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ORIGINAL ARTICLE

# USE OF STAKEHOLDER MAPPING AND SOCIAL NETWORK ANALYSIS (SNA) FOR ASSESSING PROJECT FORMULATION/PLANNING EFFECTIVENESS

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**Abstract:**

*Social Networking, the term coined by Professor Barnes in 1950's, in fact had its origin in the anthropological studies of the effect of urbanization in Africa. Further, social scientists like Dr. Moreno from US extended the application of Social Networking to organizations (sociogram). The application of Social Network Analysis (SNA) to organization settings involves statistical analysis that helps in identifying hidden connections that are important for sharing information, decision-making and innovation in an organization. Project Organizations need the above elements in improving stakeholder management, which is crucial for project success. This paper is based on the research study carried out in a large infrastructure development company in India, and concludes based on the research findings that the two visual tools namely Stakeholder Mapping and SNA can be used to assess the effectiveness of Project Formulation/Project Planning in a company by inferring on how effective the project teams are in coordinating project activities in the organization without going into the technical and planning nitty-gritty's of the project which is privy only to the concerned people within the organization. The technique is pragmatic and organizations can use the technique as an audit tool, say, once a year to give the top management a broad picture on how effective the project teams are in the organization and from that infer on the likely project outcome.*

**KEY WORDS:**

Stakeholder, Stakeholder Mapping, Social Network Theory (SNT), Social Network Analysis (SNA), Centrality Measures.

## .INTRODUCTION

The research is based on the study carried out over a period of 1½ years (Sept 2011-April 2013) in a large infrastructure company in India. To protect the identity of the company and to preserve the company anonymity, the designations within the company, the names of key stakeholders and the project start and planned end period have been altered. The Company is headed by a President, who is supportedbySenior Vice President (Mechanical), Senior Vice President (Electrical), Senior Vice President (Civil), and Vice President (administration). These department heads have their respective functional teams reporting to them. The planning activities are carried out in the respective departments for the respective areas of the project,and these planning activities are coordinated by a small centralized planning cell which is supported by consultants and advisors. The planning cell reports to the President.There are totally ten levels in the organization. The input data and output presented in the paper are part of the actual data and outputs used in the research.

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## RESEARCH OBJECTIVES:

(1)To identify the key stakeholders who are instrumental for the success of the company's project and carryout Stakeholder Mapping.
(2)To understand the interaction pattern across the project teams within and outside the company with the key stakeholders and develop the Social Network Map for the project.
(3)Analyze the Social Network Map to identify the key actors or players in the project team and using statistical techniques to infer how effective the project team is in achieving its objectives.

## RESEARCH SCOPE:

The study is confined to the limited project period, viz, around 1½ years from Sept 2011 to April 2013. The study has not take into cognizance what prevailed in the project prior to Sept 2011. The focus of the study is limited to certain extent on Project Formulation and to a larger degree on Project Planning and has not gone into project execution dimensions. Therefore, identification of key stakeholders both internal and external with reference to project is confined to study period only. The study in terms of its analysis and conclusions has excluded such delays and associated issues emerging out of social and political factors, which are beyond the control of the project team.

## RESEARCH LIMITATIONS:

(a)In the strict parlance the project team members interacted with across all levels were not only doing project formulation/planning activities (less of project formulation and more of project planning) but were also engaged in project execution activities as well. Therefore, the responses on the interaction pattern, which is purely judgmental on the part of the respondents, may have got influenced by project execution interactions without their (respondents) knowledge or intention.
(b)It is possible that the respondents when answering were more influenced by the recent happenings or interactions in the project that may not be representative of the interactions during the normal course of the project.
(c)Limitations on part of the researcher in not being able to understand the respondent's answer in its true sense and therefore while quantifying the interaction pattern which is qualitative in nature some errors could have crept in.
(d)As planning level data in terms of number of drawings released against plan, the number of tenders released and finalized for award of work against plan, etc. were not shared by the company, the project planning success has been assessed and inferred based on the project milestones achieved or their degree of completion, which are basically the project outcomes reporting.

## DATA COLLECTION:

### Primary Data:

The core or essential data required for generating the Social Network Map was gathered by the researcher by interacting with the majority of the stakeholders or actors and converting the qualitative data into quantitative data.

