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Research Article

Unveiling Informal Leadership Dynamics: A Social Network Analysis (SNA) Of Nursing Staff in North India's Apex Hospital

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Abstract:

Strong organizational culture in hospitals improves patient outcomes and safety. Analysing informal social networks within a hospital can reveal how information flows and identify influential leaders. Engaging these leaders can drive positive change and improve efficiency. Social Network Analysis (SNA) is a valuable tool for mapping these networks and improving decision-making.

This research aims to identify informal leaders among nursing staff in a tertiary care hospital and understand their influence on workplace culture. By studying their clinical knowledge, patient safety information network, and social relationships, the research seeks to categorize different types of informal leaders and their impact. This information will then be used to develop programs for improving organizational culture within the hospital.

This study highlights the importance of informal leaders in healthcare settings and how their influence can vary across different workplaces.

Key takeaways:

• Informal leaders don't always align with formal hierarchy: While Workplace A showed a correlation between seniority and informal leadership, this wasn't the case in the other workplaces studied.

• First study of its kind in India: This research uses Social Network Analysis (SNA) to identify informal leaders among nursing staff in India, filling a gap in existing research.

• Informal leaders are crucial for improvement: By recognizing and engaging these individuals, healthcare organizations can improve team performance and information dissemination.

This study emphasizes the need for healthcare organizations to understand their informal networks and leverage the influence of these key individuals for positive change.

Introduction:

It is posited that an enriched organizational culture within hospital settings correlates positively with improved patient outcomes. This includes a reduction in mortality rates, shorter hospital stays, an uplift in the quality of life, diminished pain levels, and an overall enhancement in patient safety (1). While the pivotal role of an organization's culture in bolstering patient safety is widely recognized, the development of precise strategies for cultural transformation remains largely unexplored. It is incumbent upon healthcare organizations to diversify their methodologies in order to gain a more comprehensive understanding of their existing organizational culture (2). Transforming the culture of an organization necessitates not merely efficacious execution, but also the precise discernment and engagement of informal leaders and affiliations within the organization's extant social networks. These informal leaders offer an additional lens to comprehend the organization's culture. The genesis of informal leadership is a multifaceted process encompassing role assimilation and perceptions among peers. These leaders may be discernible through their conduct or interactions with others, or they may attain their informal leadership stature by fulfilling a crucial role within the team or making significant contributions (3). Within the confines of organizations, information propagates through informal networks that may not necessarily align with the formal organizational hierarchy. These informal networks can wield substantial influence on the modus operandi within the organization. Strategically engaging with the informal leaders or central nodes within these social networks could potentially expedite enhancements in organizational performance, efficiency, and the velocity of information dissemination (4).

Social Network Analysis (SNA):

SNA is a versatile tool widely employed across diverse domains. Predominantly, SNA may harness to augment the effectiveness and efficiency of decision-making processes within commercial entities. It serves as a technique to scrutinize the interactions among an organization's personnel, facilitating the identification of key members based on their relational dynamics within the group. Social Network Analysis offers a mechanism to map and unveil the concealed conduits of communication and information flow, which can be visualized and analyzed through social network graphs. The foundation of SNA lies in the principles of sociograms and graph theory. Sociograms are graphical depictions of group interactions, while graph theory is a mathematical methodology for constructing model structures (5).

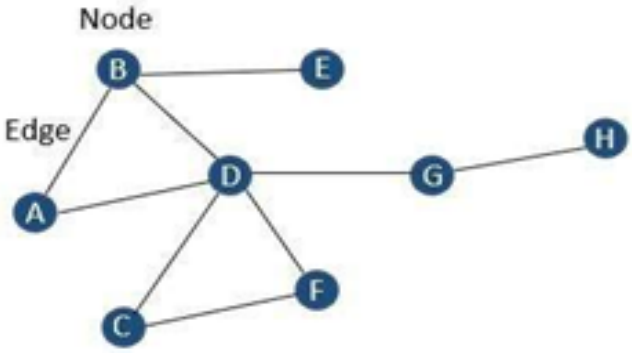

Figure 1 Social Network Graph

A social network graph is a graph in which the 'nodes' represent individuals and the 'edges' reflect their social ties, such as an informal link or communication channel, between them. Various softwares, like UNICET®, Cytoscape, and Gephi, may be used to build a Social Network Graph by using the results of a Social Network Analysis survey.

For instance, we have undertaken a Social Network Analysis on a small organisation of eight persons (A, B, C, D, E, F, G, and H) to analyse the flow of knowledge (information). Figure 1 depicts a social network diagram of these eight individuals. Visual analysis of this diagram reveals that 'D' is directly related to four persons (A, B, C, and F), while two people (E and H) have just a single relationship. It is evident from this diagram that 'D' is the most influential member of this group (highest degree centrality). Therefore, 'D' is also an appropriate candidate to be picked to disseminate any new facts or knowledge to the group, if necessary. Similarly, additional domains may be investigated using the same method, namely. Central people, isolated individuals, and informal groupings etc.

Informal leadership:

Informal leadership constitutes a crucial component within any organization. The identification of these informal leaders is indispensable for understanding group dynamics within the healthcare sector, as they contribute significantly to the realization of organizational objectives. These leaders may not possess formal authority, yet they wield considerable influence within the organization. Group members often value these informal leaders for their seniority, expertise, and other attributes. This research was conducted in a leading tertiary care hospital, encompassing three distinct workplaces. The objective of this study is to gather insights on three dimensions of influential behaviors - clinical knowledge, patient safety information network, and social relationships, with a particular emphasis on informal communication behaviors among the nursing staff in these workplaces. This study endeavors to explore the network's perception in terms of these three dimensions. This investigation serves as an initial step towards identifying the unique types of influencers present and their potential impact on the workplace culture. Utilizing an unsupervised clustering approach to identify and categorize individuals across various dimensions of influence will enable us to discern distinct patterns of influencers. Consequently, we can devise programs aimed at enhancing the organizational culture (6,7).

Review of Literature:

Systematic reviews undertaken by Duncan Chambers et al. in 2012 and Kate Sabot et al. in 2017 reveal a paucity of research in the realm of social network analysis within the healthcare sector. Both these studies advocate for the application of SNA in healthcare, underscoring its potential to enhance our understanding of intra-organizational communication (8,9).

In a study by Allan Fong et al. at the MedStar Health Research Institute, an unsupervised clustering approach was employed. Leadership was gauged across three distinct dimensions: well-rounded influencers, rational influencers, and knowledge- or skill-based influencers, utilizing personnel from Intensive Care Units (ICUs) as a representative sample to pinpoint informal leaders. Their analysis unveiled a total of 14 operative clusters within the ICUs. This research delineates the various types of influencers present in ICUs and their potential to shape the unit's culture (10).

A social network analysis was conducted by Nerida Creswick et al. in 2014, encompassing all 101 employees across two wards of a prominent academic teaching hospital in Sydney, Australia. These employees were surveyed using an exhaustive social network questionnaire. Participants were prompted to express their level of agreement or disagreement with items pertaining to doctor-nurse communication, utilizing a 5-point Likert scale ranging from 1 to 5. The study aimed to identify key sources of guidance or hubs by assessing the degree. Nodes receiving the highest number of directed connections were identified as hubs, representing the individuals most frequently consulted for guidance. Central to this network were the pharmacists, who provided guidance on a weekly or even more frequent basis to the majority of individuals (11).

