Network Analysis of Project Communication Based on Graph Theory

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Abstract: By analyzing the process flow in project management using the network analysis technique based on graph theory, it enables us to visualize the state of the management in a project. In this paper, we try to visualize the communication status in the project of a broadcasting systems development. Network analysis has been applied to the information-sharing process of the progress meeting of the project which the author actually commanded. Based on this result, visualization of the influence which the rule of a progress meeting has on the deviation of information sharing or concentration is tried.
Key words: Project Management; Project communication; Network analysis; PMBOK

1 Introduction

It is difficult to visualize the state such as communication channel and information sharing of project. In this research, we have tried to visualize the status of the information sharing of the project by the network analytical method which is based on graph theory [1-3]. Structure of the information sharing in progress meeting of the project where the author serves the manager, was analyzed with network analysis method. We paid attention to also the interaction of communication management and integrated change control. Then, we have executed also the path analysis of data flow for the 42 processes described in PMBOK [4].

From these analysis results, it was ascertained the project documents are carrying out important role in the information sharing system of project.

2 Network Analysis

2.1 Network

Network is formed from the point and the line. The point is called as a node and the line is called as bond and link etc. It is possible to express various structures by the network methodology. Also computer network and the traffic net and molecular structure etc are one example of network. In this research, the node shows the individual and organization, and the link shows the relationship like connections concerns and business relations.

2.2 Adjacency matrix

Adjacency matrix describes the relationship among the nodes which forms network. The component will be '1' when there is relationship between two nodes, or '0' when there is no relationship.

2.3 Undirected graph

An undirected graph is a graph describing the network in which the nodes are connected by undirected arcs.

2.4 Directed graph

A directed graph, or "digraph", is a graph whose edges have direction. Arrows on the nodes are used to encode the directional information. An arrow from node A to node B indicates that there is one way relationship from A to B but not from B to A.

2.5 Degree centrality

The Degree Centrality can be used to evaluate the position of a single node in an undirected network. By applying the Degree Centrality the most important node in a network can be localized.

2.6 Betweenness centrality

The network betweenness centrality considers the betweenness centrality of each node in the network and calculates the mean of all nodes.

2.7 Bonacich centrality

Bonacich proposed that both centrality and power were a function of the connections of the nodes in one's neighborhood.

3 Structure Analysis with Network Analysis

3.1 Project team

The F Corporation has accepted an order the video system from the Y Corporation which is constructed with four sub-systems. The project period is 11 months to deliver date of the product. The number of the project team members is {55, 39} members belong to the F Corporation is, {16} is the Y corporation. Project is formed from four sub projects which corresponded to every subsystem. The persons of the F Corporation and the Y Corporation were selected in every respective sub projects. As for progress meeting, specification arrangement meeting and inside meeting of F Corporation, the list of the participation member is respectively shown in table 1.

Table 1   List of the Participation Member

| | | | | Project Meeting | | | | | Bender Meeting | | | | | |
| | | | | Progress meeting | Spec. meeting | | | | Progress meeting | Group meeting | | | | |
		Person	Code	Sub system A / Sub system B / Sub system C / Sub system D	Sub system A	Sub system B	Sub system C	Sub system D	Group A – D	Group A	Group B	Group C	Group D	Group E
F Co.Ltd.	PMr	F1	1	O	O	O	O	O	O	O				
	Group A	FA–1	2	O	O				O					
		FA–2	3	O	O				O	O				
		FA–3	4	O	O					O				
		FA–4	5							O				
		FA–5	6							O				O
		FA–6	7							O				
		FA–7	8							O				
		FA–8	9							O				
		FA–9	10							O				O
	Group B	FB–1	11	O		O			O		O			
		FB–2	12	O		O					O			
		FB–3	13	O		O					O			
		FB–4	14								O			
	Group C	FC–1	15	O			O		O		O	O		
		FC–2	16				O					O		
		FC–3	17				O					O		
		FC–4	18									O		O
		FC–5	19									O		
		FC–6	20									O		
		FC–7	21									O		
		FC–8	22									O		
		FC–9	23									O		
	Group D	FD–1	24	O				O	O				O	
		FD–2	25					O					O	
		FD–3	26					O					O	
		FD–4	27					O					O	
		FD–5	28					O					O	
		FD–6	29					O					O	
		FD–7	30					O					O	O
		FD–8	31										O	
		FD–9	32										O	
		FD–10	33										O	
	Group E	FE–1	34											O
		FE–2	35											O
Y Co. Ltd.	Supervisor	Y1	36	O	O									
		Y2	37	O	O									
	Group A	YA–1	38	O	O									
		YA–2	39	O	O									
		YA–3	40		O									
		YA–4	41		O									
		YA–5	42		O									
		YA–6	43		O									
	Group B	YB–1	44	O		O								
		YB–2	45	O		O								
	Group C	YC–1	46	O			O							
		YC–2	47				O							
	Group D	YD–1	48	O				O						
		YD–2	49					O						
		YD–3	50					O						
		YD–4	51					O						