### Secondary Data:

(a)For Stakeholder Mapping, company's published document and interactions with inside stakeholders, were the basis for listing all the key stakeholders (both insiders and outsiders). For prioritizing the stakeholders as per the selected framework, the inputs were obtained by interactions with select people across all levels of the company.
(b)The physical project outcomes were based on the company's data.

## METHODOLOGY:

### Stakeholder Mapping:

The first step involved developing the stakeholder map. There are various frameworks that have been developed by research scholars over the last 30 years for prioritizing the stakeholders, in the best

interest of the firm, as the basis for stakeholder management.A short review of the literature starting with “Stakeholder' definition andfollowed by the various schools of thought for classifying or prioritizing stakeholders is presented below.

The concept of stakeholder has become very common ever since stakeholder theory was brought into the mainstream of strategic management (Freeman, 1984). He defined stakeholder as 'any group or individual who can affect or is affected by the achievement of the firm's objectives'. Stakeholder theory is most often associated with corporate social responsibility (Wood and Gray 1991). As per Project Management Institute (1996) stakeholder refers to 'individuals and organizations who are actively involved in the project, or whose interests may be positively or negatively affected as a result of the project execution or successful project completion'. In essence project stakeholders are groups or individuals who have a stake or expectation associated with the project outcome or performance and includes clients, project managers, designers, subcontractors, suppliers, funding bodies or agencies, users and community at large (Newcombe, 2003). One of the succinct definitions of stakeholder is any individual or group with a power to be a threat or a benefit to a project (Gibson, 2000).

There seems to be a natural fit between corporate social responsibility and organization stakeholders, as stakeholders represent the interests of certain group of persons whom the business should consider while undertaking a project. Further research on stakeholders can be classified under three types, namely, normative, instrumental, and descriptive (Donaldson and Preston, 1995). According to them Normative can be considered central core to stakeholder theory as it implies “organizations should acknowledge the validity of diverse stakeholder interests and should attempt to respond to them within a mutually supportive framework because it is a moral requirement”; Descriptive approach describes the methods and ways in the stakeholder management; and Instrumental approach explores the impact of stakeholder management on the organizational performance goals, both positive and negative. Essentially all studies on stakeholder management come under one of the three types described above.The main purpose of stakeholder management is to capture the diverse views of the various participants/groups/entities, improve communication amongst them, and clarify their needs (Freeman, 1984; Mitchell et.al., 1997).Some of the common approaches for identifying/classifying stakeholders and their interests relate to (1) three in-line circles, namely, first circle comprising people we know well, the second circle are the people we do not know that well, but known well to the people in the first circle, and the third circle refers to people not known to us, but known to people in the first and second circle (Krebs et. al., 2006), (2) using deskwork/questionnaire surveys (Jergeaset. al., 2000; Karlsen, 2002; Awakul and Ogunlana, 2002). Deskwork could include collating information through, for example, Board of Directors, list of major consultants, important outside agencies pertaining to the concerned State and the Central Government in the Indian context, and so on,(c) assessing Urgency, Legitimacy, and Power (Mitchell et al., 1997) of the stakeholder/s. Therefore to classify the 'Interest' as low, medium or high requires (1) understanding the context and (2) evaluation and ranking of the type, source and level of power. The nature of the influence can be (a) positive or favorable, or (b) negative or unfavorable. Fig 1 depicts Power and Interest grid and a broad outline in terms of prioritizing stakeholders.

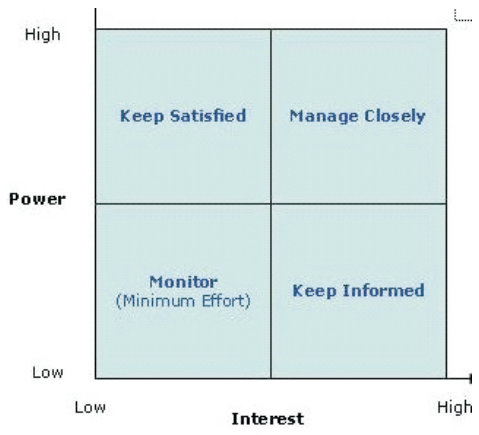


Fig. 1 Power-Interest Matrix

and, (d) developing a visualization tool called 'Stakeholder Circle' (Bourne, 2005). It involves five stages, namely, (a) identifying the stakeholders, their roles, their expectations from the project, and their significance to the project (b) prioritizing the stakeholders based on their perceived power, proximity, and urgency (c) visualizing prioritized list of top stakeholders by way of 'stakeholder circle' or 'stakeholder radar' to depict their power, proximity, and relative influence, (d) engaging in order to ensure that the expectations of the key stakeholders are understood, acknowledged, and managed, and (e) lastly monitoring and reviewing on a regular or periodic basis.

