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Collaboration Strategy for ODA Project using Social Network Analysis

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Abstract

Recently, Official Development Assistance (ODA) projects are increasing. Since ODA projects are financially stable, engineering companies planning to enter the international construction market need to make ODA projects as a first step. Engineering ODA project evaluates bidders by Quality Cost Based Selection (QCBS) method. Under the QCBS, companies make up for their lack of capacity through collaboration. Therefore, collaboration network information is required for winning. In this study, Social Network Analysis (SNA) is performed using the bidding information of socialbase, road, and water sector provided by World Bank (WB) for Vietnam ODA projects. The objectives of this study is to identify the network characteristics of the three sectors with the network shape and the density calculated through SNA, and to identify the main player by degree centrality and betweenness centrality, and to suggest an appropriate strategy. This is helpful information for decision makers when deciding whether to go overseas or not.

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Keywords: Collaboration Strategy; International Engineering Project; Official Development Assistance (ODA); Social Network Analysis (SNA)

1. Introduction

1.1. Research Background

Recently, as the ODA project expands, the size of the multi-lateral development bank (MDB) procurement market is steadily expanding. Since ODA projects are financially stable, and track records can be accumulated through these projects, ODA projects will be the first step in entering the international construction market for engineering companies that have not yet entered [1,9]. Most of the ODA projects are evaluated by QCBS. In QCBS, generally, the company with the highest score by summing the technical score and the financial score as a ratio of 8: 2 is selected as the winning company. In addition to companies whose technical score is less than the standard score will be dropped, and the price score will be evaluated for the passed companies [7]. Therefore, engineering companies should have high technical competence for winning the ODA projects. For this reason, many companies tend to cooperate in a joint venture (JV) or consortium form to improve their competence. At the initial stage of bidding, collaboration network information should be considered for successful winning the ODA projects. The purpose of this study is to identify characteristics of network among bidding companies for each sector by using SNA. It is expected that the result of this study will support to set up the strategy about winning the ODA project by giving the network information such as network structure, main players in network.

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1.2. Research scope and process

WB manages the ODA project data in the form of an open database (Open DB) and discloses the bidding information of each projects. The bidding information includes the type of project, size, bidding company and collaboration information, technical and financial scores of each bidding company, bid price and so on. Focusing on bidding company and collaboration information, this study establishes a relationship network that links companies that have collaborated. Research process is followed as Fig. 1.

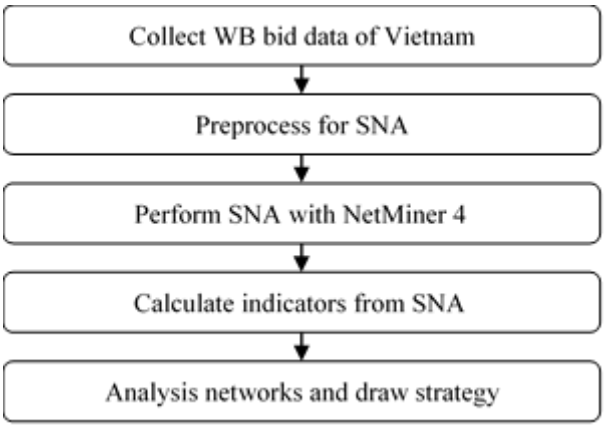

Fig. 1. Research process

First, the bid data provided by WB is collected. The collected bid data is the ODA project conducted in Vietnam where many ODA projects have been carried out, and the type of projects in the collected bid data are social base, road and water sector projects which have the highest proportion in overall ODA projects in Vietnam. In this study, bidding company and collaboration information for a total of 75 projects, 20 countries and 108 companies is used.

Second, the company name was set as the node and the relationship between the collaborating companies is created as an adjacent matrix by using the Matlab. And then, SNA is conducted by using NetMiner 4 and density and centrality are calculated. Finally, analyze the network of each sector and draw out the strategy based on the calculated indicators.

2. Research Methodology

2.1. Social Network Analysis

SNA is useful methodology for understanding the social phenomenon and social structure that Moreno started with the term “Sociometry” [5]. It has been used in not only social science research but also construction research such as communication management, stakeholder management and procurement management [2]. By using SNA, it is possible to analyze the network connecting the actor called node to the line called tie, and graphically shows the relationship or flow between the nodes by showing the given data with nodes and links. Through the structured network, various indicators can be used to identify key nodes, identify roles and positions of specific nodes, and evaluate the network itself.

