SATISFICING OPTION FOR BENEFIT COST ANALYSIS IN A HOUSING INFRASTRUCTURE PROJECT SELECTION

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Abstract. Decisions in large-scale housing project infrastructure planning are complex because they involve multiple parties such as planners, engineers, funders, and constructors. Many decisions during the development phase of the project such as routes and driveways and the location of construction materials. This paper presents a decision model that can be applied in the determination of alternative housing project development projects. The research used the process of satisficing option method where the benefits and cost for each alternative as a technical solution can be formulated on project evaluation. They are categorizing by the problem, comparing the benefits and costs, and representing the value of the project. Its scale is presented same. By creating Ps and Pr, the process can be done. Ps is a choice function that represents the project benefits and Pr is rejectability that represent project costs and normalize the problem. It makes the decision maker has a cost and benefit value to evaluate the proposed project. This method encourages future research for multi disciplines group decisions involving collaborative and negotiation processes.

Keywords: *cost benefit analysis, housing infrastructure, satisficing option,*

I. INTRODUCTION

A benefit-cost evaluation is a systematic analytical process to an investment alternative or selecting the best options of investment. It compares the economic benefits obtained with the costs incurred. It is a decision-making method that provides information about benefit, dis-benefit, and development cost of a public project. From the same point of view, looking at the cost-benefit analysis of public projects is similar to the ability to earn profits on commercial projects. The benefit analysis attempts to explain whether the social benefits of the proposed public activity are greater than the social cost. Investment decisions involve large expenditures where benefits are expected to occur over long periods. Many previous research on benefit cost analyze including studies on systems of public transport, environmental regulations for pollution and noise, training and education programs, systems of flood control and water resource development projects and also programs national security and defense. The process evaluates incremental differences of return on investment (ROI) of project investment alternatives. The differences due to the significant improvement among them. Alternatives compared throughout the project development process including operational of the project so there are many interests involved that require mutual agreement.

There are many decisions in a process of housing infrastructure development and research applied of benefit cost analysis such as in an affordable housing (Awad and Muhsen, 2014), in the scenario of varying inputs of roads benefit cost including infrastructure for housing (Tsunokawa, 2010) and in costs and benefits of green infrastructure in housing development projects (Beauchamp and Adamowski. 2012). Because existing benefit cost analysis on many previous research in project evaluation commonly accept optimization-based models, so the characteristic of 'benefit' and 'cost' cannot be applied on group decision to accommodate the interests of all parties.

This paper presents the application of satisficing games method. It is formulated by categorizing the problem and representing the value of a project on same scale. The solution techniques is evaluated by (Utomo et al, 2014) creating selectability (Ps) and rejectability (Pr) functions. Using them the solution may be done. Then it is normalized the problem. A unit of function utility and a unit of cost utility is used by decision-maker to evaluate the project. This model can be applied in a group decision, because each decision maker can collaborate, make coalition, and take negotiation of their preference for each criteria to others decision maker. This decision-making is recognized as a process involving multiple stakeholders. It is the characteristic of decisions in project development (Miles et al, 2015).

The benefit cost analysis is known as an important part of the economic analysis. It is the process of comparing the capital expenditure (CAPEX) of the project with the potential benefits of the project. Public decision makers should be able to explain whether the productive resources of project is used to provide the best benefits to the community.

To evaluate a public project, it is necessary to measure all benefits and project costs in the same unit. The framework of cost benefit analysis on a single and independent project can be explained as follows: first is to identify all benefits to users and the losses arising from the planned project; second is to calculate, wherever possible all the benefits and losses are in units of money, so it can be compared with cost; third is to identify and calculate the costs incurred by the government; fourth is to determine the equivalent of benefits and costs over a given period of time, using the appropriate rate of return for the project; and fifth is to receive the project if the user benefits exceed the cost incurred by the government.