From the above brief literature survey it is clear, that there are so many variants/approaches to categorizing stakeholders for developing a practical framework for managing stakeholders.

Since the objective of the researcher was not managing stakeholders, which is the responsibility of the project team, but more to ensure all the key stakeholders (Instrumental approach) for the project are captured, it was decided to use the Power-Interest grid shown in Fig 1 for documenting. For capturing the key stakeholders the deskwork approach (Jergeaset. al., 2000; Karlsen, 2002; Awakul and Ogunlana, 2002)was followed. Annexure I indicates the illustrative Stakeholder Mapping for the company/project.

Social Network Analysis:

A brief introduction to SNA and SNT is presented before proceeding into the analysis.In fact Moreno in the 1930's began systematic recording and analysis of social interaction in small groups, especially for classrooms and work groups and developed Sociograms (Moreno, 1934), which was the precursor to Social Networking Maps. In the 1950's Professor Barnes (Barnes, 1954) coined the term 'Social Networking. The Social Network Approach (SNT) “focuses on relationships rather than individuals and brings dynamic and structural issues to the fore” (Loosemore, 1996).Given the dynamic nature of the stakeholder relationships and its structure and the influence stakeholder management process has on the stakeholder inter-relationships and its influence on the project, SNT can be used to develop a stakeholder relationship model to make analysis and take suitable measures in the interest of the project. Social Network Theory had its origin from Sociology (Simmel, 1950), and Anthropology (Mitchell, 1969; Boissevain, 1974). It focuses on social and behavioral analysis to a great degree (Wasserman and Faust, 1994). Under SNT a project is viewed as a system environment in which exists a network of anfractuous lines representing the relationships between the stakeholders or actors or participants. In fact social network was defined by Mitchell (1969) as:

[. . .] a specific set of linkages among a defined set of persons, with the additional property that the characteristics of these linkages as a whole may be used to interpret the social behavior of the persons involved.

Therefore, Social Network Analysis (SNA), which is part of SNT, is a method for mapping the relationships between various stakeholders (Scott, 2000). The network boundaries can be defined by snowball techniques (Scott, 2000; Wasserman and Faust, 1994), or interviewing network members or use of other value adding study methods. The network analysis is fundamentally different from the standard social and behavioral science research methodology (Wasserman and Faust, 1994). Instead of focusing on stakeholders' attributes, the social network analyses characteristics and behavior of stakeholders resulting from a social structural environment. It emphasizes analyzing the interactions.

Given this backdrop, the researcher interacted with all the key stakeholders who were available to gather information as per a structured format given in Annexure I. The Stakeholder Mapping that was developed was used as the reference for knowing who all to contact subject to their availability. For every person interacted with, the name of the person , date of interaction, whether an internal or external stakeholder, his/her designation, level, in terms ofTM (Top Management) or SM (Senior Management) or MM (Middle Management) or JM (Junior Management) and who all he/she interacted in course of their project work were recorded. For each person/position the person (interviewee) interacted with, the information gathered was on the frequency of interaction in terms of daily (7 points) or weekly (3 points) or occasionally (1 point). The researcher using his judgment assigned the points.The level of interaction with the person/position interacted with basically meant how much was the importance of the matter for the project work as perceived by the person (interviewee). It was scored on a 5-point scale, where 1 stands for very low, 2 for low, 3 for average, 4 for high and 5 for very high as stated by the person. Similarly, by value of interaction, it was meant how useful the interaction with the person/position was felt by the person (interviewee) in understanding the work and what is to be done very well. It could be advice, guidance, or suggestion. Again it was scored on a 5-point scale, viz, 1 for very low, 2 for low, 3 for average, 4 for high and 5 for very high.