Materials & Methods:

A comprehensive social network analysis was undertaken across three distinct workplaces within a apex academic tertiary care hospital in Northern India. A holistic network approach was employed to delve into the social networks prevalent within these workplaces. The study encompassed all nursing personnel operating in these workplaces.

Study Duration: This investigation was carried out over a span of four months, subsequent to obtaining approval from the Institute Ethics Committee.

Data Collection: Participants were presented with a structured questionnaire comprising close-ended questions (Refer to Annexure-I)

1. To analyse the organizations clusters of nursing staff in the workplace A, B and C, survey questionnaire was distributed to all the nursing staff (N=34+35+41).

2. Questionnaire (Annexure-I) was converted into electronic form as well as hard copy of the questionnaire was made and distributed among all along with the copy of list of staff (in alphabetical order).
3. Electronic copy of questionnaire was distributed through the e-mails, to those who are comfortable in filling the questionnaire online.
4. All the copies of answered questionnaires were collected and data was converted into Microsoft Excel® sheets.
5. Network diagrams were created using Netdraw v2 (Analytic Technologies, Boston, MA), and network metrics were calculated using UCINET® v. 6.752 (Analytic Technologies, Boston) (12).

Research Procedure

We followed the recommendations of Robert A. Hanneman et al and the collected data of the questionnaire was converted into following two types of structures (13):

1. Basic characteristics (Age, Designation, and experience) of the actors (nursing staff). (Annexure-II) this was analysed by the Microsoft Excel.
2. Social Network data: where both rows and columns refer to the same actors, and the cells report information on one variable that describes variation in the relations between each pair of actors. (Annexure-III) This data was processed by the UCINET® v. 6.752.

Data Analysis:

In this study, the technique of Social Network Analysis (SNA) was employed to construct a network diagram for each workplace. SNA serves as a quantitative instrument for gauging and scrutinizing relationships between individuals; in this study, we utilized this technique to investigate interactions among nursing staff within their respective workplaces.

For the analysis of the visual network, we generated multiple diagrams of the network data, inclusive of the entire network with designations as attributes. A variety of measurements were employed to conduct an analysis of the network's characteristics. The subsequent five network parameters were evaluated:

a. The degree centrality: The number of edges connected to the node.
b. The betweenness: Extent to which a particular node lies on the shortest path between other nodes.
c. The closeness: Average of the shortest distances to all other nodes in the network map.
d. EigenCentrality: assesses the impact of a node based on the number of linkages it has to other nodes in a network.
e. Isolates: Nodes which are not connected to any other node.

Ethics:

Approval was obtained from the institute ethics committee before starting the study. The institute ethics Ref. No. is IEC-626/03.09.2021, RP-29/2021.

Results:

Out of the 3 different workplaces (Table 1) maximum response rate (97%) was received from workplace B, which is a National Drug Dependence Treatment Centre. Whereas minimum response (65%) was noted in Workplace A, which is a Centre for Dental Education and Research. 34

Table 1 Response rate for the survey among 3 workplaces.

Workplace	Details of workplace	Total Nursing Staff	Responses (%)
A	Centre for Dental Education and Research	34	22 (65%)
B	National Drug Dependence Treatment Centre	35	34 (97%)
C	Chemotherapy Day care	41	34 (83%)

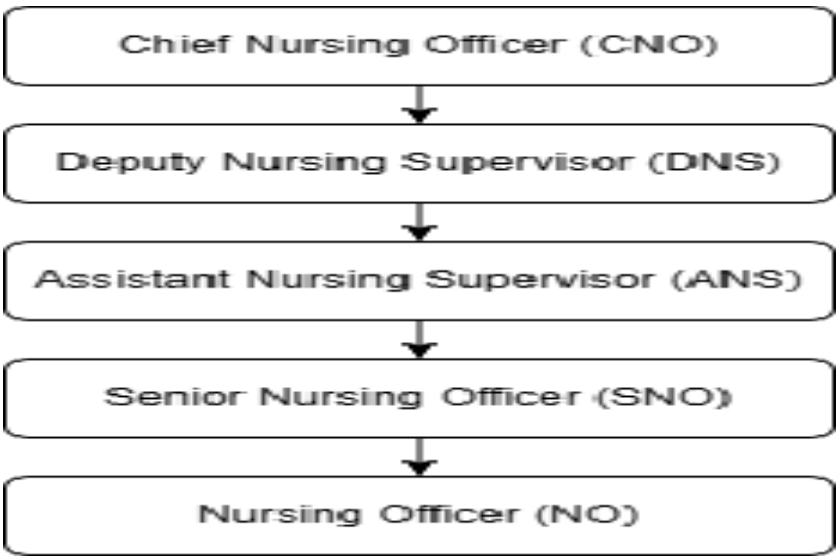

Figure 2 Formal hierarchy of the nursing staff.

This study was conducted on the network of nursing staff only. In our organization, the formal hierarchy of designations among nursing cadre is as per figure 2.

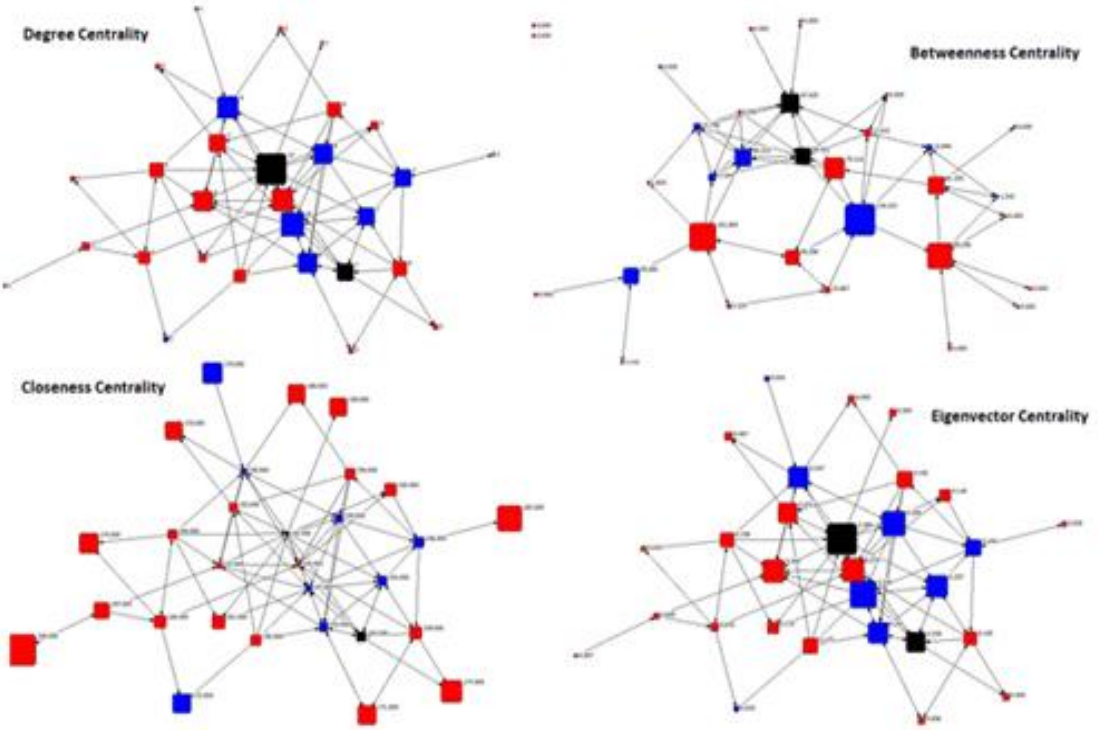

Figure 3 Network Map for Workplace A (knowledge)

