Parking lots and evacuation sites extension through public-private partnership in park management

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Nowadays, Public-Private Partnership (PPP) has been introduced in many countries as an innovative approach to the procurement of public projects. This approach helps many local governments to improve the operation efficiency of public projects through employing the knowledge and proficiency of private agents. This matter becomes more significant when local government faces to some problems in a huge disasters. Hence, recreational parks can be utilized as evacuation sites while they are usually used for citizens' amenity in normal situations. However many large cities with dense population have a considerable shortage of such spaces. For this reason, the topic of park management can be a remarkable issue for these governments.

The consideration of this paper mostly relates to the extension of parking lots through cooperation among public and private agents in normal situations and enlarging the evacuation and amenity sites for citizens in emergencies. Future estimation of these kinds of cooperation by using some microeconomics model such as Cobb-Douglas utility and production functions, can help the agents to improve their insights about their coalitions and boost their propensity to develop such partnerships with government.

Key Words: *Public-Private Partnership, Park management, disaster mitigation, Evacuation operation, Social welfares*

1. INTRODUCION

Recently, government is no longer considered as the sole provider of public works or services. Private participation in providing public works and services has been recognized as an important approach for governments (Walker and Smith 1995; etc.) [1)]. The role of government has evolved into the coordinating partner providing infrastructure system along with the private sector, which has brought both managerial and financial efficiencies into the process. Therefore various definitions come out for describing these kinds of relation between public and private agents, such as private finance initiative (PFI) and build-operate-transfer (BOT). A more universal definition has been explained for such long-term public-private cooperation in providing public works or services as public-private partnership (PPP). Hence in our modern society the concept of public-private partnership has been introduced as an innovative approach to the procurement of public projects.

In most countries the goal of public-private partnerships is to enhance the social welfare and providing more services for citizens as well as try to increase their own benefits through developing a firm. In this paper the firm has been defined as a coalition of two or more agents include of public and private to supply particular goods or services to inhabitants by the aim of increasing their benefits and improving the social welfares of the society.

The demand on outdoor areas of every kind has been increasing faster than the supply of lands and facilities can accommodate. As ecosystems within park lands deteriorate and visitor numbers and the type of uses they demand multiply, a fundamental shift in our approach to managing park lands is necessary. This shift requires moving from a per-

spective of serving diverse demands to one of tending a productive landscape within a regional context (Samuel V. Lankford et al. 2011) [2].

Capital investment by private agents in the park to increase benefits and enlarge the available services to the park users requires to develop some coalition among these private agents and park manager under the limitation of enforced policies inside the park. Hence, the issue in this paper is to recognize the possibility of forming coalition among the mentioned agents in park management.

This research aims to explain the possibility of formation of available coalition among the agents under the public-private partnership procurement approach. It tries to analyze the different patterns of various possible cooperation and discuss the result of each coalition respectively.

Another factor which should be discussed here is the behavior of these cooperation in normal and emergency situations. Hence, it attempts to focus on partnership in both situations which will make it more considerable issue. The significance of this paper is to represent the enhancement of social welfare not only in normal situations, but also increasing the social welfare through adopting comprehensive evacuation plans for optimization the evacuation operation in the case of huge disasters.

2. CASE STUDY

The case study strives to focus on a Tsuruma park as an important evacuation site in Nagoya city where is a strategic place for different public and private agents which are located around this park.

The main agents which are involved in partnership in the research case study can be introduced as follows:

- **The city government** is the main public sector which aims to improve citizens' welfare along providing different amenities for inhabitant in normal situations and also tries to save lives at the time of occurring disaster.
- **Hospital** can be counted as a public sector that wants to get the citizens' welfare through providing medical services in normal situations as well as at the time of disasters.
- **The park manager** is another public sector which tries to enhance the social welfare across providing facilities inside the park in normal situations and also tries to provide enough rooms as evacuation site for evacuees at emergency situations.
- **Nagoya civic assembly hall** is one of the first public hall in Japan and usually acts as public sector that aims to improve citizens' welfare through providing cultural activities and social services to inhabitants in a daily work.
- **Railway companies** would be rather in the public sector by aiming to get the citizens' welfare along providing transportation services for commuters in normal situation. It may halt at disaster emergency.
- **Shopping center** always acts as a private sector which usually wants to get its own benefit through sells goods in the normal situations. This agent can increase the social welfare across providing round the clock services and seven days a week operation to supply citizens' demands.