A. Benefit

To identify the benefits to users, it is necessary to distinguish between primary and secondary benefits. The primary benefit is the benefits directly derived from the project. Secondary benefits are the benefits indirectly derived from the project. Despite the benefits, a project will have an undesirable result called loss due to the project. For Example, that the construction of new access of a housing will provide benefits such as reduced travel time, increased land values, and the growth of new businesses such as gas station facilities, restaurants and commercial. However, the development will reduce on the other part of housing so as to provide dis-benefit for businesses on the location.

B. Cost and Rate of Return

Government-issued costs include costs for initial investment, operating expenses and annual maintenance. All revenues earned, such as highway tolls, will reduce government costs (C). The use of discount rate for public projects can be distinguished in two points of view:

First, if the projects without any involvement of a third party (private), the used of minimum attractive rate of return is generally only the interest rate on the government borrowed loan to finance the project. Examples are flood control projects, roads for non-commercial users, and waterways.

Second, if the projects with third party (private) involvement and the entire project is financed by private investment, then the rate of return used takes into account the opportunity costs of alternative investments. So that the rate of return for a public project that produces the goods or services sold, the average capital cost is used to set the rate of return as is the co-commercial project.

To illustrate the value of a project is to compare the benefits to users by the cost of the government through the calculation of the cost benefit ratio or B/C ratio.

C. Life Cycle Cost and Time Value of Money

The 'life-cycle cost' calculates the initial cost and future costs. It is used to analyzing and comparing the project (Karim et al, 2012). It is a process for evaluating the total economic value of a project. LCC implementation can be an effective tool to evaluate the cost of each level of project design process. The LCC equation is composed of three main variables that are the relevant cost, the investment period and the expected rate of return. As the total cost of the project over its lifecycle, the LCC is the sum of the estimated total cost experienced by consideration to time value of money.

II. METHODOLOGY

The process of this research is described on Figure 1. It combines sequentially two stages. These stages are benefit cost analysis process and satisficing options process. It consists of three step that are (1) decision hierarchy, (2) judgment and synthesis, (3) and satisficing options on benefit cos criteria.

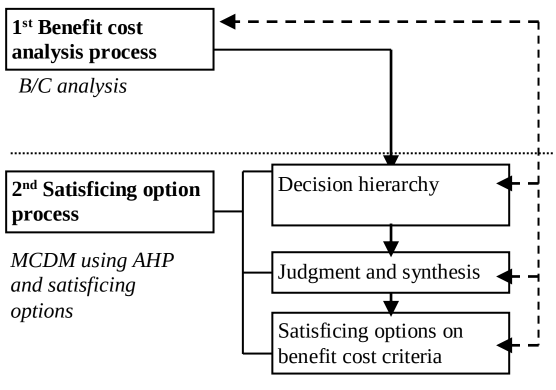

Figure 1. Process of satisficing options on benefit cost criteria

III. RESULT AND DISCUSSION

Conventional decision theory uses rational choice to the basis of optimization. The theory is widely applied in behavioral sciences, in economics, and also in engineering (Simonson and Sela, 2011). There is another concept which defined as being good enough or satisficing (Stirling, 2003). The differences between optimization and satisficing is in the way to compare alternative solution to the decision criteria. A global comparison is required by optimizing, while satisficing requires a local one. There are positive and negative attributes of each option individually in satisficing. A dual utilities approach is employed and they are separately evaluate the attributes which are the desirable to the decision maker (benefits) and the attributes that are considerable (cost) (Utomo et al, 2009).

The following example illustrates the optimization. It is to address the optimizer's questions for the best deal, a preference function was defined as non-equally-weighted sum of the ordinal rankings of the all attributes; that is: J = c1 + c2 + c3 + bn1 + bn2 + bn3 + bn4. Figure 2 presents the decision hierarchy for optimization model. The result from optimization is the best deal.