Given that our study was confined to smaller sections of the organization, the study population included only ANS, SNO, and NO. To maintain anonymity, the names of staff members were replaced with identifiers C1-C32, I1-I39, and N1-N34 for workplaces A, B, and C respectively, and these individuals will be referred to as 'actors' in this study. Table 2 encapsulates the basic characteristics of the actors, with a majority being females (79%, 76%, and 85% in workplaces A, B, and C respectively). Each workplace had 2 ANS, whereas the number of SNOs was 12, 16, and 9 in workplaces A, B, and C respectively. Figures 3 and 4 depict the age and work experience of the actors, with a majority falling within the age groups of 31-40 years and 41-50 years. However, in workplace B, the proportion of actors within the age group of 51-60 years (26%) was notably higher compared to the other two workplaces.

Table 2 Basic characteristics of the actors.

Workplace	Gender	Age	Experience	Designation
A	Male= 7 Female= 27	18-30 years= 04 31-40 years= 12 41-50 years= 13 51-60 years= 05	0-5 years= 05 6-10 years= 10 11-15 years= 12 16-20 years= 06 >20 years= 03	ANS=02 SNO=12 NO=20
B	Male=08 Female=26	18-30 years=02 31-40 years=12 41-50 years=09 51-60 years=11	0-5 years=11 6-10 years=03 11-15 years=04 16-20 years=14 >20 years=02	ANS=02 SNO=16 NO=16
C	Male= 06 Female= 35	18-30 years=08 31-40 years=14 41-50 years=14 51-60 years=03	0-5 years=13 6-10 years=03 11-15 years=11 16-20 years=09 >20 years=03	ANS=02 SNO=09 NO=28

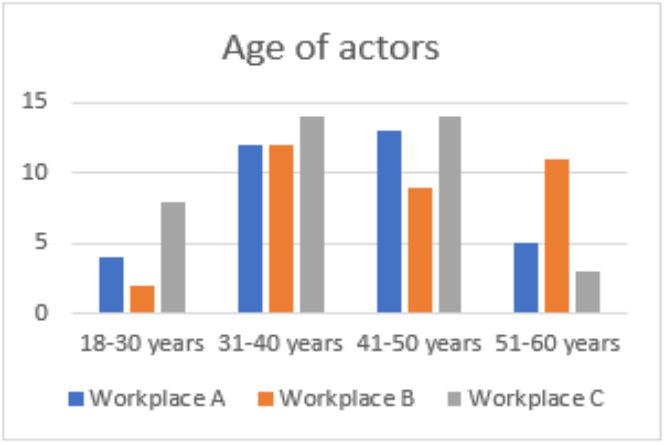

Figure 4 illustrates the work experience of the actors, workplace A has majority of staff with a work experience of 6-15 years, in workplace B majority of work experience was of 0-5 years and 16-20 years and in workplace C it was 0-5 years and 11-15 years of work experience.

Social Network Graphs:

While analysing the data and creating the network graphs we kept the designation as attribute and following colours in the graphs denotes the specific designation:

- Red Colour: Nursing Officers
- Blue Colour: Senior Nursing Officers
- Black Colour: Assistant Nursing Superintendents

Whereas size of the node signifies the value of that node.

Table 3 SNA measures for workplace A

Workplace A						
Domain	**Factor**	**Min. range**	**Max. range**	**Mean**	**SD**	**skewness**
Knowledge	Degree Centrality	0.00	13.00	4.56	3.44	0.46
	Betweenness Centrality	0.00	75.39	16.84	20.40	1.26
	Closeness Centrality	142.00	992.00	239.06	246.33	2.91
	Elgenvector Centrality	0.00	0.39	0.14	0.11	0.47
Near misses	Degree Centrality	0.00	9.00	3.63	2.77	0.51
	Betweenness Centrality	0.00	119.33	25.66	35.86	1.24
	Closeness Centrality	124.00	992.00	200.50	208.29	3.75
	Elgenvector Centrality	0.00	0.42	0.12	0.13	0.98
Social Support	Degree Centrality	0.00	10.00	2.94	2.76	0.96
	Betweenness Centrality	0.00	74.61	12.66	21.53	1.89
	Closeness Centrality	326.00	992.00	515.50	278.42	1.04
	Elgenvector Centrality	0.00	0.41	0.11	0.14	1.06

Table 4 SNA measures for workplace B

Workplace B						
Domain	**Factor**	**Min. range**	**Max. range**	**Mean**	**SD**	**skewness**
Knowledge	Degree Centrality	1.00	18.00	6.90	3.22	1.06
	Betweenness Centrality	0.00	206.87	23.90	35.82	3.80
	Closeness Centrality	60.00	133.00	85.79	13.31	1.48
	Elgenvector Centrality	0.01	0.39	0.14	0.08	0.79
Near misses	Degree Centrality	0.00	10.00	5.59	2.48	-0.24
	Betweenness Centrality	0.00	127.05	26.09	26.33	1.62
	Closeness Centrality	107.00	1482.00	164.26	216.93	6.21
	Elgenvector Centrality	0.00	0.28	0.14	0.08	0.28
Social Support	Degree Centrality	1.00	11.00	6.00	2.14	-0.27
	Betweenness Centrality	0.00	122.56	26.69	24.80	1.80
	Closeness Centrality	74.00	123.00	91.38	12.24	0.99
	Elgenvector Centrality	0.02	0.27	0.15	0.06	-0.05

Table 5 SNA measures for workplace C

Workplace C						
Domain	**Factor**	**Min. range**	**Max. range**	**Mean**	**SD**	**skewness**
Knowledge	Degree Centrality	0.00	14.00	6.94	3.26	0.02
	Betweenness Centrality	0.00	66.77	17.50	16.20	1.21
	Closeness Centrality	87.00	1122.00	132.06	175.17	5.80
	Elgenvector Centrality	0.00	0.31	0.15	0.08	-0.08
Near misses	Degree Centrality	1.00	12.00	6.12	3.02	0.29
	Betweenness Centrality	0.00	100.94	22.09	27.42	1.57
	Closeness Centrality	58.00	114.00	77.18	13.03	1.17
	Elgenvector Centrality	0.02	0.29	0.16	0.07	0.02
Social Support	Degree Centrality	0.00	11.00	6.00	2.81	-0.38
	Betweenness Centrality	0.00	73.97	19.41	19.75	1.22
	Closeness Centrality	89.00	1122.00	135.88	174.56	5.80
	Elgenvector Centrality	0.00	0.32	0.15	0.08	0.26

Tables 3, 4 and 5 summarize the minimum and maximum range, means, standard deviations, and skewness for the factors used in our study. The findings we observed are summarized in Table 6.