**DATAANALYSIS:**

The frequency if interaction between various positions/persons (also referred to as nodes in SNT)

was captured in an adjacency matrix. Asymmetric ties were symmetrized using the minimum method (Borgatti et al., 2002). This meant the strength of the tie between two nodes A and B was assigned the smaller of the strength of tie from A to B and from B to A. This is a standard method in SNA (Hansen 1999, Mardsen and Campbell 1984), especially in previous studies of multimodal networks (Kane and Alavi 2008). A section of the frequency of interaction matrix used in the research is presented in Annexure II. The node numbers assigned to various positions have no bearing with the rank. The total of positions/persons/nodes interacted with were 66. This frequency of interaction data was entered into UCINET 6.381 of Analytic Technologies to obtain the network mapping (Annexure IV) and various centrality measures (Annexure VA, &VB).

Centrality is one of the most studied concepts in social network analysis. Numerous measures have been developed to infer certain characteristics of networks as well as actors (nodes), some of the important ones being degree centrality, closeness, betweeness and eigenvector centrality (Borgatti, 2005).Freeman (1979) defined node's closeness centrality as the sum of graph-theoretic distances from all other nodes, where the distance from a node to another is defined as the length (in links) of the shortest path from one to another. Thus in connected graphs or networks there is a natural distance metric between all pairs of nodes, defined by the length of their shortest paths. The farness of a node s is defined as the sum of its distances to all other nodes, and its closeness is defined as the inverse of the farness. Hence, the more central a node is the lower its total distance to all other nodes. Closeness can be regarded as a measure of how long it will take to spread information from s to all other nodes sequentially. Therefore it represents in one way an influencing characteristic of the node which is one form of the node's strength. The other measure is betweeness (Freeman, 1979). This centrality is defined as the share of times that a node i needs node k (whose centrality is being measured)to reach node j via the shortest (geodesic) path where I and j can stand for any pair of nodes in the total set of nodes under study excluding node k.Thus betweeness reflects in a way the brokerage power of a node and it indicates the strength of the node to link two different entities/persons into a dialogue or discussion mode. Degree centrality (Freeman, 1979) is defined as the number of ties incident upon a node. There are two types of degree centrality, namely, in-degree centrality ,which is measure of number of persons/nodes in communication with the node/person under consideration, and the other the out-degree centrality which is the number of persons/nodes the person/node under consideration is communicating with. The out-degree is strength of the node in terms of information/decision that can disseminated to large number of persons/nodes in the shortest period by the node. In-degree indicates the importance of the node in the sense that many persons/nodes directly communicate with the concerned node. Both represent the influencing power of the node. The last one is the eigenvector centrality (Bonacich, 1972) which reflects the strength of the node in terms of its connection to well-connected nodes. Therefore it conveys how the node has direct contacts with influential people in terms of getting work done or executed. Ineigen represents the influential nodes that connect with the node under consideration, and the Outeigen represents the number of influential nodes the node under consideration can communicate directly with.

Therefore from the above brief literature survey it is clear that the four centrality measures when computed for each node/position/person/actor would reflect on the degree of power, importance, and influencing capability of the actor in the project network or team, and hence the role the actor can play in contributing towards project success.

Besides, the centrality measures that are computed, the other measure to be computed is the capability index of each position/person, which reflects the capability, competence, etc. of the position as perceived by those persons interacting with the position in context of project work. Though this is subjective in nature, however, when the perception of all persons interacting with the position is taken into consideration, it should indicate a fairly reliable picture on the capability aspect (which is reflected by capability index). The capability score is defined by the researcher as product of level of interaction and value of interaction.The capability index for each person/position has been derived by summing up capability score across all persons interacting with the position and dividing it by the number of persons interacting. This capability index is taken as indicative of the true capability of the person/position. In their paper (Kane and Borgatti, 2011) refer to Information Systems (IS) proficiency as a measure of every individual, in the set-up studied by them, in terms of competency on IS. Since as they state in the paper that heterogeneity of IS proficiency in groups is a virtual certainty, it is important to consider how IS proficiency is distributed in the group, as the distribution of proficiency may be as or more important than average levels (Burton_jones and Gallivan 2007; Kozlowski and Klein 2000). IS proficiency is equivalent of capability index in the present context. Members in a network with greatest proficiency or capability should be located conveniently for others to access their help. In short they should be highly central (Freeman 1979) in the communication network. Particularly, they should have high eigenvector centrality (Bonancich, 1972), an aspect of centrality that considers the centrality of the people to whom they are

