Game Theory Based Partnership Modeling to Procure Construction Material Between Suppliers and Housing Developer

Eva Sundari*, Trijoko Wahyu Adi*, Erwin Widodo*

*Department of Civil Engineering
Institut Teknologi Sepuluh Nopember, Surabaya, Jawa Timur, Indonesia
dheva_crown@yahoo.co.id, tri_joko@ce.its.ac.id, erwin@ie.its.ac.id

Abstract—The demand of residential housing always keeps increasing throughout several decades in developing countries such as Indonesia. The population growth and economy upsurge speed up the housing demand. This situation results in glittering prospect in housing development. The developer together with its suppliers play significant roles in the success of this business. Hence the corresponding relationship between the two is critical to analyze in order to attain a certain level of effectiveness. At the time being, this relationship is commonly lead by the developer in a one-way approach. Developer does supplier selection based on lowest price, minimum quality requirement and lead time. This conventional approach is considered to be inadequate since the developer decision on supplier selection is very possible to be manipulated by those suppliers in opposite ways. The effective decision making process should be made on the basis of cooperation between developer and supplier. This study aims to model the relationship between suppliers and developer based on cooperative game theory. The preliminary outcome is a set of models on relationship between suppliers and developer. This model is later on utilized to provide a win-win solution in term of satisfactory profit distribution within cooperative relationship.

Keywords: developer-supplier relationship, cooperative game theory, win-win solution.

I. INTRODUCTION

Background
To many relationship between developer and supplier urges developer to thoroughly threat its business operations with its suppliers. Suppliers also an important part to make products and services, but so far developers often do not try to maintain good and sustainable relationships with its suppliers.

At the time being, supplier selection is difficult and have a risk when a comprehensive criteria have not incorporated properly. Therefore, mutual relationship between suppliers – developer in assuring the business runs well is necessary.

Many theory and method can be used to make decision making, there are Analytical Hierarchy Process (AHP) dan Fuzzy Analytical Hierarchy Process (FAHP). Choosing a suitable strategy can help a evaluator in analyzing and evaluating the best strategic alternatives [1]. In this research used Game theory method. Game theory is method that focus on dynamics process change strategy [2]. The advantage of Game theory method is all player were satisfied with the decisions taken (win – win solution). If Game theory not applied, the possibility of one player will gain loss. The game consists a set of rule that builds competing situation from two player or more in choosing strategy for maximize profits [3]. Game Theory have two kind that is cooperative dan noncooperative. Cooperative game theory form joint commitment with attention relative strength of player. While non cooperative game theory that means one of the player make own decisions without commitment between players.

In this research, proposed cooperative game theory that assumes a benchmark relationship between decision maker in making decisions.

Problem Formulation
Based on the background described above, the problem can be formulated as follows: How to model a relationship between material suppliers - developers under cooperative game theory approach as well as analyse its possible equilibrium solution as a proposal for making the common goal of profit maximization in win-win solution way might be attained?

Research Objective
The purpose of this research is to: Modeling cooperation between material suppliers - developers with cooperative game theory approach, so both of them get optimum benefit.

II. RESEARCH METHOD

The purpose of this research is to modeling cooperation between material suppliers - developers with cooperative game theory at PT. Graha Agung Kencana. Stages of the research described in the flowchart Figure 2.1 below.
Based on figure above the player for this case study is supplier and housing developer PT. GrahaAgungKencana. Each of player will be generate their strategy. To arrange a payoff matrix in this study is by measuring or predicting the specific value from the strategy of each player that is suppliers and developers of Green Semanggi Residence. Payoff between suppliers whose contested is maximize net revenue. But payoff between supplier with developer the effectiveness of cost or price. The assumption that the payoff matrix known both of players.

III. APPROACH AND DATA

Research Population
The population of this research is the project leader of several developers who use the Supply By Owner method in Surabaya that will be used to create a model of material procurement cooperation between suppliers - developers. Furthermore, case study the population of this research is the project leader of Green Semanggi Residence, unit of procurement PT GrahaAgungKencana, unit of logistics Green Semanggi Residence and material suppliers of PT GrahaAgungKencana.

Sampling Techniques
In this research, the researcher used a purposive sampling technique. This technique with have purpose of completely sampling according to research, so that those people who understand well the cooperation strategy of relationship between supplier - developer.

Research Respondents
Respondents for this research is project leaders, unit procurement and logistics department in several developers who use the method Supply By Owner in Surabaya and in the Project Green Semanggi Residence with developer of PT GrahaAgungKencana, and two material suppliers owned by PT GrahaAgungKencana.

Data Collection Phase
In this phase, the data required is data about strategies of supplier and criteria of material suppliers include equality and price. The strategies and the criteria for the developer is price.

Method of data collection was done in the following way:
- Interview to find data and information about system of weight in deciding for selection of material suppliers.
- Preparing materials interview/question to the Leadership Project, unit procurement of PT. GrahaAgungKencana, and logistics department in Green Semanggi Residence project. The expected outcome from interview is strategy/criteria in selection material suppliers.
- Interview to obtain data and information from material suppliers. Doing interviews with material suppliers PT. GrahaAgungKencana. Expected results from this interviews with material suppliers is show the strategies used, so the supplier can establish a relationship with the developer in order to procure material for developers.

IV. RESULT

Before determine material supplier matrix payoff, first step do a Pareto analysis, there is a way of organizing data that visually highlights categories for more detailed study.

The results of the calculation of the Pareto analysis of several material suppliers by developer described in the Table 4.1.