Workplace	**Domain**	**Interpretation**
A (n=34)	Knowledge	In workplace A, we observed 3 isolates under the domain of knowledge. Maximum degree centrality was 13. Top values for degree centrality were 13, 10, 9 and 8.
	Near misses	Maximum value for degree centrality was 9, there were 2 isolates and top values were
	Social Support	For social support maximum degree centrality was 10 and there were 5 isolates.
B (n=34)	Knowledge	In workplace B, we observed 0 isolates under the domain of knowledge. Maximum degree centrality was 18. Top values for degree centrality were 18, 13, 11 and 10.
	Near misses	Maximum value for degree centrality was 10 and 1 isolate.
	Social Support	There were no isolates and maximum value for degree was 11
C (n=39)	Knowledge	In workplace C, observed value for degree centrality was 14, there was 1 isolate
	Near misses	Maximum observed value was 12 and 0 isolates.
	Social Support	Maximum value for degree was 11 and 1 isolate.

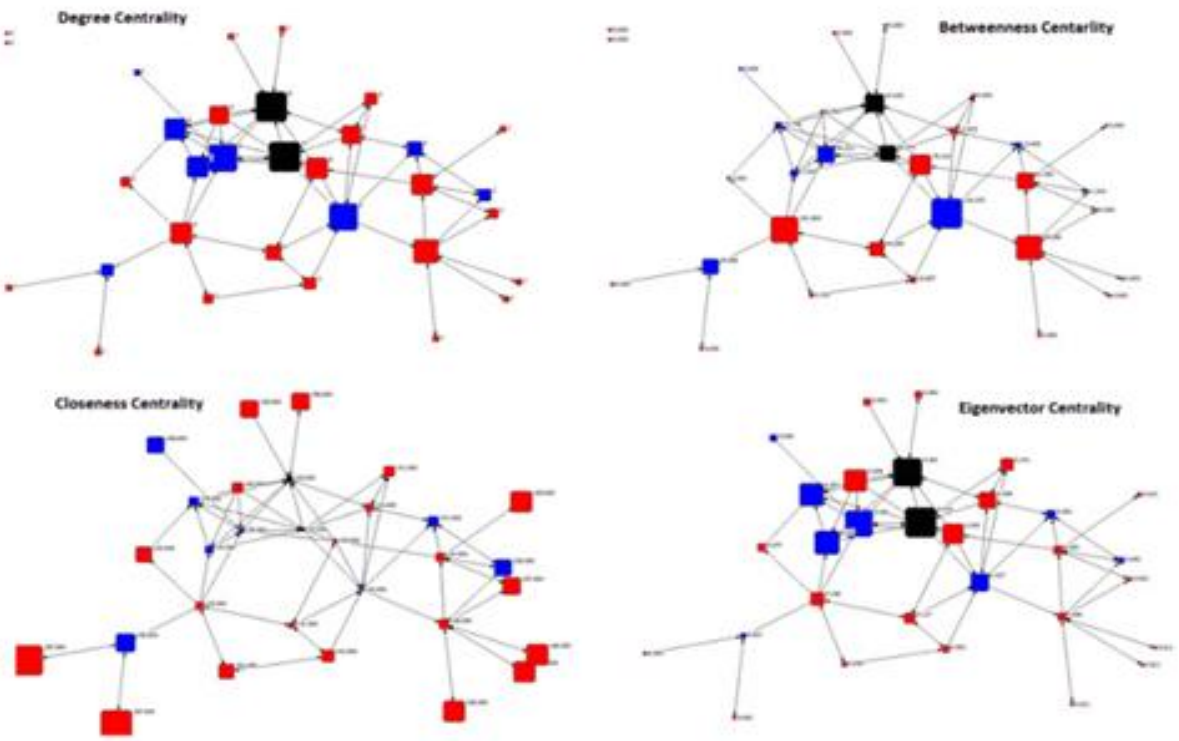

Figure 4 Network Map for Workplace A (Near misses)

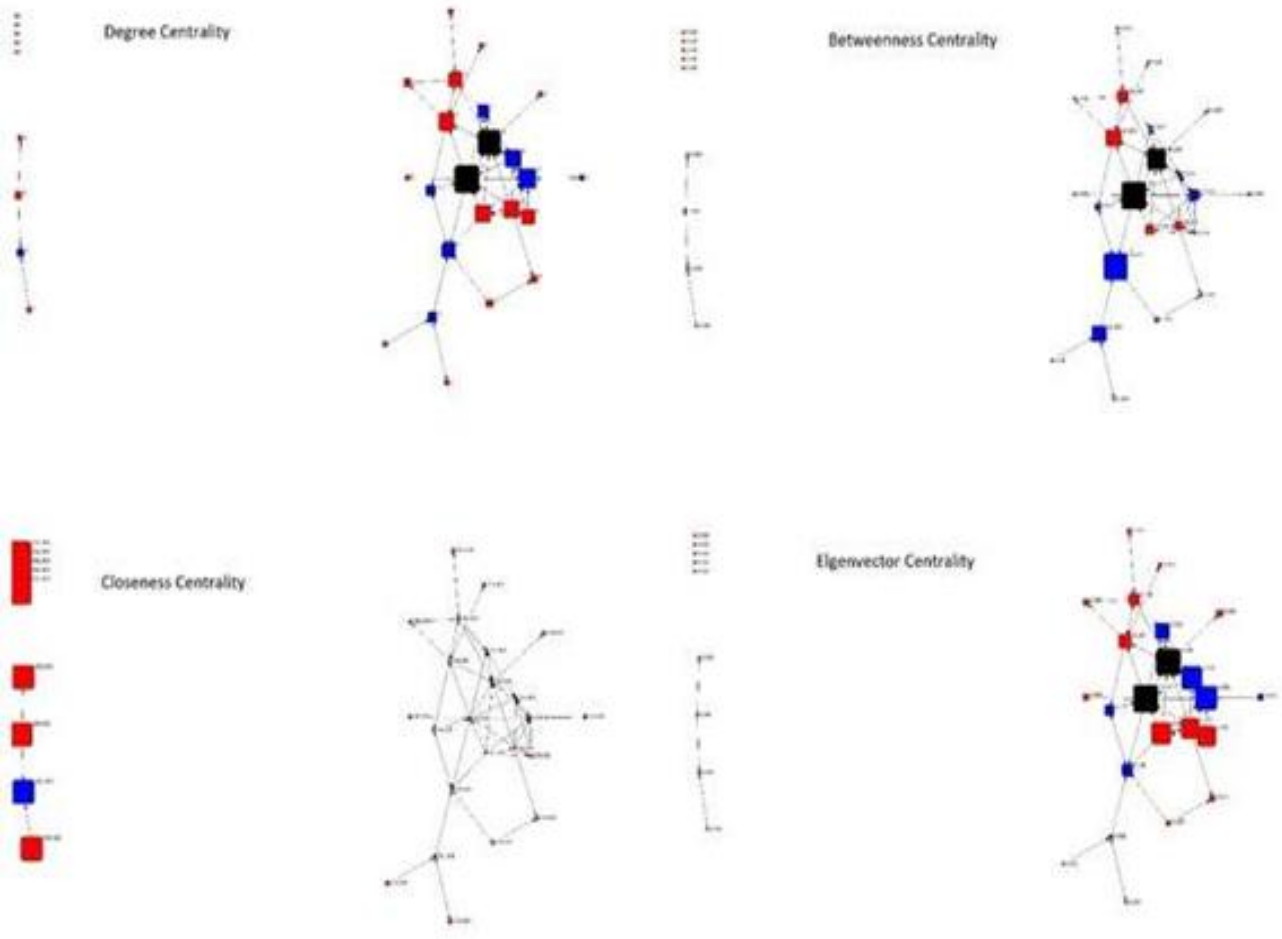

Figure 5 Network Map for Workplace A (Social Support)