connected. Basically, a person's eigenvector centrality in the network is a function of having connections with others who are well connected in the network. Eigenvector centrality has been associated with power and influence (Baum et al. 2005; Roy and Bonacich 1988) as well as information access (Borgatti 2005; Rodan and Galunic 2004). Individuals with high eigenvector centrality strongly affect the groups they are part of, both because they are positioned to diffuse information and practices (Borgatti 1995) and because centrality can confer status, which in all likelihood make others adopt the concepts and practices of the central person. Hence, group performance should improve when persons with high proficiency are given reasonable authority and responsibility, and in even more so when these persons are more central members in the network. Even if they are not more central they can diffuse knowledge, practices, and information to those around them, and hence contribute towards overall capability of the (project) group. Capability alignment with Eigenvector Centrality is measure to understand whether the capable people hold a central position or a marginal position or in-between (Kane and Borgatti). Therefore a group's social network is an important source of information regarding role of actors with capability in the network or project set-up (Burkhardt and Brass 1990; Kane and Labianca 2011; Rice and Aydin 1991).

Annexure VI presents a section of the excel sheet recording the capability score across nodes. Annexure VII carries a section of the table containing the rank (rank 1 is highest and rank 10 is lowest), centrality scores and capability index for every node. The node number has no bearing on the rank of the person. Since the adjacency matrix has in-centrality score and out-centrality equal (50%), it means in and out dimensions of communications/interactions for all the nodes are equal. Therefore, the in-eigenvector, in-degree, and in-closeness figures have been used for processing, as it makes no difference on the conclusions to be drawn.Based on the importance of centrality measures and the capability index of every node, the following hypotheses are made to infer on the project team effectiveness.

**Hypothesis 1(H1)**: Individuals (nodes) high on Eigenvector Centrality are also high on Degree Centrality.

**Hypothesis 2 (H2):** Individuals (nodes) high on Eigenvector Centrality are also high on Betweeness Centrality.

**Hypothesis 3 (H3):** Individuals (nodes) high on Eigenvector Centrality are also high on Closeness Centrality.

**Hypothesis 4 (H4):** Eigenvector Centrality of an individual (node)is closely correlated with the Capability Score.

**Hypothesis 5 (H5):** Organizational position of an individual (node) has an effect on the co-ordination ability (eigenvector centrality) of an individual.

A statistical analysis of the data shown in Annexure VII, gave the following results:

| Sl.No. | Description | Correlation Coefficient |
|---|---|---|
| 1 | Correlation between Eigenvector Centrality & Degree Centrality | 0.91 |
| 2 | Correlation between Eigenvector Centrality &Betweeness Centrality | 0.68 |
| 3 | Correlation between Eigenvector Centrality & Closeness Centrality | 0.88 |
| 4 | Correlation between Eigenvector Centrality & Capability Index | -0.07 |

From the above correlation coefficient scores, the null hypothesis H1, H2, & H3 are proved to be true. This means that individuals (nodes) high on eigenvector centrality are also high on degree centrality, betweeness centrality and closeness centrality. This is a very powerful combination, making all such individuals (nodes) exceptional in project coordination ability as well as in their ability to contribute towards project success. As the correlation coefficient between eigenvector centrality and capability index shows virtually zero correlation, H4 turns out to be false. It means individuals with high capability index do not occupy the central position in the network. Zero correlation only means there is no linear correlation,

and does not mean there is no other relation. A high positive correlation indicates individuals with high capability index are occupying central position which augurs very well for project coordination and a high negative correlation means these individuals with high capability index are on the fringes of the network or company which results in poor project co-ordination. A zero correlation indicates that high capability actors are randomly positioned in the network or company (Kane and Borgatti). What is the impact of this on project coordination? We will see this a little later. In the case of H5, the Spearman's rank correlation turned out to be -0.31, which means virtually zero correlation. This means rank (organizational position) has no linear relationship with eigenvector centrality. This could mean that there is good decentralization leading to delegation of authority and responsibility down the organizational hierarchy. This coupled with the observation that the individuals with high capability index do not necessarily have high eigenvector centrality score could mean, the project teams have members who have good capability, but may not be powerful/influential in the company. It could mean individuals with power and influence are supported by team members who have good capability. It is not always necessary that the team leader has to be highly capable for the team to be effective. If the leader can leverage the strengths of the members, the team can be still effective. Therefore to conclude it appears the company has a good degree of delegation of authority and responsibility down the line and this coupled with capable team members should mean that the project team's effectiveness must be fairly good.