2.2. Indicators of Social Network Analysis

There are various indicator to represent characteristic of network. In this study, density, degree centrality, and betweenness centrality are used to analyze the network.

Density (D) is the most widely used indicator for analyzing a networks and indicates how many nodes are connected on the network. It is possible to see how cohesively the network through density. Density is a value calculated for the entire network, and the equation is as follows [8].

$$D = \frac{l}{n(n-1)/2} \quad (1)$$

where l = the number of existing ties and n = the number of existing nodes

Density has a value ranging from 0 to 1, and the closer to 1, the more cohesively. It is not an indicator of detailed information of the company level, but it can confirm the overall condition of the market or sector [3]. In this study, density of each sector of projects in Vietnam is investigated to see how cohesively network for each sector.

Degree centrality (C_D) is the sum of the number of nodes connected to one node, representing the extent to which a particular node is connected to other nodes. Since bigger network have larger value, sometimes the normalized value are adopted. There are two methods of normalization: i) dividing b *N*-1, the maximum degree centrality that can be calculated in the network, and ii) dividing by the sum of all Degree Centralities in the network, and the equation is as follows [4,6].

$$C_D(p_k) = \sum_{i=1}^{n} a(p_i, p_k) \quad (2)$$

where $a(p_i, p_k) = 1$ if and only if p_i and p_k are linked, otherwise 0

In the network of this study, the fact that a particular node is connected to many nodes means that the particular node is a main player that has collaborated with many companies. Therefore, the values of the top five companies with high degree centrality are identified. In the case of directional networks, in-degree and out-degree are calculated separately when calculating degree centrality, but the network used in this study is not considered since it is a non-directional network.

Betweenness centrality (C_B) is measured as the ratio of the path through a particular node among the shortest paths (i.e., geodesic) connecting any two nodes, and the equation is as follows [4].

$$C_B(p_k) = \sum_{i}^{n} \sum_{j}^{n} \frac{g_{ij}(p_k)}{g_{ij}}, i < j \quad (3)$$

where $g_{ij}(p_k)$ = the number of geodesics connecting p_i, p_j with passing p_k

Betweenness centrality represents a node acting as a mediator or broker, which means that there is a possibility to mediate the flow and exchange of information within the network [6]. Companies with high value of betweenness centrality can collaborate with many other companies by using their network. Therefore, if company A has a relationship with company B, which has high value of betweenness centrality, then A company can indirectly use the company B's network. In this study, companies with high betweenness centrality are identified and defined as target company for cooperating.

3. SNA Result

As previously mentioned this study analyses the collaboration network. Thus, nodes in the network stand for companies and each node is tied with the companies with which it has collaborated. The nodes with less than 4 ties were removed in the forthcoming figures since the purpose of the study is to identify the company with high centrality.

3.1. Socialbase sector

Companies from 15 countries participated in the bid and the majority of them were Korean company except local companies. The network has 290 ties between 122 nodes and shows the density of 0.021 which is the least among the sectors. The entire network of socialbase sector is shown in the Fig. 2. forming a huge single network.

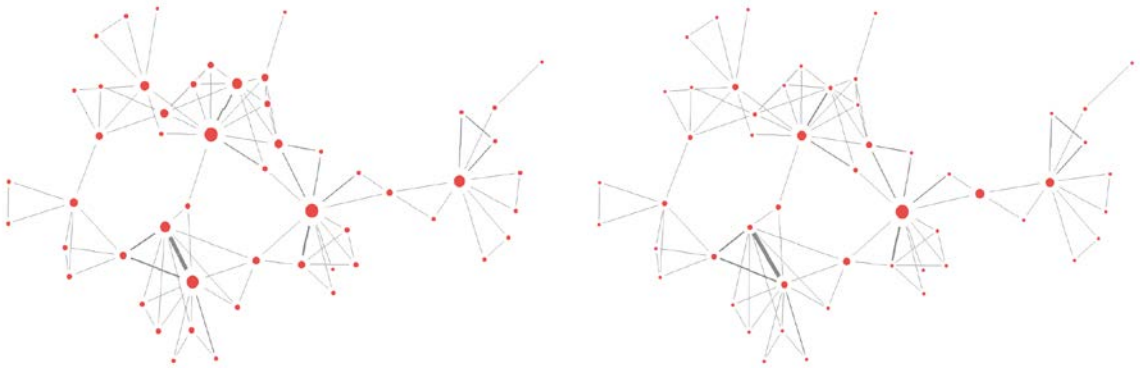

Fig. 2. Network of socialbase sector based on degree centrality (left), betweenness centrality (right)

Bigger node size represents higher Degree centrality on the left figure and higher betweenness centrality on the right, respectively. The analysis result shows that the value of highest degree centrality is 0.092 and the value of highest Betweenness centrality is 0.092 (Table. 1).

