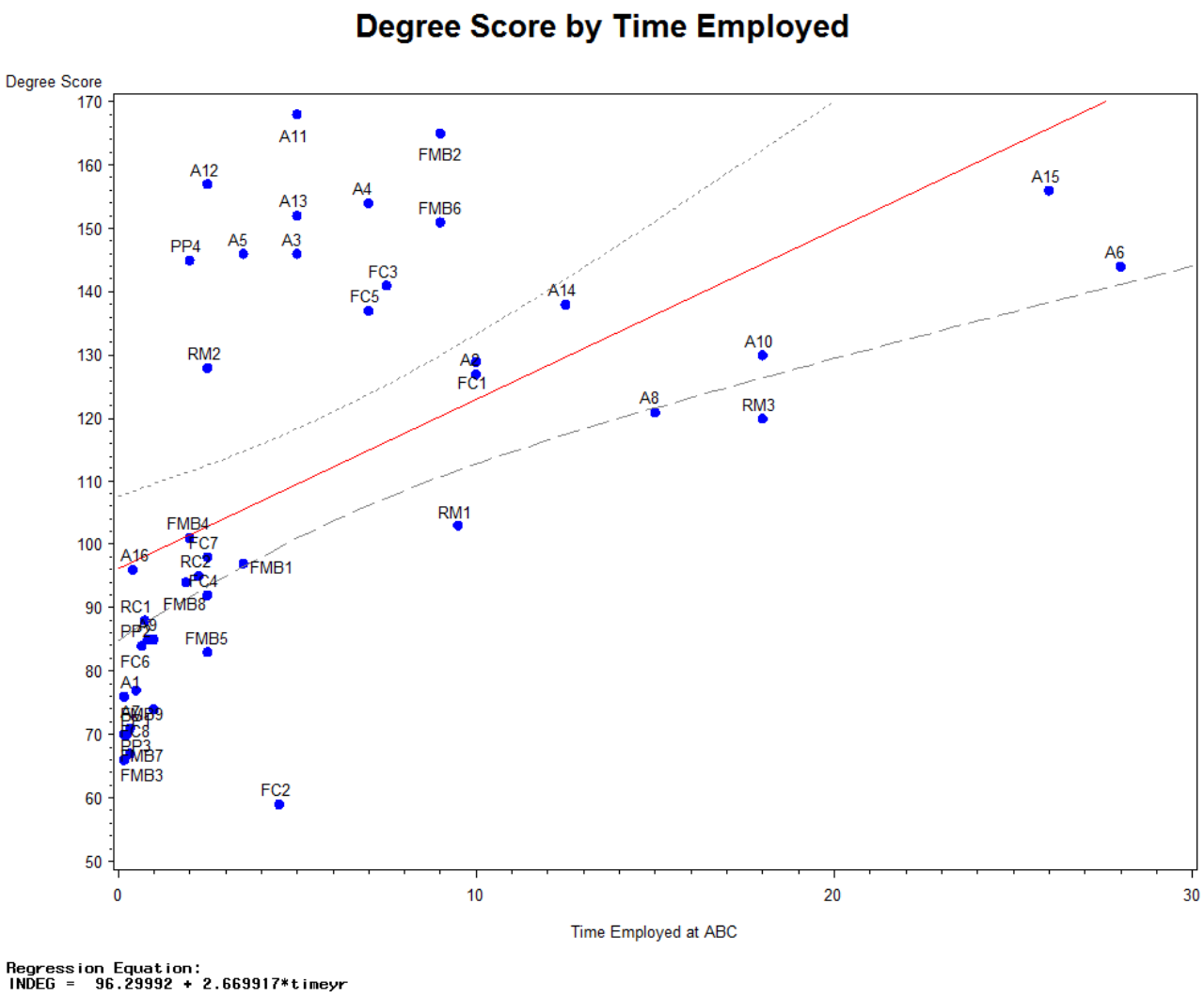

Figure 4-8. Degree Score by Time Employed

Table 4-1. Communication Method: Frequency of Use

ID	Email Sum	In Person Sum	Phone sum[1]	Other sum	Total Sum
A1	449.5	1	221	230	901.5
A10	605	890	355	0	1850
A11	171.5	575	169	0	915.5
A12	0	1204	80	0	1284
A13	133	807	161	3	1104
A14	460	497	28	0	985
A15	51	353	86	0	490
A16	1120	1323	1410	20	3873
A2	201	232.5	124	0	557.5
A3	1230	1125	1315	50	3720
A4	487	407	260	0	1154
A5	560	1864	260	0	2684
A6	355	845	356	5	1561
A7	115	169	163	0	447
A8	0	239	4	0	243
A9	532	0	325	0	857
FC1	146	863	189	0	1198
FC2	0	830	0	0	830
FC3	0	1418	237	0	1655
FC4	0	817	1	0	818
FC5	119	785	54	0	958
FC6	1	1100	11	0	1112
FC7	0	714	1.5	0	715.5
FC8	0	55.5	0	0	55.5
FMB1	8	952	0	8	968
FMB2	233	1334.5	122	61	1750.5
FMB3	0	462	0	0	462
FMB4	0	851	6	5	862
FMB5	2	1340	0	8	1350
FMB6	238	934	49	56	1277
FMB7	3	655	0	0	658
FMB8	0	900	0	2	902
FMB9	0.5	865	0	0	865.5
PP1	7	205	1	120	333
PP2	0	652	0	0	652
PP3	10	773	0	19	802

[1] Note: Phone communications also include the use of the intercom within XYZ

Table 4-1. Continued

ID	Email Sum	In Person Sum	Phone sum[2]	Other sum	Total Sum
PP4	267	730	166	20	1183
RC1	1.5	213.5	0	10	225
RC2	19	250	25	6	300
RM1	263	156.2	44.7	0	463.9