The effectiveness of the project formulation/planning has been inferred from the project outcome data as at the end of financial year, i.e., March, 2013. The planned project completion period is around 60 months. As of March 31, 2013, the project had completed 48 months. This means 75% of total project time has been consumed. As per the company's data 70%-80% of the project work is completed in this period. Looking at the project completion (physical) vis-à-vis time consumed (75% of planned time), the physical progress appears to be close to plan. From this we indirectly infer that project formulation/planning must have gone well. Therefore, the project team's effectiveness must be fairly good, which is in line with the findings of the analysis.

## CONCLUSIONS:

The research has reasonably established the use of the two visual tools, namely, stakeholder mapping and SNA in assessing the effectiveness of project teams and the likely project outcome. Therefore, the researcher feels that top management should carry out this exercise at least once a year and based on the analysis and its findings suitable corrective measures can be deployed to ensure greater project success.

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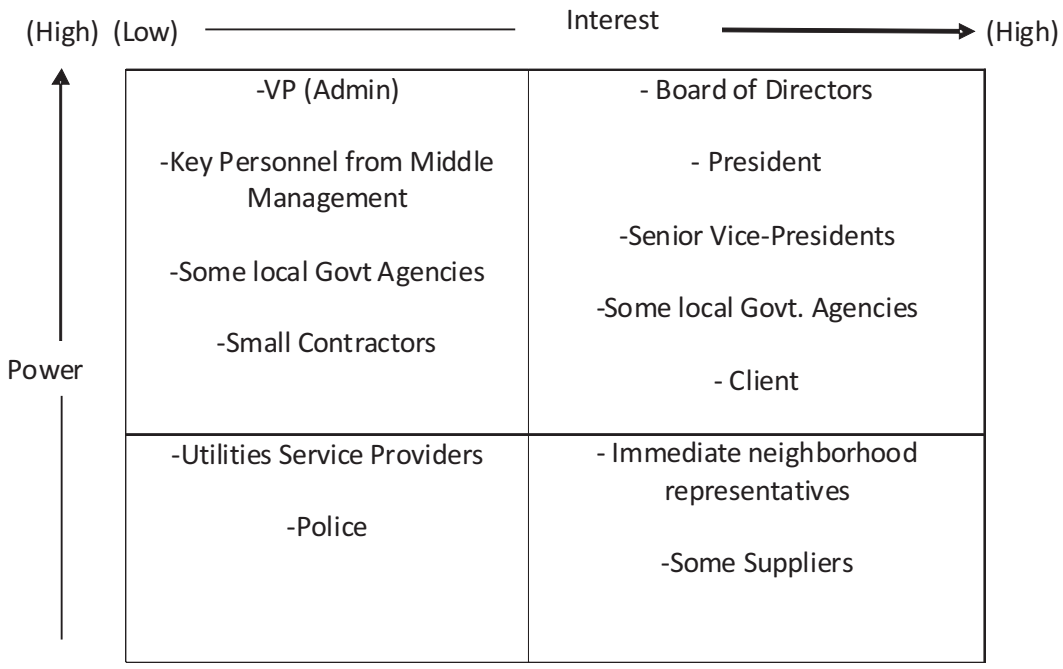
Annexure I

Indicative Stakeholder Mapping for the company




Annexure II
Data For Social Network Analysis

Date:
Name:
Designation Level: (TM/SM/MM/JM/Below)