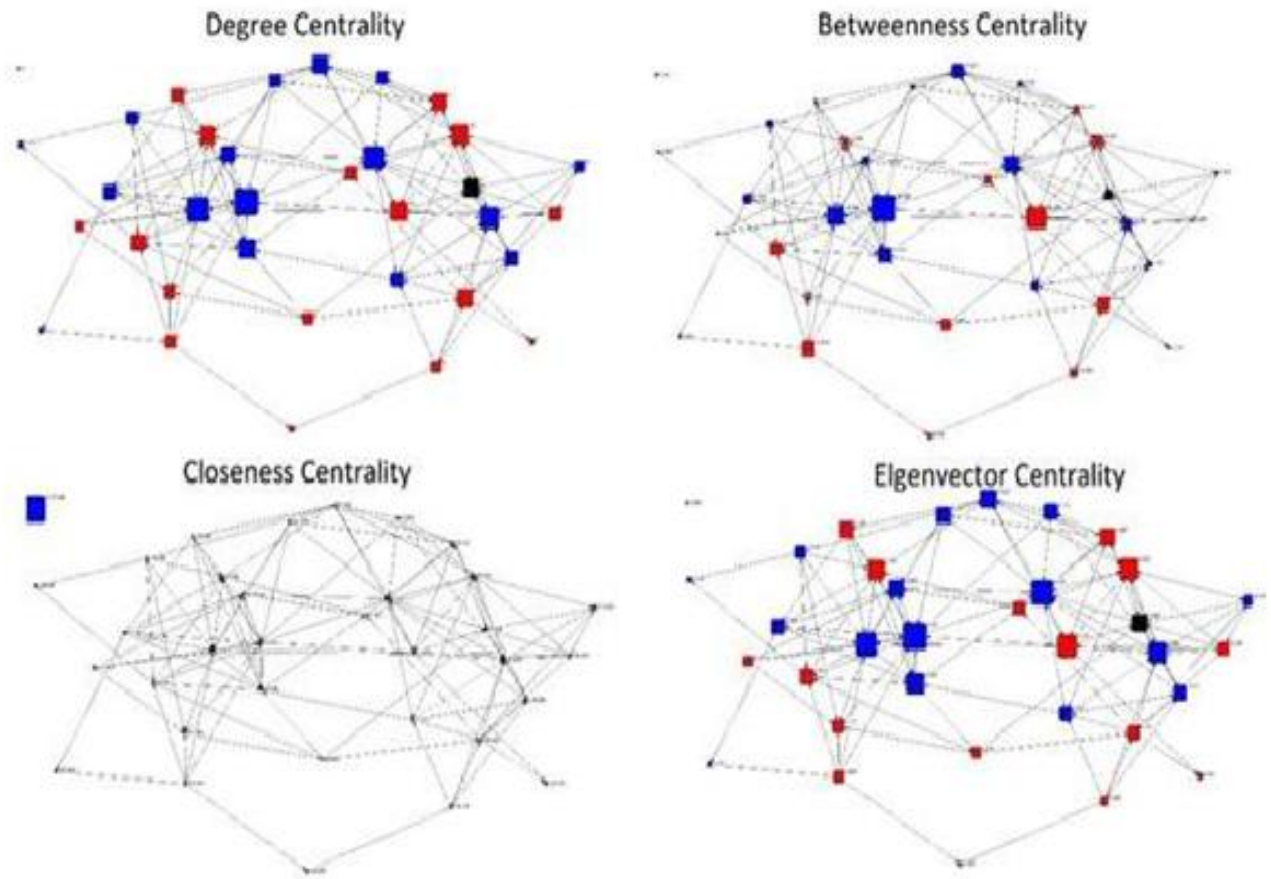

Figure 6 Network Map for Workplace B (Knowledge)

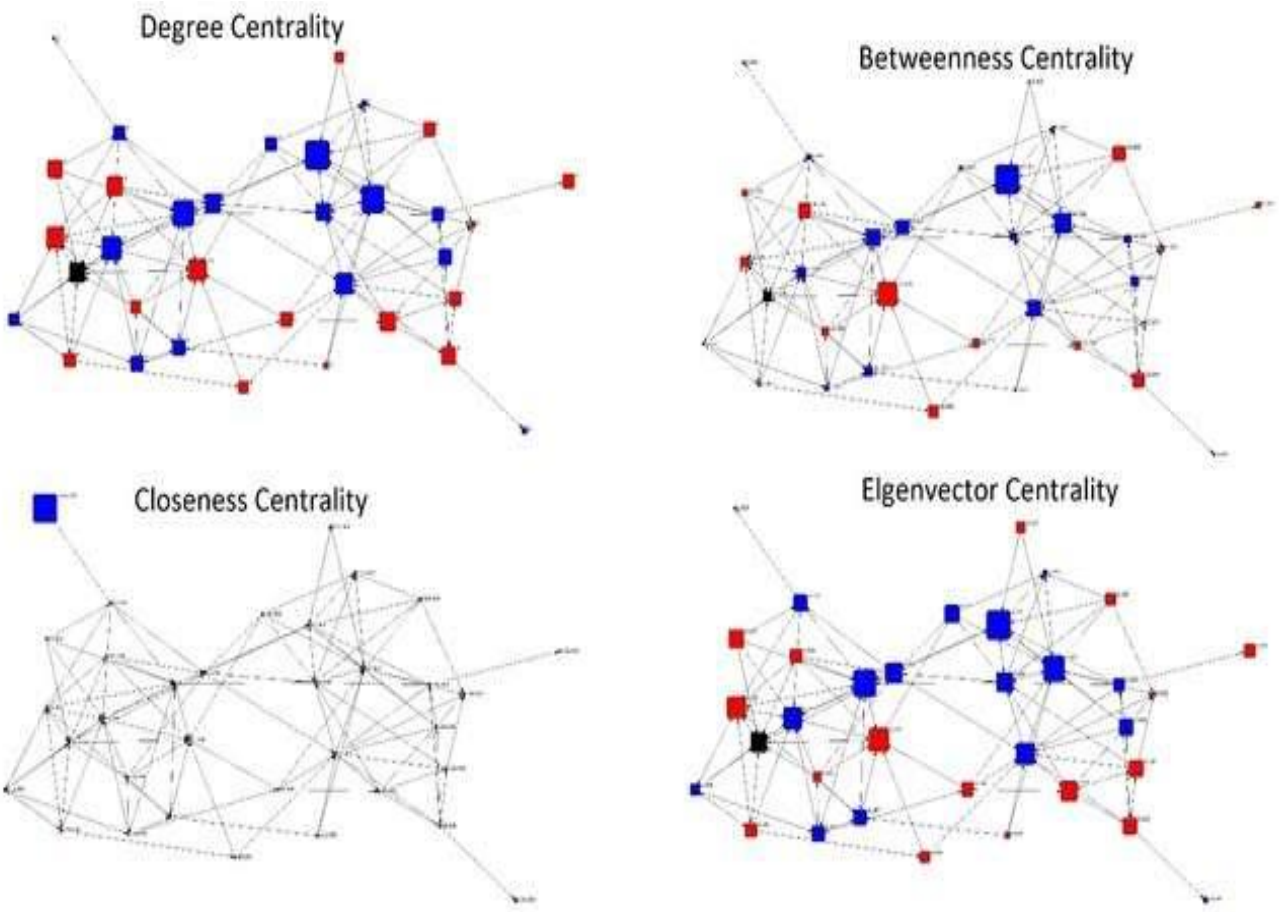

Figure 7 Network Map for Workplace B (Near Misses)