Table 1. Degree/Betweenness centrality of TOP 5 companies on socialbase sector

Degree Centrality		Betweenness Centrality	
K (KOR)	0.092	E (CAN)	0.092
E (CAN)	0.092	C (VNM)	0.059
R (NLD)	0.083	K (KOR)	0.058
Y (KOR)	0.075	Y (KOR)	0.053
J (KOR)	0.067	D1 (VNM)	0.040

Two Korean companies are included in the three companies which belongs to Top 5 in terms of both Degree centrality and Betweenness centrality. Moreover, the fact that other Korean companies are also in the high ranking implies that Korean companies are the main player of the socialbase sector.

3.2. Road sector

Companies from 16 countries participated in the bid in the road sector and the majority of them are American company except local companies. 242 ties between 90 nodes appeared in the network and the density is 0.031. The higher density of road sector is attributed to the fact that the number of tie is relatively larger to the number of node comparing to the socialbase sector. Hence, the network of the road sector is denser than that of the socialbase sector. Fig. 3., however, shows that the network forms the several clusters severed while there was single network in the socialbase sector.

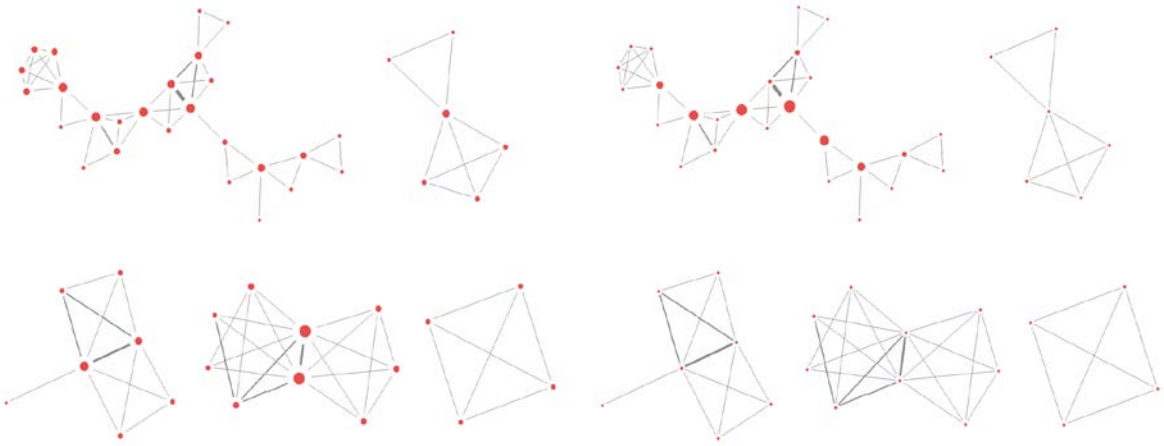

Fig. 3. Network of road sector based on degree centrality (left), betweenness centrality (right)

Those closed clusters indicate that the companies have formed the strong relationship which is exclusive to the outside. In this case it is recommended that a company takes a broker position linking clusters so that there would be higher possibility that the company enjoys takes advantage of both clusters.

The table below shows the highest Degree centrality of 0.091 and the highest Betweenness centrality of 0.042.

Table 2. Degree/Betweenness Centrality of TOP 5 Company on Road Sector

Degree Centrality		Betweenness Centrality	
C (USA)	0.091	S (AUS)	0.042
A (VNM)	0.091	T (VNM)	0.039
Y (KOR)	0.068	I (VNM)	0.033
T (VNM)	0.068	K (KOR)	0.032
S (AUS)	0.068	C (DNK)	0.027

Relatively low Betweenness centrality which stems from the network with the severed clusters make the market less profitable no matter which company collaborates in the road sector. Therefore, it is desirable to become the bridge linking the clusters.