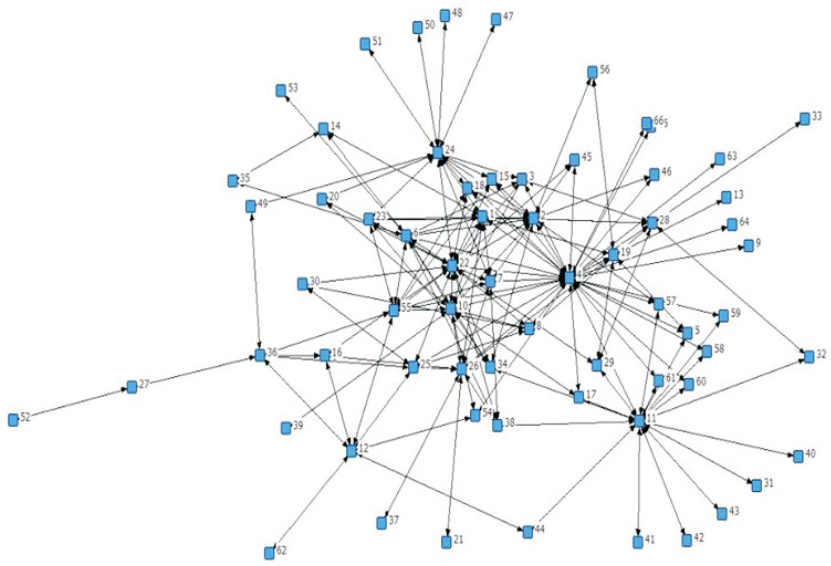
| Name/Designation<br><br>Heads | | | | |
|---|---|---|---|---|
| Internal (I)<br>Dept | | | | |
| External (E)<br>Organization | | | | |
| Frequency of Interaction (F)<br>(daily/weekly occasionally) | | | | |
| Work related level of interaction (5-pt scale) | | | | |
| Value of interaction (5-pt scale) | | | | |

**Annexure III**
**Frequency of Interaction Matrix**

**(A section of data used)**

| Node No. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | | 7 | | 7 | | 3 | 3 | | | 3 | | | | 3 | | | | |
| **2** | 7 | | | 7 | | 3 | 7 | | | 7 | | | | | 7 | | | 7 |
| **3** | | | | 7 | | 3 | | | | 7 | | | | | | | | |
| **4** | 7 | 7 | 7 | | 3 | 3 | 3 | 3 | 3 | 3 | 3 | | 3 | | 3 | | 3 | 3 |
| **5** | | | | 3 | | | | | | | 3 | | | | | | | |
| **6** | 3 | 3 | 3 | 3 | | | | | | 3 | | | | 7 | | | | |
| **7** | 3 | 7 | | 3 | | | | | | | | | | | | | | |
| **8** | | | | 3 | | | | | | 3 | | | | | | | | |
| **9** | | | | 3 | | | | | | | | | | | | | | |
| **10** | 3 | 7 | | 3 | | 3 | | 3 | | | | | | | | | 7 | |
| **11** | | | | 3 | 3 | | | | | | | | | | | | 3 | |
| **12** | | | | | | | | | | | | | | | | 7 | | |
| **13** | | | | 3 | | | | | | | | | | | | | | |
| **14** | 3 | | | | | 7 | | | | | | | | | | | | |
| **15** | | 7 | | 3 | | | | | | | | | | | | | | |

**Annexure IV**
**Social Network Mapping for the Project**



**AnnexureVA**
**Closeness Centrality Data**
**(A section of the UCINET Output)**

CLOSENESS CENTRALITY

---

Input dataset: Mohan data (C:\Users\common\AppData\Roaming\Microso
Method: Geodesic paths only (Freeman Closeness)
Output dataset: Closeness (C:\Program Files\Analytic Technologies\d

Note: Data not symmetric, therefore separate in-closeness & out-closeness computed.

WARNING: Data matrix dichotomized such that Xij > 0 was recoded to 1

Closeness Centrality Measures

| | | 1 inFarness | 2 outFarness | 3 inCloseness | 4 outCloseness |
|---|---|---|---|---|---|
| 4 | 4 | 101.000 | 101.000 | 64.356 | 64.356 |
| 22 | 22 | 123.000 | 123.000 | 52.846 | 52.846 |
| 2 | 2 | 131.000 | 131.000 | 49.618 | 49.618 |
| 1 | 1 | 133.000 | 133.000 | 48.872 | 48.872 |
| 10 | 10 | 133.000 | 134.000 | 48.872 | 48.507 |
| 24 | 24 | 134.000 | 134.000 | 48.507 | 48.507 |
| 11 | 11 | 135.000 | 135.000 | 48.148 | 48.148 |
| 55 | 55 | 135.000 | 135.000 | 48.148 | 48.148 |
| 7 | 7 | 137.000 | 137.000 | 47.445 | 47.445 |
| 6 | 6 | 137.000 | 137.000 | 47.445 | 47.445 |
| 26 | 26 | 139.000 | 139.000 | 46.763 | 46.763 |
| 25 | 25 | 140.000 | 140.000 | 46.429 | 46.429 |
| 15 | 15 | 143.000 | 143.000 | 45.455 | 45.455 |
| 18 | 18 | 143.000 | 143.000 | 45.455 | 45.455 |
| 3 | 3 | 144.000 | 142.000 | 45.139 | 45.775 |