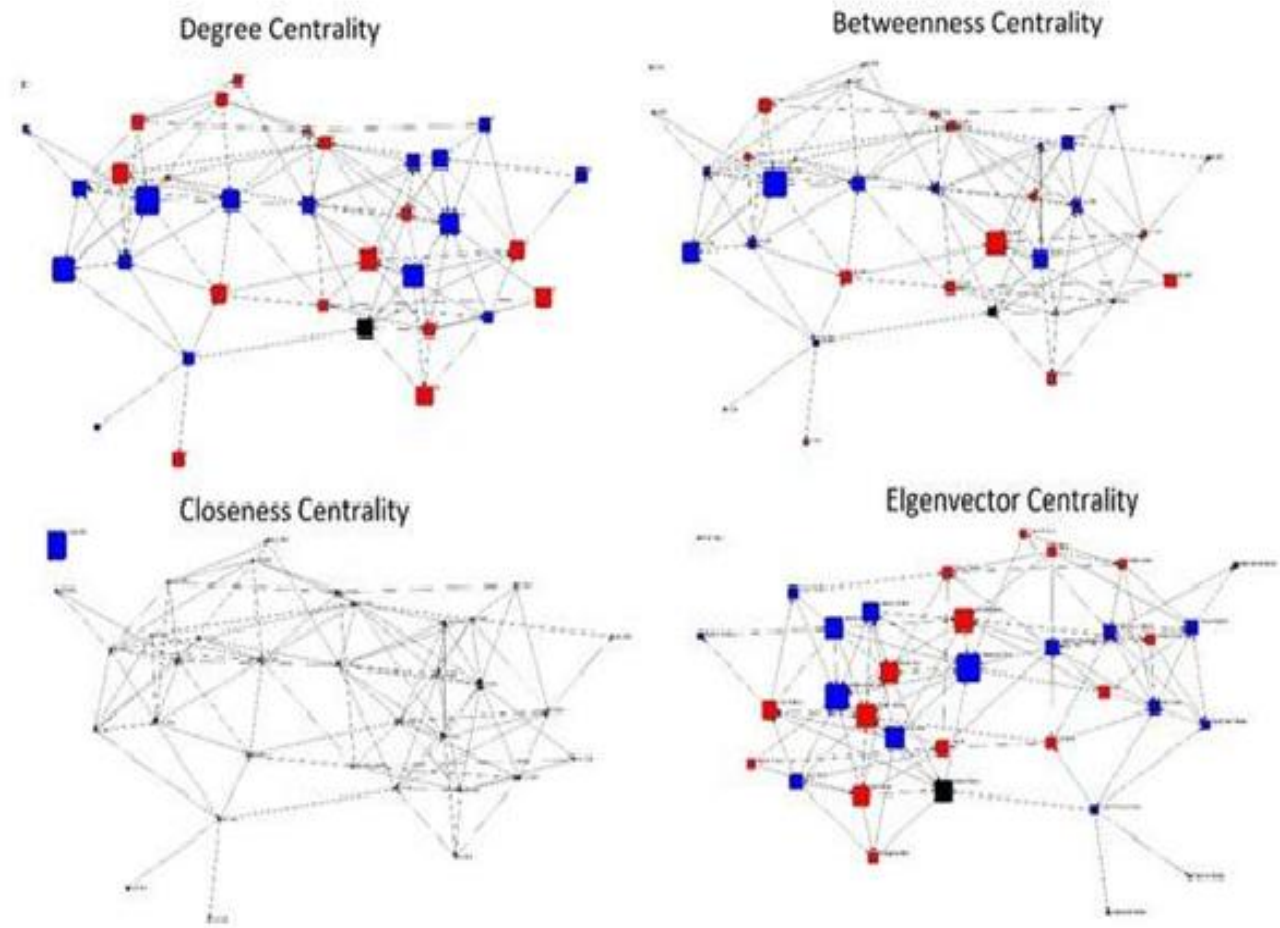

Figure 8 Network Map for Workplace B (Social Support)