3.3. Water sector

Companies from 8 countries participated in the bid in the water sector and the majority of them are French company except local companies. The network has 226 ties between 93 nodes and the density is 0.05 which implies that the nodes are most concentrated. The dense network shown in Fig. 00 results in the high density even though the node-tie ratio in the water sector is lower than in the road sector.

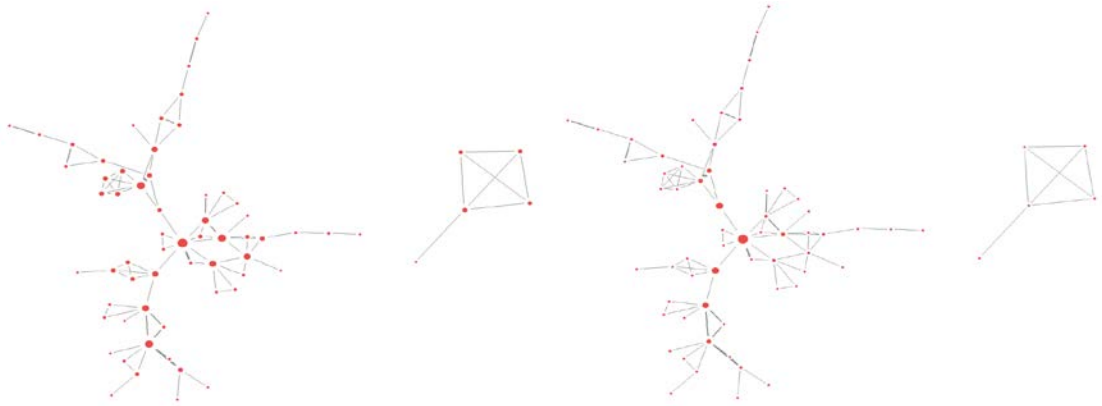

Fig. 4. Network of water sector based on degree centrality (left), betweenness centrality (right)

Table 3. Degree/Betweenness Centrality of TOP 5 Company on Water Sector

Degree Centrality		Betweenness Centrality	
E (CAN)	0.099	E (CAN)	0.309
V1 (VNM)	0.077	D3 (VNM)	0.198
S (VNM)	0.077	V2 (VNM)	0.190
D2 (VNM)	0.077	S (KOR)	0.157
S (KOR)	0.066	R (NLD)	0.108

Betweenness centrality of water sector is far higher comparing to the other sectors. This is ascribed to the radial shape network in which companies are stretched from the main company in the center. As several companies might play a role as a broker it could bring the huge profit to collaborate with those companies.

4. Conclusion

In order to analyze the network of ODA engineering projects in Vietnam, this study used the bid information, which is provided by WB. With the information, companies that collaborated are represented in the form of network, calculating the density by sector and identifying main player companies. Among the three sectors, the socialbase sector has lowest density of 0.021, and the highest value of degree centrality and betweenness centrality are both 0.092. Since the density of the network is relatively low and the companies, except one company, do not have a high value of betweenness centrality, collaborating with a specific company is not a big benefit. In other words, there is no big difference in collaboration with any company except one. Road sector has a density of 0.031, the highest degree centrality is 0.091, and the highest degree of betweenness centrality is 0.042. Since there are several clusters forming a network, the betweenness centrality is low overall, so if it is possible to act as a broker connecting two or more clusters, it is a great benefit from a collaboration network. However, it is hard to be in the broker position from the beginning, it is necessary to take a chance by performing some projects. Water sector has the highest density of 0.05 and the highest degree centrality is 0.091. Because the network is radial shape, the highest betweenness centrality is 0.309, which is very high compared to other sectors. This means that there are several companies located in the broker position already, and if it is possible to collaborate with that companies, it will be of great benefit in a short period of time from a network.

Some limitations of this study are as follows. First, time is not taken into consideration. Even if the centrality is high, there may be companies that have bid in the past and are not currently. Second, it does not take into account the capabilities of companies. Even if the number of bids is large, it may not lead to win because of lack of competence.

In the future study, change of centrality of companies according to time will be analyzed and promising companies in recent years are derived. Also, technical score of each company will be analyzed, and then it is reflected on the network. Lastly, not only collaboration network but also competing network will be structured to analyze how strong the competition.

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