**Annexure V B**
**Multiple Centrality Measures**
**(A section of the UCINET output)**

MULTIPLE CENTRALITY MEASURES

---

| | |
|---|---|
| Input dataset: | Mohan data (C:\Users\common\AppData\Roaming\Microso |
| Output dataset: | Mohan data-cent (C:\Program Files\Analytic Technolo |
| Treat data as: | Auto-detect |
| Type of scores to output: | Raw scores |

Network Matrix 1 is directed? YES
Principal eigenvalue was: 10.0213430535109
Centrality Measures

| | 1 OutDeg | 2 Indeg | 3 OutEige | 4 InEigen | 5 Between |
|---|---|---|---|---|---|
| 1 | 12.000 | 12.000 | 0.612 | 0.615 | 162.769 |
| 2 | 16.000 | 16.000 | 0.706 | 0.710 | 229.863 |
| 3 | 6.000 | 5.000 | 0.385 | 0.326 | 24.494 |
| 4 | 33.000 | 33.000 | 1.000 | 1.0001 | 939.824 |
| 5 | 3.000 | 3.000 | 0.154 | 0.155 | 7.467 |
| 6 | 12.000 | 12.000 | 0.543 | 0.542 | 326.371 |
| 7 | 8.000 | 8.000 | 0.481 | 0.482 | 35.967 |
| 8 | 6.000 | 6.000 | 0.319 | 0.322 | 36.255 |
| 9 | 1.000 | 1.000 | 0.100 | 0.100 | 0.000 |
| 10 | 13.000 | 14.000 | 0.581 | 0.617 | 241.738 |
| 11 | 18.000 | 18.000 | 0.308 | 0.309 | 840.458 |
| 12 | 7.000 | 7.000 | 0.125 | 0.126 | 186.489 |
| 13 | 1.000 | 1.000 | 0.100 | 0.100 | 0.000 |

**Annexure VI**
**Capability Score Matrix**
**(A section of the excel sheet with capability scores)**

| Node No. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | | 25 | | 25 | | 25 | 16 | | | 12 | |
| **2** | 25 | | | 10 | | 10 | 15 | | | 15 | |
| **3** | | | | 10 | | 16 | | | | 16 | |
| **4** | 25 | 10 | 10 | | 8 | 8 | 16 | 12 | 8 | 8 | 12 |
| **5** | | | | 8 | | | | | | | 16 |
| **6** | 25 | 10 | 16 | 8 | | | | | | 16 | |
| **7** | 16 | 16 | | 16 | | | | | | | |
| **8** | | | | 12 | | | | | | 16 | |
| **9** | | | | 8 | | | | | | | |
| **10** | 12 | 15 | 16 | 8 | | 16 | | 16 | | | |
| **11** | | | | 12 | 16 | | | | | | |
| **12** | | | | | | | | | | | |
| **13** | | | | 8 | | | | | | | |
| **14** | 20 | | | | | 16 | | | | | |

**Annexure VII**

**(A section of the matrix containing complete information for every node)**

| Node No | Rank | Betweeness | Closeness | Degree | Eigenvector | Capability Index |
|---|---|---|---|---|---|---|
| 7 | 4 | 35.967 | 47.445 | 8 | 0.481 | 15.4 |
| 8 | 5 | 36.255 | 44.828 | 6 | 0.319 | 15.5 |
| 9 | 5 | 0 | 39.394 | 1 | 0.100 | 8 |
| 10 | 4 | 241.738 | 48.872 | 13 | 0.581 | 15 |
| 11 | 5 | 840.458 | 48.148 | 18 | 0.308 | 15.2 |
| 12 | 8 | 186.489 | 37.572 | 7 | 0.125 | 20.3 |
| 13 | 5 | 0 | 39.394 | 1 | 0.100 | 8 |
| 14 | 8 | 6.488 | 35.326 | 3 | 0.122 | 14 |
| 15 | 4 | 5.362 | 45.455 | 5 | 0.358 | 13.4 |