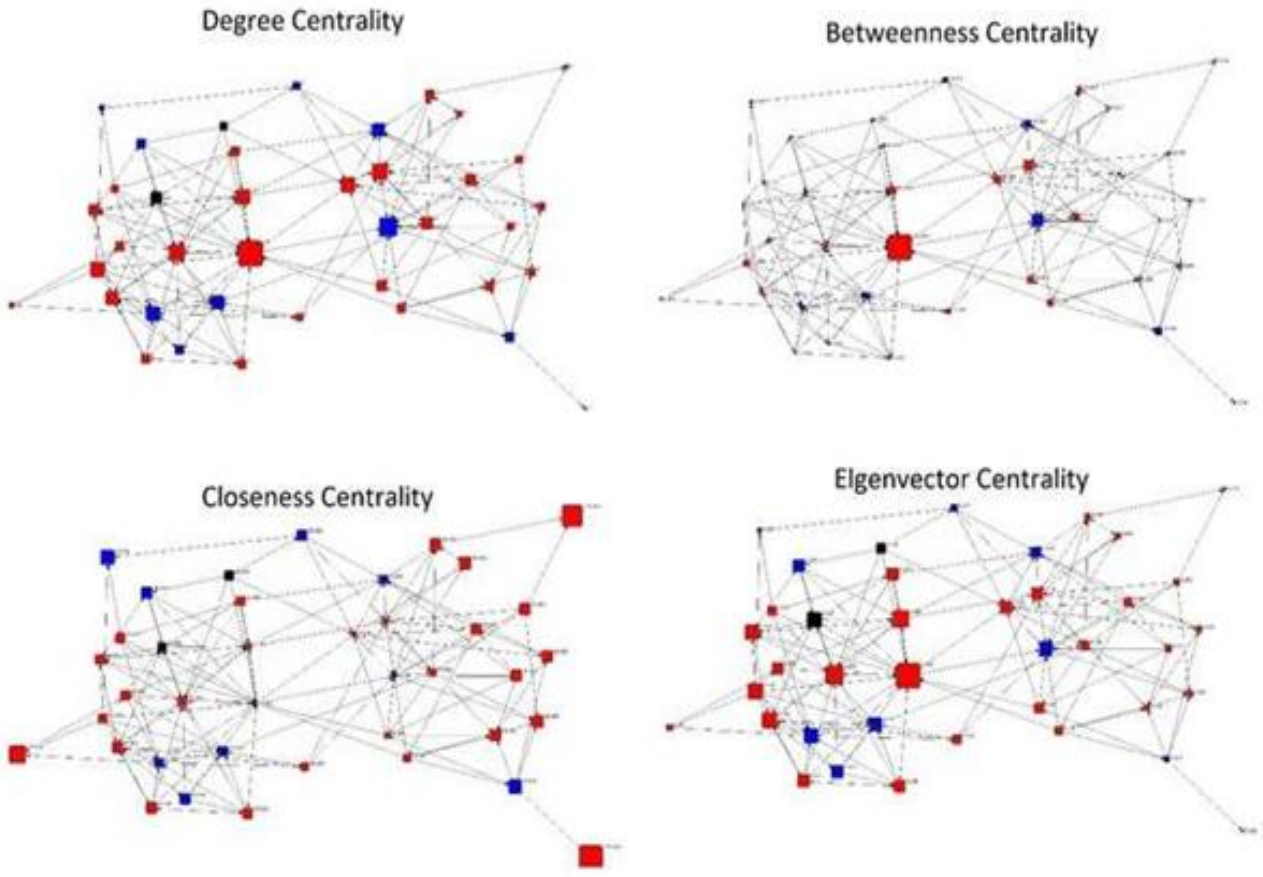

Figure 9 Network Map for Workplace C (knowledge)

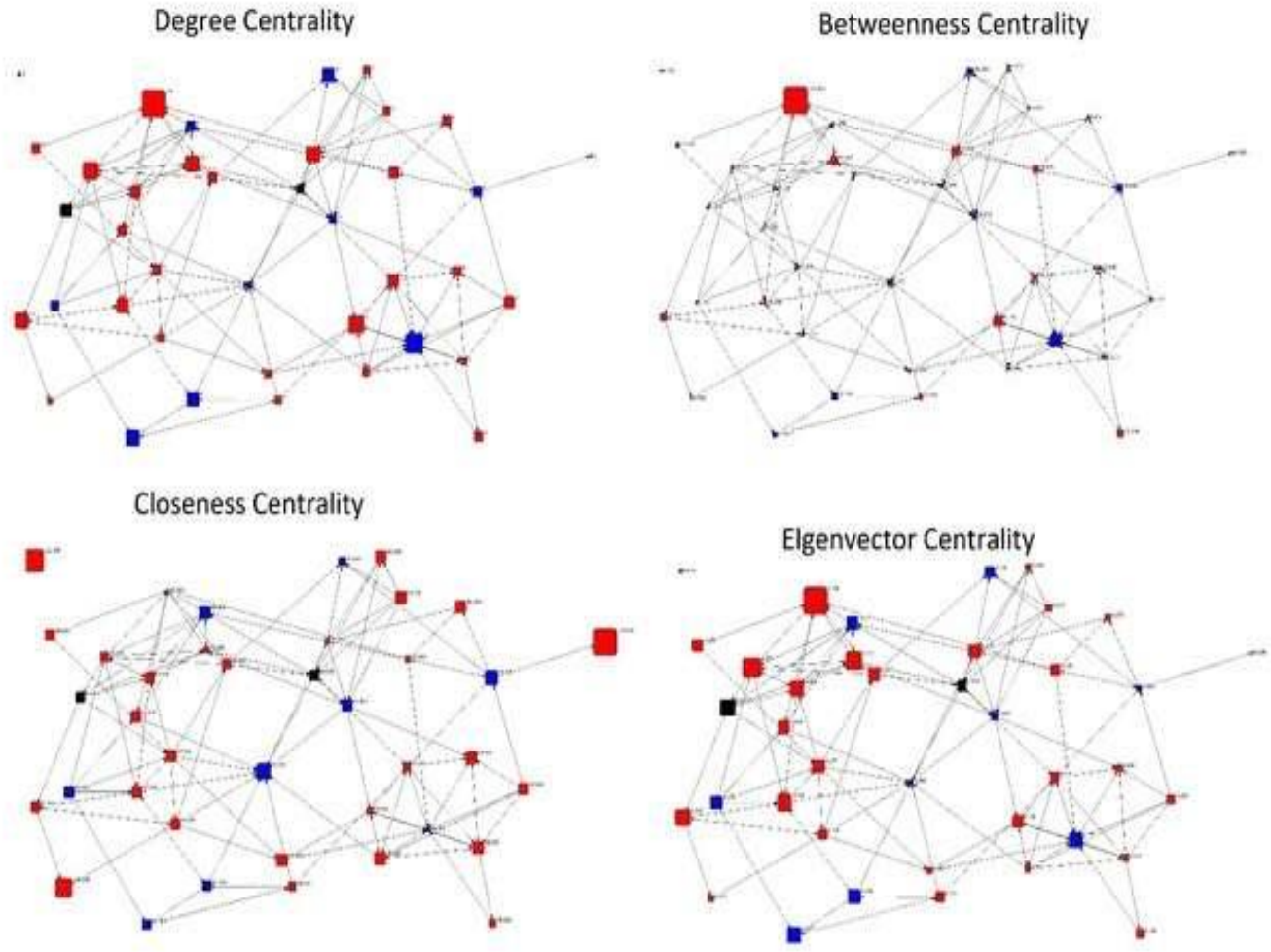

Figure 10 Network Map for Workplace C (Near misses)