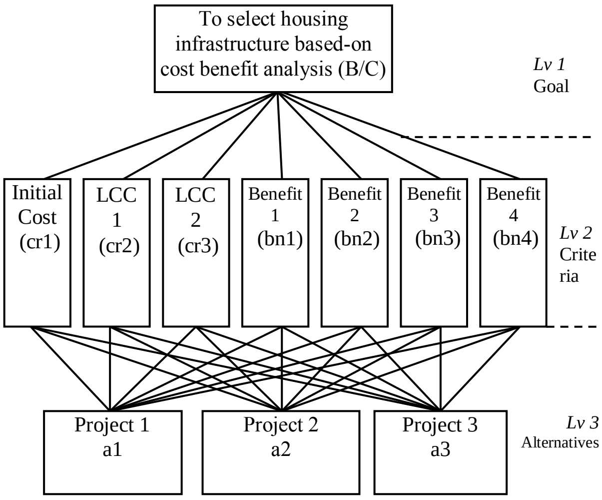

Figure 2. Decision hierarchy for optimization model

The following example illustrates the satisficing game (Consider the decision problems of choosing 3 alternatives project). To compare the project benefit and project cost, they must be represented on the same scale. The result will represent the value of a technical solution. By creating selectability (Ps) and rejectability (Pr) functions, a unit of benefit utility and a unit of cost utility may be done. By this condition the decision-maker has to apportion among the alternatives. Figure 3 show the decision hierarchy based on satisficing and.

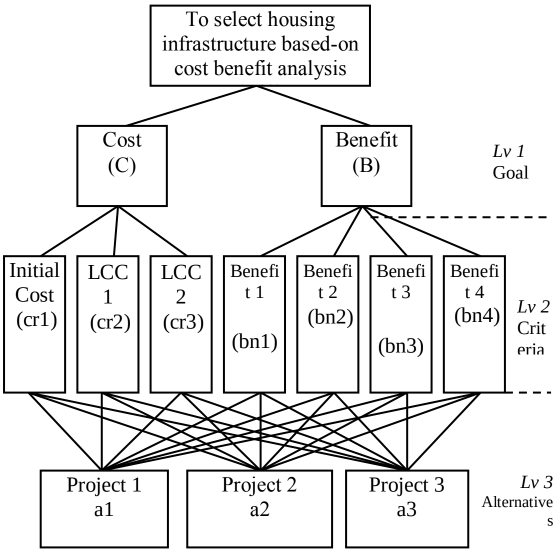

Figure 3. Satisficing hierarchy of decision

Table 1. Process of satisficing analysis for cost

	COST				
	cr1	**cr2**	**cr3**	**COST**	**Lost**
a1	0.002149	0.028616	0.064203	0.094968	0.026479
a2	0.015648	0.005395	0.005436	0.026479	0.094968
a3	0.008861	0.015219	0.019155	0.043235	0.078212
					0.199659

Table 2. Process of satisficing analysis for benefit

BENEFIT (B)				
bn1	**bn2**	**bn3**	**bn4**	**B**
0.249943	0.013636	0.049588	0.033536	0.346703
0.047131	0.050402	0.020208	0.014462	0.132203
0.088672	0.021563	0.120562	0.125598	0.356395
				0.835301

Table 3. Normalization and rank

Alternatives	NORMALIZATION			**Ranking**
	Loss (Pr)	**Gain (Ps)**	**B/C**	
a1	0.132621	0.415064	3.129694	1^{st}
a2	0.475651	0.15827	0.332744	3^{rd}
a3	0.391728	0.426667	1.089191	2^{nd}

Table 1, 2, 3 present the calculation of 'cost' and 'benefit'. The two columns on Table 3 show the utility of cost and benefit for each option. Based on the results presented in Table 1-3, Figure 3 provides a cross plot of benefit and cost, with *Pr* (rejectability) the abscissa and *Ps* (selectability) the ordinate. The index *B/C=1* is the border line that alternatives will be "select" or "reject". If the value B/C is >1 the alternative will be selected and when the B/C is <1 the alternative will be rejected. Figure 4 shows that a2 has the lowest benefit, it also has the highest cost. A rational decision maker can eliminated the a2 as an alternative. Options a1 is easily selected by the cost-benefit evaluation. Options a3 here give the highest benefit but also have higher cost comparing to a1.