RM2	411	1253	131	0	1795
RM3	0	831	0	0	831
TOTAL	8199	30471.2	6355.2	623	45648.4

Table 4-2. Demographic Information

ID	Time-employed	Department	Age	Race	Education	Employment	Gender	Away
A1	2	7	4	1	4	1	1	1
A10	216	7	3	1	1	1	2	1
A11	60	7	4	3	4	1	2	0
A12	30	7	8	2	1	1	1	0
A13	60	7	6	5	5	1	2	0
A14	150	1	7	1	2	1	2	0
A15	312	1	9	1	1	1	2	0
A16	5	1	2	1	3	1	1	0
A2	120	7	5	4	4	1	1	0
A3	60	1	5	1	3	1	1	0
A4	84	1	4	1	5	1	2	0
A5	42	1	8	1	4	1	1	0
A6	360	1	8	2	2	1	1	0
A7	6	1	3	1	2	2	1	0
A8	180	1	11	1	5	2	1	0
A9	12	7	7	1	2	1	1	1
FC1	120	2	6	2	3	1	2	0
FC2	54	2	7	4	3	1	2	0
FC3	90	2	7	1	2	1	1	0
FC4	30	2	3	1	2	1	1	0
FC5	84	2	7	1	3	1	2	0
FC6	10	2	2	1	3	1	2	0
FC7	30	2	3	1	3	1	1	0
FC8	12	2	2	1	2	2	1	0
FMB1	42	4	2	2	2	2	2	0

[2] Note: Phone communications also include the use of the intercom within XYZ

Table 4-2. Continued

ID	Time-employed	Department	Age	Race	Education	Employment	Gender	Away
FMB2	108	4	5	3	2	1	1	0
FMB3	4	4	2	1	2	2	2	0
FMB4	24	4	3	3	3	1	2	0
FMB5	30	4	2	1	3	1	2	0
FMB6	108	4	4	1	3	1	1	0
FMB7	3	4	2	1	2	2	1	0
FMB8	22.8	4	2	3	3	2	2	0
FMB9	4	4	2	3	2	1	2	0
PP1	2	6	2	4	3	2	2	0
PP2	8	6	3	4	3	2	2	0
PP3	2	6	2	1	3	2	2	0
PP4	24	6	5	1	4	2	2	0
RC1	9	3	4	5	5	2	1	0
RC2	27	3	2	1	3	1	1	0
RM1	114	5	10	1	5	2	1	0
RM2	30	5	3	1	3	1	2	0
RM3	216	5	7	1	1	1	2	0