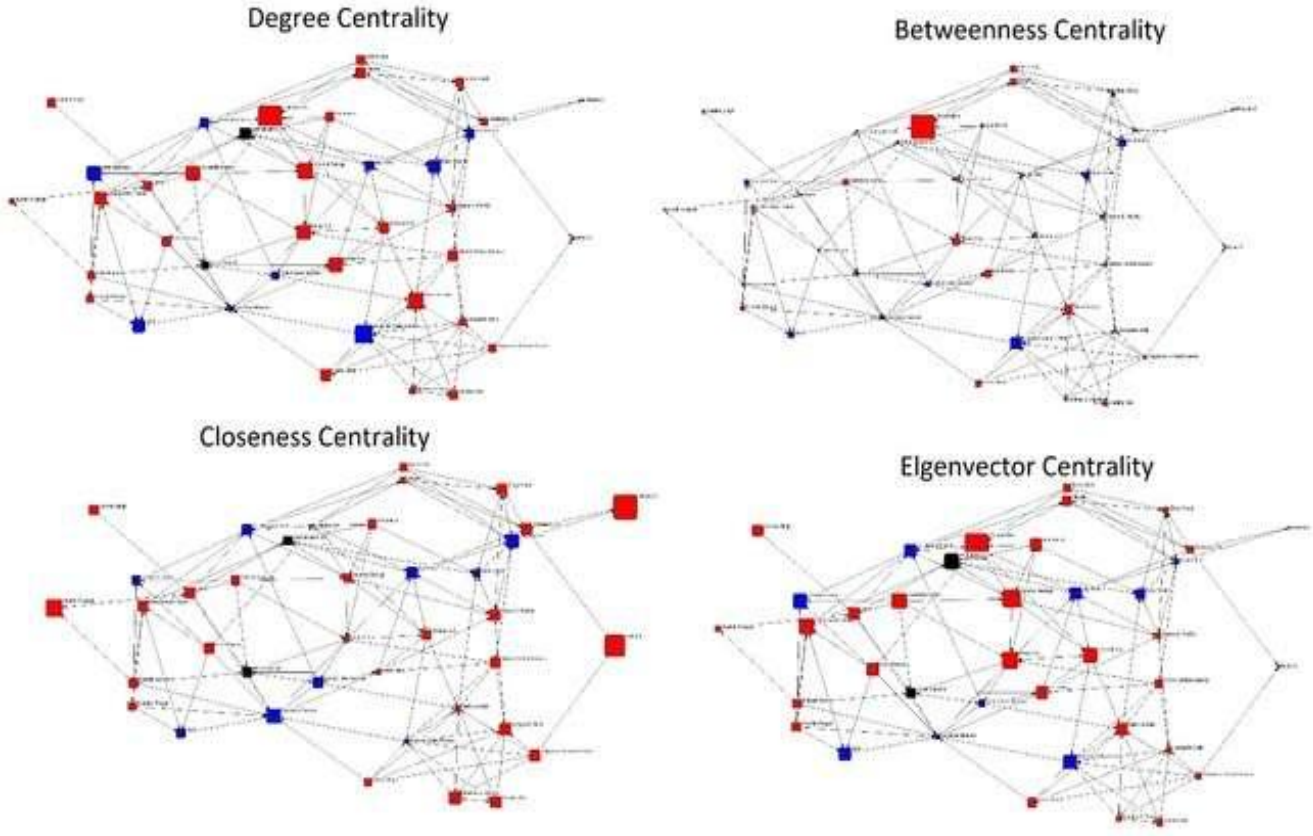

Figure 11 Network Map for Workplace C (Social Support)

Discussion:

In this research, we used Social Network Analysis (SNA) to gain overview of existing social networks and to determine which staff members are informal leaders within the three specified categories.

Workplace-A:

The initial workplace is a Central Dental Education and Research institute where a total of 34 nursing staff are posted, and 22 participated in the study. Figures 3, 4, and 5 represent the sociograms (Social Network graphs) of workplace-A. The sociograms of workplace-A exhibit a single cluster for 'knowledge' and 'discussing near misses', with an additional cluster of 4 actors for 'social support'.

Interestingly, the top three maximum values of degree centrality were held by the most senior nurses of the group. Degree centrality assigns a relevance value to each node based on the number of connections it has, providing information on the number of direct, 'one hop' connections each node has to other nodes in the network. It is utilized to identify individuals who are highly connected, popular, likely to possess the greatest knowledge, or who can rapidly connect to the larger network. Degree centrality is the most straightforward indicator of node connection.

The maximum observed value of betweenness centrality was 119, which was also held by one of the Assistant Nursing Superintendents (ANS). Betweenness centrality estimates the frequency with which a node is situated on the shortest path between other nodes. This metric indicates which network nodes serve as 'bridges' between other nodes. It accomplishes this by discovering all shortest paths and calculating the frequency with which each node falls on one. It is used to identify individuals who impact a system's flow. Betweenness is valuable for evaluating the dynamics of communication, but it should be used with caution. A high betweenness count may indicate that someone has control over many clusters in a network, or that they are merely situated on the boundary of both clusters.

The same individual also holds the lowest value for Closeness centrality. Each node's closeness centrality score is dependent on its proximity to all other nodes in the network. This metric computes the shortest paths connecting all nodes and provides each node a score based on the sum of its shortest paths. It is used to swiftly identify individuals who are best positioned to impact the entire network. Closeness centrality may assist in locating effective 'broadcasters', however, in a densely interconnected network, all nodes have comparable scores. Using Closeness to locate influencers inside a single cluster may be more beneficial.

EigenCentrality ranges from 0 to 0.42 for workplace-A. Similar to degree centrality, EigenCentrality assesses the impact of a node based on the number of linkages it has to other nodes in a network. EigenCentrality then takes into account a node's degree of connectivity, the number of interconnections between it and its connections, and so on across the network. By estimating a node's extended connections, EigenCentrality can discover nodes that have an impact over the entire network, not just those that are directly linked to it. EigenCentrality is an excellent 'all-around' SNA score, useful not just for comprehending human social networks but also networks such as virus transmission.

Workplace-B:

The second workplace is a National Drug Dependence Treatment Centre, where a total of 35 nursing staff are posted, and 34 participated in the study. Figures 6, 7, and 8 depict the sociograms (Social Network graphs) of Workplace B. The sociograms for Workplace B reveal a single cluster for 'knowledge', 'discussing near misses', and 'social support'.

Table 4 presents the values of the SNA measures for Workplace-B. The maximum observed values of degree centrality were 18, 10, and 11 for knowledge, near miss discussion, and social support, respectively. The maximum observed values of betweenness centrality were 207, 127, and 123, respectively, for all three domains. The lowest values for Closeness centrality were 60, 107, and 74, respectively, for the three domains. EigenCentrality ranges from 0 to 0.39, with the

maximum values for all three domains being 0.39, 0.28, and 0.27, respectively. Contrary to Workplace-A, there was no correlation between seniority or formal hierarchy and the higher values in the SNA parameters.

Workplace-C:

Workplace-C is a Day-care Centre situated within a cancer hospital, where a total of 41 nursing staff are posted, and 34 participated in the study. Figures 9, 10, and 11 depict the sociograms (Social Network graphs) of Workplace-C, revealing a single cluster for 'knowledge', 'discussing near misses', and 'social support'.

Table 5 presents the values of the SNA measures for Workplace-C. The maximum observed values of degree centrality were 14, 12, and 11 for knowledge, near miss discussion, and social support, respectively. The maximum observed values of betweenness centrality were 68, 101, and 74, respectively, for all three domains. The lowest values for Closeness centrality were 87, 58, and 89, respectively, for the three domains. EigenCentrality ranges from 0 to 0.32, with the maximum values for all three domains being 0.31, 0.29, and 0.15, respectively. Contrary to Workplace A, in Workplace-C, there was no correlation between seniority or formal hierarchy and the higher values in the SNA parameters.

Stregnths and Limitations:

We acknowledge that this study has several constraints. The social network was assessed only once, leaving the optimal number of connections or network density undetermined. Furthermore, while the network in this study is predicated on interprofessional connectivity, there is a scarcity of information regarding the quality of these connections. Moreover, although 95 percent of the professionals were ultimately incorporated into the network following the replacement, the initial response rate was merely 65%, 97%, and 83% for workplaces A, B, and C respectively.

Conclusion:

Upon visual examination of the social network diagrams procured from all three centres across three domains each, it can be inferred that the formal hierarchy among the nursing staff may exert varying degrees of influence on the social networks and the informal connections therein. In Workplace A, the informal leaders are also senior nursing members, whereas in the other two workplaces, the formal hierarchy does not correlate with the presence of informal leaders. To the best of our knowledge, this type of study in healthcare has not been previously conducted in India. The methodology of social network analysis can be leveraged to survey the organisational structure and pinpoint the informal leaders. These informal leaders can be harnessed to enhance team performance (14).

Furthermore, individuals occupying pivotal positions in the social network were identified across each profession. Research has demonstrated that these key individuals, serving as informal leaders, play an integral role in the implementation or dissemination of information. Their enthusiasm and networking capabilities with other team members make them indispensable (15).

Acknowledgment:

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