<table>
<thead>
<tr>
<th>No</th>
<th>Name of Supplier</th>
<th>Material</th>
<th>Vol. Transaction (Rp.)</th>
<th>Cumulative (Rp.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PT. Prasada Hidup Sento sa</td>
<td>Granite</td>
<td>1,520,142,500</td>
<td>1,520,142,500</td>
</tr>
<tr>
<td>2</td>
<td>PT. Monier</td>
<td>Roof tile</td>
<td>1,040,726,271</td>
<td>1,520,142,500</td>
</tr>
<tr>
<td>3</td>
<td>Toya Fiberglass</td>
<td>Septic tank Biofilter</td>
<td>373,500,000</td>
<td>2,934,368,771</td>
</tr>
<tr>
<td>4</td>
<td>Toto</td>
<td>Closet</td>
<td>283,362,000</td>
<td>3,217,730,771</td>
</tr>
</tbody>
</table>
Based on pareto diagrams, selected materials supplier granite and roof tile. But in this study, the material to be analysed is a supplier of granite. There are two materials suppliers of granite to be analysed strategy, PT Prasada Hidup Sentosa and Toko Dunia Keramik.

**Supplier Payoff Matrix**

In this study there are two material suppliers are used in determining the matrix payoff where are Granite material suppliers. Strategy material supplier A (PT Prasada Hidup Sentosa) is maximize net income.

1. Strategy[I] material suppliers A
   a. Supply material with quality is always the same or fixed.
   b. Give discount 1-5% when making reservations in a certain amount.

2. Strategy[II] material suppliers A
   a. Ability to provide products with good quality.
   b. Giving discounts 6-10% when making reservations in a certain amount.

Strategy material supplier B (Toko Dunia Keramik) is maximize net income.

1. Strategy[I] material supplier B
   a. Ability to provide products with good quality (no defects) based on standards specifications of the product.
   b. Give as slightly cheaper price (6%-10%) than the other.

2. Strategy[II] material supplier B
   a. Ability to provide products with good quality.
   b. Give as slightly cheaper price (above 11%) than the other.

The income of Supplier A for years Rp. 3.040.285.000,00. Supplier A get income from supply housing developer about 50%, so the income supplier A just from supply housing developer about Rp. 1.520.142.500,00.

The income Supplier B for years Rp. 21.600.000.000,00. Supplier B get income from supply housing developer just 5%, so the income supplier B just from supply housing developer about Rp. 1.080.000,000,00.

If supplier A dan supplier B using strategy [I], the income supplier A will decrease 5% for years and the income supplier B will increase until 8%. The calculation of Gaming if Supplier A and supplier B using strategy [I] can be described in Table 4.2.

**Table 4.2 Calculation of Gaming if Supplier A and Supplier B Using Strategy [I]**

<table>
<thead>
<tr>
<th>Player</th>
<th>Payoff Value (Rp.)</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supplier A</td>
<td>1,444,135,375.00</td>
<td>Bruto income for years</td>
</tr>
<tr>
<td>Supplier B</td>
<td>1,166,400,000.00</td>
<td>Bruto income for years</td>
</tr>
</tbody>
</table>

Source: Processed Results (2014)

The described calculation of Gaming with Pairwise between Supplier A and Supplier B is shown Table 4.3 until Table 4.5.

**Table 4.3 Calculation of Gaming if Supplier A Using Strategy [I] and Supplier B Using Strategy [II]**

<table>
<thead>
<tr>
<th>Player</th>
<th>Payoff Value (Rp.)</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supplier A</td>
<td>1,398,531,100.00</td>
<td>Bruto income for years</td>
</tr>
<tr>
<td>Supplier B</td>
<td>1,209,600,000.00</td>
<td>Bruto income for years</td>
</tr>
</tbody>
</table>

Source: Processed Results (2014)

**Table 4.4 Calculation of Gaming if Supplier A Using Strategy [II] and Supplier B Using Strategy [I]**

<table>
<thead>
<tr>
<th>Player</th>
<th>Payoff Value (Rp.)</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supplier A</td>
<td>1,520,142,500.00</td>
<td>Bruto income for years</td>
</tr>
<tr>
<td>Supplier B</td>
<td>1,080,000,000.00</td>
<td>Bruto income for years</td>
</tr>
</tbody>
</table>

Source: Processed Results (2014)

**Table 4.5 Calculation of Gaming if Supplier A and Supplier B Using Strategy [II]**

<table>
<thead>
<tr>
<th>Player</th>
<th>Payoff Value (Rp.)</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supplier A</td>
<td>1,596,149,625.00</td>
<td>Bruto income for years</td>
</tr>
<tr>
<td>Supplier B</td>
<td>1,242,000,000.00</td>
<td>Bruto income for years</td>
</tr>
</tbody>
</table>

Source: Processed Results (2014)

Based on Matrix Payoff calculations above, individual choice of each player is to use strategies [II] (1,596,149,625; 1,242,000,000). This condition is called the *nashequilibrium* is a condition where none of players who not benefit by changing his strategy while the other players do not change own strategy. This can be evidenced magnitude value
of pay-off between supplier A and supplier B there are at [row 2; column 2] (1,596,149,625; 1,242,000,000). If one of the players change their strategy, then the other player will get losses.

V. CONCLUSIONS

Based on the simulation, game theory can used as tools to choose procurement partnership between suppliers and housing developer. Based on the result from case study, Game theory it is only model that need to be developed in choosing a more varied strategy.

REFERENCES