3.2 Network analysis of status of information sharing

With this project, progress of sub project was reported with the progress meeting. But, the checking adjustment of important matter between sub-system was not easy by just only the review of progress report. Then, in order to promote the information sharing between sub projects, name of progress meeting was changed with modification control board. As same time, the prescribed form of the report was changed. With this operation, the information sharing in meeting improved markedly. Network analysis has been applied to the propagation of the information in the meeting before and after the name modification. Before changing the name of meeting, we call the meeting as the progress meeting, after changing the name of meeting, change control board (CCB).

At the progress meeting, "as for the participant you inquire about the review of report, the hypothesis that, but the contents are not always verified", is put in place. We have made an assumption that the participation members listen the review of reports, but the contents are not always verified. In

that case, the graph for the progress meeting is displayed with the unidirectional arrow to the participant.

On the other hand, review of progress reports and request for change are given approval by the participant in CCB. Therefore, consistency of subsystem is maintained. In this case, between the reporter and the participant, we could make an assumption that bidirectional information propagation was done. In that case, the graph for the CCB is displayed with the undirected link among the participants.

From assumptions above, it is possible to make the Adjacency matrix of the status of the information sharing in meeting. The participant is displayed with the node; information transmission between the participants is displayed with the arrow. At the progress meeting it means to describe in one side arrow. As for this it can draw as the directed graph (A). At the CCB it means to tie the information transmission between the nodes with the both sides arrow. As for this it can draw as the undirected graph (B). Adjacency matrices co-responding to graph (A) and (B) are shown in Fig. 1 and Fig.2 respectively

Figure 1   Adjacency Matrix of Graph (A) Co-responding to the Progress Meeting

Figure 2   Adjacency Matrix of Graph (B) Co-responding to the CCB

A drawing of a network diagram of progress meeting based on adjacency matrix of graph (A) is

showed in Fig.3. The numbered circles in fig.3 are indicating project team members in table 1. The line between circles is indicating a communication pass co-responding a flag as shown in fig.1. The circle (1) is the project manager of F cooperation. It is found that there are many communication routes which do not go through the project manager.

A drawing of a network diagram of CCB based on adjacency matrix of graph (B) is showed in Fig.4. It is found that almost communication pass are going through the project manager. This means that the project manager is able to control the information exchange and decision-making.

The score of centrality which was calculated from the adjacency matrix which is shown in Figure 1 and Figure 2 is shown in table 2[5].
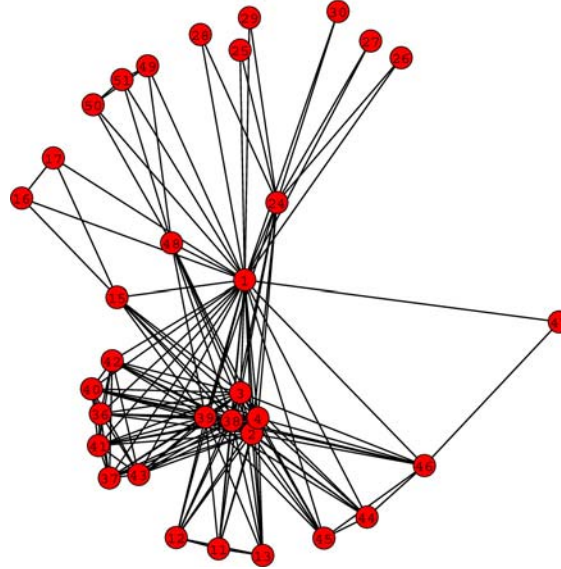