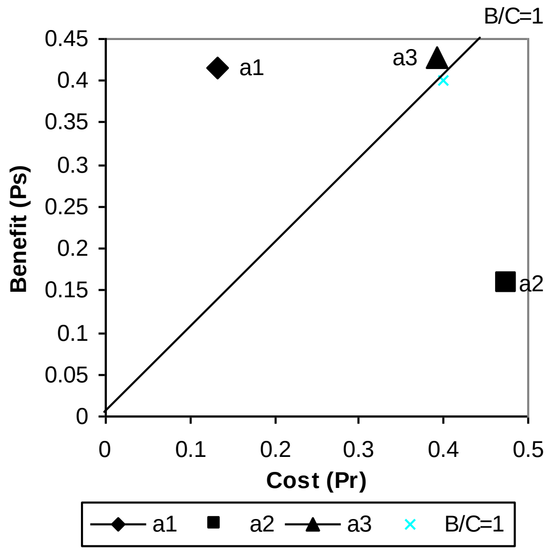

Figure 4. Cross-plot of benefit and cost

Group Decision Process

Decision making for Group (GDM) is the process of making a judgment. It is based upon the opinion of different decision maker. It can be formed as collaboration (Rahmawati et al, 2014a; Rahmawati et al, 2014b). The group members have their own attitudes and motivations. It is also recognized the existence of a common problem, and attempt to reach a collective decision (Rahmawati & Utomo, 2014; Rahmawati & Utomo, 2015). Decision making is a key component of a planning process, because the selection performance involves more than only individuals action and multidisciplinary.

To change a single decision maker to a group of multiple decision-maker is setting introduces a great deal of complexity. It is needed into the analysis (Utomo et al, 2014; Utomo et al, 2015). The group decision making concept can be applied to multi criteria decision making techniques. The satisficing is basic form for group decision based on coalition and agreement options.

The method of calculating the group utility can be generated from the group composite performance score of an alternative A_i (for i=1, 2… N). Further, each attribute B_j (for j=1, 2… M) to the individual weights of importance of the attributes are aggregated into the group weights w_j (for j=1.2,…,M). This can be formed in the equation (1)

$$w_j = \frac{\sum_{k=1}^{n} 1_{g(k)} w_j}{\sum_{k=1}^{n} 1_{g(k)}} \qquad (1)$$

j=1,2,…,M

Qualification the group of Q_{ij} to the alternative A_i against to the attribute B_j is described by equation as follow:

$$Q_{ij} = \frac{\sum_{k=1}^{n} 1_{g(k)} m_{ij}}{\sum_{k=1}^{n} 1_{g(k)}} \qquad (2)$$

j=1,2,…,M; i=1,2,…,N

Finally, the group utility P_i of alternative A_i is determined from the value of all decision maker as the weighted algebraic mean. Then the value is aggregated from qualification values. Using satisficing with the aggregated weights, the equation is presents as follow:

$$P_i = \frac{\sum_{j=1}^{M} w_j Q_{ij}}{\sum_{j=1}^{M} w_j} \qquad (3)$$

i=1,2,…,N

IV. CONCLUSION

Choosing alternatives for housing infrastructure has a nature of multi participant decision. It is important to provide a model for group decision and to design the principles of multi participants to accommodate cooperation. Conventionally, the cost benefit analysis cannot accommodate this environment. Satisficing option on game theory is a significant for possibility multiple participant decision making. Satisficing options is more elastic in its nature, since it does not demand a single best solution, but each of which is good enough. It is willing to accommodate a set of solution. Applying the satisficing options on cost benefit analysis will give huge benefit to the project evaluation of housing infrastructure investment.

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