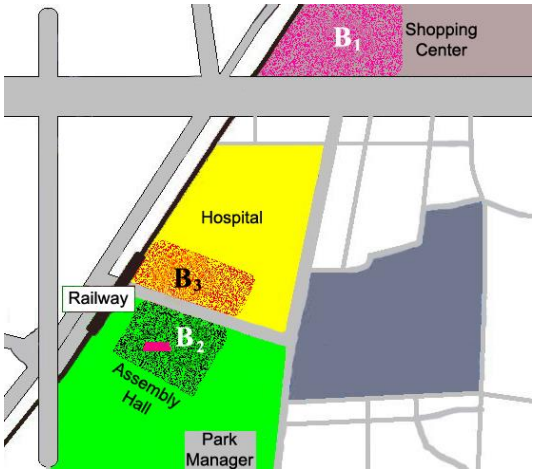

Fig. 1. Involved agents in cooperation and their parking area

The partnerships of the mentioned agents can emerge as different projects. The most important coalitions among agents can be described as follows:

1) Coalition between assembly hall and shopping center to increase the parking lots for increasing the number of customers as well as social welfare in both situations.
2) Coalition of park manager and assembly hall to enlarge the evacuation site for evacuees in emergency situations.

3. ANALYTICAL FRAMEWORK

(1) Method

As it is described before the possible cooperation among agents can be defined as any coalition to increase the vehicle parking lots and to enlarge the evacuation sites by the aim of enhancing social welfare and involved agent's benefit. To form a coalition the agents have to share or exchange their particular resources. As a consequence common resource among the mentioned projects should be shared or exchanged between two or more agents. Hence, to analyze the resource allocation from the

limited available resources, partnership through sharing or exchange strategy is the most efficient decision. There is a convenient graphical tool known as the Edgeworth box that can be used to analyze the exchange of two goods (resources) between two agents as a method. The agent's common resources for developing coalitions can be named as lands and time in this paper. The geographical locations of mentioned agents and their available resources as vehicle parking area are shown in Fig. 1.

It is clear that to get more satisfaction, all the agents try to boost their benefits and reduce their cost simultaneously. To get this purpose developing some coalitions can be a better approach. Through forming coalition, agents can use their available resources by spending minimum cost.

(2) Coalition stability

Coalitions are collections of players. Their stability is usually defined in terms of outcomes and the incentives that coalition members have to sustain them. Based on the objectives of this paper the first priority condition to make a coalition for each agent in addition to improve social welfare for citizens is to enhance their own utilities which resulted from the partnership. This enhancement can be achieved alone or by developing a coalition. The intention for making coalition exist when the payoff of each agent at least equal or greater than payoff in solitary state. In general the tendency for a public or private agent to form a partnership can be defined as:

$$u\{1,2\} \geq u\{1\} + u\{2\} \tag{1}$$

$$u\{1\} \geq v\{1\} \,\&\, u\{2\} \geq v\{2\} \tag{2}$$

Here the expression of $u\{1,2\}$ in equation (1), shows the amount of payoff resulted the coalition of agents 1 and 2. $u\{1\}$ represents the utility of agent 1 in partnership while $v\{1\}$ shows the utility of this agent in solitary state and the same thing is also true for agent 2.

(3) Feasibility extension

As it is mentioned before to form a coalition the two resources (land and time) should be exchanged according to Edgeworth box method, and this issue can better illustrate through using graphical analysis. The letter x which is shown in fig. 2, represents amount of parking lots (lands) of each agent and the expression d shows the range of time that customers use the parking area. Hence, the amount of feasible parking area for each agent is:

$$u\{1\} = x_1 \cdot d_1 \tag{3}$$

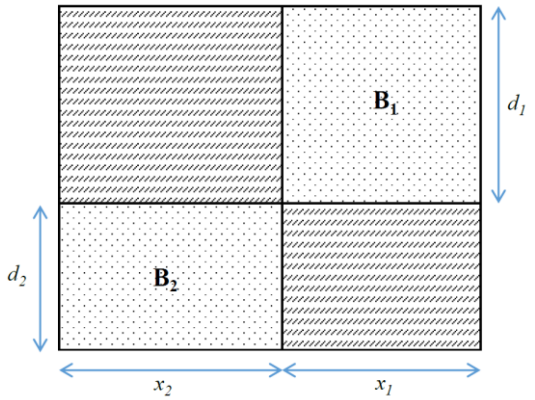

Fig. 2. Feasible extension of parking lots after cooperation

$$u\{2\} = x_2 \cdot d_2 \tag{4}$$

This coalition will cause to feasibility extension if the range of time differs. This range difference can be include of different month in a year, different days in a month or even different hours in a day. As it is shown clearly in fig. 2, the feasibility extension can be described as:

$$u\{1,2\} = (x_1 \cdot d_1) + (x_2 \cdot d_2) + (x_1 \cdot d_2) + (x_2 \cdot d_1) \tag{5}$$

$$u^*\{1,2\} = (x_1 \cdot d_2) + (x_2 \cdot d_1) \rightarrow \forall d_2 \subset d_1 \tag{6}$$

The expression $u^*\{1,2\}$ in equation (6), represents the pure beneficial payoff of developed coalition. The hatched areas in fig. 2, show the feasibility extension of parking lots after defining of different time usage. The extension of evacuation site can also be analyzed similarly between park manager and assembly hall in emergency situations.

4. SENSITIVITY ANALYSIS

(1) Cobb-Douglas method

In addition to feasibility extension of parking lots which increase the propensity of agents to develop a coalition, estimation of the future output can enhance the possibility of forming cooperation among agents. In microeconomics the Cobb-Douglas functions are particular functional form of the utility and production functions, widely used to represent the technological relationship between the amounts of two or more inputs, particular physical available goods or resources, and the amount of output that can be derived by those inputs. The general form of the production function can be expressed as:

$$X_i = K_i^{\alpha} L_i^{\beta} \tag{7}$$

While the utility of citizens from the two provided goods or services by agents can be illustrated as:

$$u(X_1, X_2) = X_1^{\alpha} X_2^{\beta} \tag{8}$$

Here we have to note that X_i (capital letter) is completely different form x_i (small letter) which is used in previous section for representing the agent's available parking lots, while X_i use to show the amount of supplied particular goods or services by firm *i*, or the amount of consumed that goods or services by citizens. In the case study of this paper these goods are denoted to supplied parking lots by firm 1 when (i = 1) and supplied public transportation by firm 2 when (i = 2) in normal situation. However they are denoted to supplied parking lots by firm 1 when (i = 1) and supplied evacuation or amenity sites by firm 2 in emergency situations. The expressions of K and L are shown in equation (7) represent the amount of capital and labor respectively which are used to provide these two services for citizens while α and β represent the output elasticity or usage propensity of the belong items in both equations. The amount of usage of these services are directly proportional to the citizen's budget set or income (y) and inversely proportional to the final price of each consumed products or service which are shown here by p_i. In perfect competition market consumers always choose the most preferred bundle from their budget sets (Hal R. Varian 1990) [3]. In other words citizens always endeavor to select the most efficient transportation method to come to this area. It is clear that more usage of private cars by citizens to come to this area causes to increase the usage of parking lots and this increment results to improve the firm's utility. Therefore the selection of private car or public transportation by citizens directly influence to the behavior of firms and it is highly significant for agents to have intention for developing cooperation. As it is obvious that the optimal choice of citizens in using private cars is equal to efficient amount of parking lots which are supplied by the firm 1. Therefore the amount of usage of parking lots and public transportation by consideration of budget constraint of citizens can be expressed as:

$$X_1^* = \alpha \frac{y}{p_1} \tag{9}$$

$$X_2^* = \beta \frac{y}{p_2} \tag{10}$$

(2) CGE model and its application

The concept of equilibrium is an important issue in the topic of coalition stability. In fact each closed market tends to reach in equilibrium. This model can help the agents to estimate their final cost, utility and the behavior of consumers in equilibrium situation. Therefore they can better decide whether or not to form a cooperation. For employing Cobb-Douglas functions in CGE model it is required to define each