Figure 3   A Drawing of a Network Diagram before Changing the Name of Progress Meeting
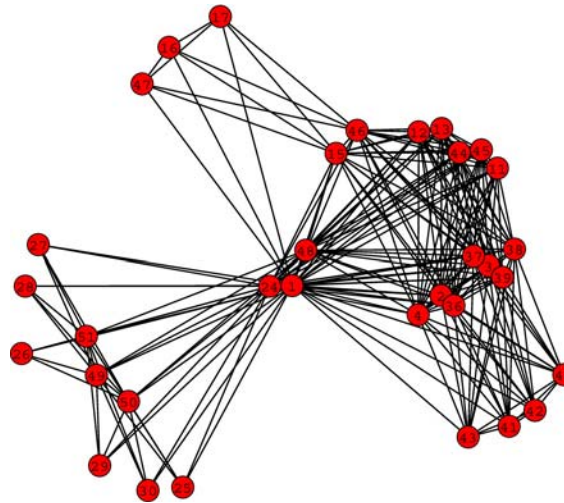

Figure 4   A Drawing of the Network Diagram after Changing the Name of Meeting as CCB

The score of Bonacich centrality of Code {1} and Code {36, 37} is compared in table 2. At the progress meeting, it is found that the score of Code {36, 37} (Supervisor of the Y corporation) is larger than one of Code {1} (the project manager). On the one hand, it is observed the score of Code1 has become larger than the one of Code {36, 37} in CCB. This means that the influence and reliability of Code {1} is improved.

From these results, it is suggested that the modification of rule of progress meeting promoted information sharing regarding progress reports and change requests.

4   Conclusion

In this research, we have analyzed the structure of the information sharing in progress meeting with the past project where the author serves the project manager by network analytical method. We were able to show change of the communication route in a project by network analytical method.

Table 2   Score of Centrality (Degree Centrality, Bonacich Centrality)

Code	Progress Meeting (before rename)			Change control board (after rename)		
	Degree centrality	Standardization	Bonacich centrality	Degree centrality	Standardization	Bonacich centrality
1	9	0.18	0.8	32	0.64	1
2	9	0.18	0.8	20	0.4	0.89
3	9	0.18	0.8	20	0.4	0.89
4	9	0.18	0.8	20	0.4	0.89
5	0	0	0	0	0	0
6	0	0	0	0	0	0
7	0	0	0	0	0	0
8	0	0	0	0	0	0
9	0	0	0	0	0	0
10	0	0	0	0	0	0
11	8	0.16	0.69	16	0.32	0.78
12	8	0.16	0.69	16	0.32	0.78
13	8	0.16	0.69	16	0.32	0.78
14	0	0	0	0	0	0
15	8	0.16	0.57	19	0.38	0.81
16	3	0.06	0.17	5	0.1	0.17
17	3	0.06	0.17	5	0.1	0.17
18	0	0	0	0	0	0
19	0	0	0	0	0	0
20	0	0	0	0	0	0
21	0	0	0	0	0	0
22	0	0	0	0	0	0
23	0	0	0	0	0	0
24	12	0.24	0.64	25	0.5	0.86
25	2	0.04	0.16	5	0.1	0.15
26	2	0.04	0.16	5	0.1	0.15
27	2	0.04	0.16	5	0.1	0.15
28	2	0.04	0.16	5	0.1	0.15
29	2	0.04	0.16	5	0.1	0.15
30	2	0.04	0.16	5	0.1	0.15
31	0	0	0	0	0	0
32	0	0	0	0	0	0
33	0	0	0	0	0	0
34	0	0	0	0	0	0
35	0	0	0	0	0	0
36	11	0.22	1	20	0.4	0.89
37	11	0.22	1	20	0.4	0.89
38	9	0.18	0.8	20	0.4	0.89
39	9	0.18	0.8	20	0.4	0.89
40	9	0.18	0.8	11	0.22	0.5
41	9	0.18	0.8	11	0.22	0.5
42	9	0.18	0.8	11	0.22	0.5
43	9	0.18	0.8	11	0.22	0.5
44	8	0.16	0.69	16	0.32	0.78
45	8	0.16	0.69	16	0.32	0.78
46	9	0.18	0.71	18	0.36	0.76
47	2	0.04	0.17	5	0.1	0.17
48	9	0.18	0.6	18	0.36	0.77
49	4	0.08	0.2	11	0.22	0.23
50	4	0.08	0.2	11	0.22	0.23
51	4	0.08	0.2	11	0.22	0.23

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