Table 4-3. Demographic Code

Departments	Age	Race	Education	Employment	Gender	Away
1=Administration	1= 16 to 19	1=White	1=High School	1= Full-time	1=Male	1=Lives away
2=Food Chemistry	2= 20 to 24	2=Black	2=Some College/2 year	2= Part-time	2=Female	0=Lives locally
3= Research Chemistry	3= 25 to 29	3=Hispanic	3=Bachelors			
4=Food Microbiology	4= 30 to 34	4=Asian	4=Masters			
5=Research Microbiology	5= 35 to 39	5=Other	5=PhD			
6=Product Performance	6= 40 to 44					
7=Admin/Other	7= 45 to 49					
	8 = 50 to 54					
	9= 55 to 59					
	10= 60 to 64					
	11= >65					

Table 4-4. Freeman's Centrality Measures

ID	Degree	Closeness	Betweenness
A1	76	63	1
A10	130	85	17
A11	168	100	42
A12	157	87	44
A13	152	87	18
A14	138	82	18
A15	156	95	55
A16	96	73	6
A2	127	89	15
A3	146	89	36
A4	154	93	23
A5	146	89	42
A6	144	87	26
A7	77	65	1
A8	121	82	11
A9	85	66	5
FC1	129	79	13
FC2	59	56	2
FC3	141	89	17
FC4	92	63	2
FC5	137	87	15
FC6	85	64	5
FC7	98	68	8
FC8	74	60	1
FMB1	97	69	7
FMB2	165	98	35
FMB3	67	59	0.5
FMB4	101	68	6
FMB5	83	63	3
FMB6	151	89	35
FMB7	70	60	0.5
FMB8	94	66	5
FMB9	71	60	7
PP1	70	61	2
PP2	84	68	3
PP3	66	61	3
PP4	145	93	30
RC1	88	72	9
RC2	95	69	6

Table 4-4. Continued

ID	Degree	Closeness	Betweenness
RM1	103	67	1
RM2	128	85	23
RM3	120	79	10

Table 4-5. Select Variables: Effect on Degree Centrality

Variable	Parameter Estimated	P-value
Hybrid	47.6	<.001
Administration	-1.45	0.901
Time Employed	0.2	<.001
Email Sum	0.08	0.004
Phone Sum	-0.06	0.032
In person Sum	0.02	0.020
Away	-73.5	<.001

Table 4-6. Select Variables: Effect on Closeness Centrality

Variable	Parameter Estimated	P-value
Hybrid	18.1	<.01
Administration	-0.4	0.933
Time Employed	0.07	<.01
Email Sum	0.03	0.011
Phone Sum	-0.02	0.093
In person Sum	0.01	0.081
Away	-27.6	0.001

Table 4-7. Select Variables: Effect on Betweenness Centrality

Variable	Parameter Estimated	P-value
Hybrid	20.01	0.001
Administration	6.43	0.3
Time Employed	0.06	0.01
Email Sum	0.027	0.07
Phone Sum	-0.02	0.11
In person Sum	0.01	0.01
Away	-25.5	0.01

Table 4-8. Demographics and Degree Centrality

Variable	Parameter Estimated	P-value
Ethnicity	-5.30	0.557
Gender	2.83	0.761

CHAPTER 5
CONCLUSIONS

The purpose of this research was to better understand intra-organizational communication within an agribusiness firm. Social network analysis was used to investigate the statistical relationship between network position and human resource management demographics. XYZ Corporation provided the necessary medium in which to conduct this research.

Even though social network analysis is still in its early stages of development (especially from a human resource standpoint), it still can provide great insight on how communication impacts productivity and the managing of human capital. A firm can only be as productive and efficient as its employees. Therefore, it is important to study how the employees and (on a bigger scale), how a firm's departments communicate, exchange information, and learn from each other. XYZ is a prime example of a firm that understands the importance of intra-organizational communication for several reasons.

Cross *et al*. (2001) note the importance of simply allowing employees to choose which method of communication they are most comfortable using. Something so seemingly trivial has rather large implications in the workplace environment. This is especially important in XYZ in that the types of jobs vary greatly from department to department leading to a unique, established "communication culture". For example, in cases where employees are working mostly in labs collecting and analyzing samples (e.g., Food Chemistry and Food Microbiology), we can see that emails are rarely used (Table 4-1). The preferred method of communication seems to be In Person. Conversely, we can see that those in the administrative department use email extensively to communicate with other employees. There is an understanding between

employees of how to efficiently get into contact with each other, regardless of the department.