Table 1. CGE model parameter specifications

Parameter	Specification [in normal situations (case 1)]	Specification [in emergency situations (case 2)]	Parameter	Specification [in normal situations (case 1)]	Specification [in emergency situations (case 2)]
Z_1	Citizen's demand for parking lots	Citizen's demand for parking lots	L^*	Fixed endowment of labor in the closed society	Fixed endowment of labor in the closed society
Z_2	Citizen's demand for public transportation tools	Citizen's demand for evacuation sites, services and amenities	p_1	Price of parking lots usage by citizens	Price of parking lots usage by citizens
X_1	Supply of parking lots by firm 1	Supply of parking lots by firm 1	p_2	Price of public transportation usage by commuters	Price of amenity and services usage by citizens (evacuees)
X_2	Supply of public transportation tools by firm 2	Supply of evacuation sites, services and amenities by firm 2	r	Rental on capital	Rental on capital
K_1	Demand for lands to construct parking lots by firm 1	Demand for lands to construct parking lots by firm 1	w	Wage rate	Wage rate
K_2	Demand for materials to construct transportation tools by firm 2	Demand for lands to construct amenities and services by firm 2	B_1	Profits of firm 1	Profits of firm 1
L_1	Demand for human resource to construct and operate parking lots by firm 1	Demand for human resource to construct and operate parking lots by firm 1	B_2	Profits of firm 2	Profits of firm 2
L_2	Demand for human resource to construct and operate transportation tools by firm 2	Demand for human resource to construct and operate amenities and services by firm 2	y	Citizen's income	Citizen's income
K^*	Fixed endowment of capital in the closed society	Fixed endowment of capital in the closed society	u	Amount of social welfare	Amount of social welfare

parameter of Cobb-Douglas functions in our case study and matching them in park management issue. Table 1 represents the CGE model parameter's specification in both normal and emergency situations.

To apply this model in the case study of this paper, we have to use both Cobb-Douglas method and VBA computer programming to analyze the future of developed cooperation among agents. To make simplicity in our analysis we will use the amount of α and β respectively equal to 0.25 and 0.5 for production of parking lots; 0.5 and 0.25 for production of public transportation tools and 0.5 for citizen's utility functions. After calculation and using VBA the relations between equilibrium prices of parking lots and public transportation can be achieved.

$$p_1 = 0.8 p_2 \tag{11}$$

As it is shown in equation (11), the behavior of parking lot price to the change in amount of public transportation price can be analyzed. This equation expresses that the growth rate of parking lots price is 80% of public transportation price and according to our assumption it will be estimated that more citizens will use parking lots in the future instead of public ones and the possibility of forming cooperation by agents will increase in normal situation. It is remarkable that similar result can be achieved from CGE model in emergency situations. In the case of emergency situation X_1 represent the number of supplied parking lots by firm 1, while X_2 shows the amount of supplied evacuation sites, services and amenities by firm 2, which is clearly expressed in table 1. In this situation the final result of employing Cobb-Douglas functions in CGE model is the variation of parking lots price to the change in the price of services and amenities inside the evacuation sites which are used by citizens in emergency situations.

5. CONCLUSIONS

The concept of PPP is completely a new method for efficient coordination among agents by the aim of enhancing social welfare. This concept becomes more interesting when it wants to emerge with a social engineering issues such as park management. The usage of park management cannot limit to the emergency situations and it can be used to deliver amenity areas, provision of parking lots and many other purposes in normal situations. This paper investigate to check the possibility of developing cooperation among public and private agents at park management in both normal and emergency circumstances.

The propensity and the basis of each partnership is to increase the final utility of the developed coalition. Therefore it is significant to have an estimation about the output of this coalition, the amount of utility which would be derived from this coalition, and the effect of this coalition to the society and social welfares. The paper focuses upon the illustration of common interest among the agents who can be involved in cooperation.

This paper investigates exhaustively on the extension of parking lots and evacuation sites for citizens in normal and emergency situations respectively. Through graphical analysis the feasible extension of parking lots is possible if the range of usage time of parking lots differs. Moreover the estimation of final outputs of coalitions is possible through applying the Cobb-Douglas model. This application is expected to help the local government and private agents to improve the utility and efficiency of their coalitions.

Note that, as in many microeconomic studies, some simplified assumptions in the model setup and parameters are made in this research, so that clear insight can be derived from real partnership in complex situations. These insights could provide agents and local government to decide their critical decision whether or not to develop a coalition, despite that the real situations are more complex. The insights and qualitative implications of a microeconomic model are often more significant than the exact solutions obtained in the model. Therefore, through well understanding and imagination of these factors and parameters and their effects to the result of partnerships, it is expected to determine the possibility of cooperation of these agents at both normal and emergency situations in park management.

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