Wellman (1983) states that cross-linkages connect individuals and in doing so, they inherently connect clusters (or for our purposes, departments). It was fascinating to view this principle working within XYZ, as they have several "hybrid" employees that straddle the line between administration and other departments. They perform duties in their respective departments and also act as liaisons between their departments, allowing for the smooth and efficient flow of information. This strategic placement of "knowledge" (i.e., the hybrid employees), without a doubt, aids in productivity at XYZ in the sense that relatively little to no time is wasted looking for answers.

Regarding the second area of focus regarding this research project, we will now look at the statistical relationships between social network analysis variables and human resource demographics. Specifically addressing this research, the term "human resource demographics" includes the standard demographic variables of age, race, gender and education, with the addition of department, time-employed, employment, and away (Table 4-2).

The results of the regression analysis showed that demographics (age, race, gender and education) were never significantly related to the employees' network scores. This is a strong point for XYZ because it shows workplace diversity and signifies that regardless of race, age, gender or education, employees have an equal opportunity to grow within the company. This is evidenced in Table 4-8, where none of the aforementioned variables have any significance in the model.

However, variables related to their human resource status (time-employed, department, whether or not they worked in or away from the main location) were significant. Length of time an employee was with the company is positively related to all network centrality scores (Table 4.4). In cases where long-time employees had lower centrality scores, other factors could be involved. For instance, time employed might not be capturing the following:

1. Physical structure of work space (e.g., hypothetical employee A works in the back corner of the lab, in a physical building separate from other employees making constant communication unlikely), and therefore reducing the possible centrality score.
2. Language barrier (e.g., English not being the first language of an employee might reduce the amount of communication between them and others). However, given that race and ethnicity were not significant, this is not as likely.
3. Personality of employee (e.g. some employees might naturally be soft-spoken and frugal with words making centrality scores lower)

It is important to note that in these particular cases, the lower centrality score by no means indicates that these employees are less productive or efficient. Management would need to evaluate these employees to determine if other explanations exist. In the case of XYZ, after presenting the results to the CEO, it was determined that the first and third issues were the likely explanations for employees with a lower score than their time employed indicated they might have.

In-person communication is positively related betweenness and degree but it is only marginally related to closeness. This may indicate that direct contact with a person (i.e., face to face interaction) is a great way for an employee to put him or herself in the middle of a network. When people see your face and can connect it with a name and a personality, they are more likely to remember you than if the initial contact was through any other method.

With respect to email communication, it was not related to betweenness; however, it was positively related to degree and closeness. This may mean that while email correspondence doesn't necessarily seem to move a person closer to the center of a network, it could allow one to maintain relational ties with those one knows. In other words, it seems to have more of a maintenance function.

When phone communication was significant (66% of the time), it was negatively correlated to all centrality scores. This may signify that this method of communication is an impersonal way to convey information.

While the overall research project was interesting and insightful, there were certain challenges. Challenges inherent within social network analysis include finding a suitable network (company) that allows access to their employees and interview them. Finding an appropriate network was only half the battle, however. Being that XYZ is such a busy research firm, simply finding time to allow us to conduct our survey was somewhat difficult: everyone is on a different and tight schedule with deadlines looming. Aside from that, were fortunate to have a firm with an optimal number of employees. This was especially important when it came to our survey design. The more people an employee indicated knowing, the more time was required for that employee to answer questions about them.

A positive thing about how the survey was conducted was that the principal investigator was always side by side with the employees being interviewed (with the exception of the two or three employees who work offsite, and in those cases, the principal investigator was on the phone with the employees). It is understood that taking surveys are not the favorite pastime for many people, and we do not always finish them

or focus all of our attention on them while doing them. Having the principle investigator onsite essentially "forces" the respondents to finish the survey free from distraction.

Overall, social network analysis proved to be a useful tool within the human resource context and revealed some interesting statistical relationships. Future research may be used to prove how important it is to understand how intra-organizational communication impacts a firm’s efficiency and productivity.

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BIOGRAPHICAL SKETCH

Dwayne Haynes was born in Manhattan, New York. He lived in Queens, New York until the age of 15. Soon after finishing his first year at Benjamin Cardozo High School, his father's job transferred to Tampa, Fl where the Haynes family would start life anew. In Tampa, Dwayne finished his high school career at Paul R. Wharton High School in the top 3% of his class. His next goal was to be a Florida Gator so Dwayne applied, was accepted, and graduated four years later with an undergrad degree in Food and Resource Economics. He was married shortly thereafter and is now looking forward to the PhD program at the University of Florida continuing in Food and Resource Economics.