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Developing a Goal Programming Model for Ideal/Mutual House Price

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Abstract. One cannot deny the importance of a house as a living need. Unfortunately, the unreasonable house price makes it approximately impossible to be owned, mostly for middle income group. Nowadays, the middle income house buyers have two alternatives, whether to buy it from a private developer or through PR1MA and My First Home scheme, since both parties have their own advantages. Goal programming has been employed to resolve the multi objective problem among parties. Due to the complex decision making in house price determination between the parties, this study purposely modeled the problem using interval goal programming approach. Goal programming and interval goal programming can be differ based on their goal (i.e. the aspire level) which is in the form of interval. This study employed primary data and secondary data, which primary data is acquired from semi-structured interview with private developer, while secondary data is the data obtained from literature review. Initial result shows the satisfactory house price over preferences and needs of the decision makers, which are RM454, 050.00 for the private developer, RM322, 880.00 for the government and range of RM2380.95 to RM245, 100.00 for the house buyer. This suggests the house price range that is satisfied by all parties which is about RM238, 000.95 to RM460, 000.00.The satisfaction might occurred when they are all cooperating, which the way could enlighten the impact of collaboration between the parties. This could be the limitations for this study.

INTRODUCTION

Housing sector is vital in household portfolio and budget as well as an important sector for economic development in most countries around the world. Kim stated that housing sector contributes about 30% of the world's wealth, which is more than equities (19%) [1]. In addition, the World Bank highlighted that about 2% to 8% of Gross National Product (GNP) is settled from housing investment, and also contributes more about 5% to 10% of GDP from housing service [2]. However, housing sector seems to face acute problems such as high price and overdue of delivery time. These issues cause the residents from middle income group to face the problem of buying a house as claimed by the Real Estate and Housing Developers' Association (REHDA) deputy president Datuk FD Iskandar that lower income group was entitled for low income house, while the higher income group has no problem in buying houses, except for the middle income group which is in dilemma [3].

Nevertheless, the government has provided several solutions to overcome the problem. For instance, the program of "Perbadanan PR1MA Malaysia" (PRIMA) which is the housing program for middle household income so that residents can afford to own their house [4]. There are also 'My First Home' which the target buyer is the residents who are not working with the government [5]. PRIMA and "My First Home" is a government housing development project to encourage home ownership of first time buyer. These schemes are a kind of Public and Private Partnership (PPP) program. PPP is a collaboration between public sector and private sector with the purpose of developing public infrastructure [6]. The collaboration between public and private sector is believed to be a good chance in developing real properties. However, number of PPP practice seems to be not encouraged as PPP might not attract

either from the public or the private point of view. Several studies have been done to identify the failure factor of PPP collaboration [6], [7]. It is clear that the private developer is eager to maximize the profit. Due to the high land price, the private developer is tend to build more high cost house because it gives more profit that can cover up all the development cost. Instead, the government has other objective that is to provide more affordable house to the house buyers. These objectives are likely to lead unsuccessful cooperation between the private developer and the government. On the other hand, Teck Hong Tan found that recently the house buyers are preferring a safe and good environment house, and in addition the researcher also posited that many public housing turns into slum because it is not compliance with the house buyer preferences [8]. Instead, the government, which is obviously non-profit maximize insisted to fulfill resident's need, without taking into consideration the preferences. This phenomena has been motivates from several factors such as lacking of expertise in public sector and also lacking of financial source [6]. The conflicts between the parties (i.e. the government, the private developer, and the house buyer) have led to the issue of owning house that obviously put the middle income group at a lose situation.

Hence this study considers the house buyer's preferences in buying house by developing a three-party GP model. The model considers every parties' (government, private developer, house buyers) perspective in getting the mutual housing price range.

Goal Programming

Generally, numerous real world problems are multi objectives that conflict each other, thus to cope with the problem, Charnes and Cooper introduced goal programming in 1961 [9]. Goal programming is a technique that uses the concept of satisfying, it is suitable for the situation that confront with multiple objectives or goals [10]. In housing development, each party has their own preferences and goals to achieve, for instance, preference in house price and house location. Fortunately, goal programming was designed to simulate the problem, which is it can deal with the objectives simultaneously, as it suggests the satisfying solution over the goals and constraints. Thus, each objective has a range of solution rather than a specific one. This application is able to suggest a range of house price that can be satisfied by the parties. Consequently, we can conclude a mutual house price range that can be agreed by three of them.

In goal programming, there are four compulsory elements which are the parties (decision makers), objective (maximize or minimize), goal and constraint (hard and soft). A general form of goal programming is as follows:

$$MinZ = \sum_{k=1}^{k} P_k (d_i^- + d_i^+) \text{ for } i = 1,2,3,...m \tag{1}$$

Subject to

$$\sum_{j=1}^{n} x_j - \alpha \tag{2}$$

$$\sum_{j=1}^{n} x_{ij} + d_i^- - d_i^+ = \beta \qquad \text{(for } i = 1,2,...,m, \; j = 1,2,...,n) \tag{3}$$

And

$$d_i^+, d_i^- \geq 0 \text{ (for } i = 1,2,...,m) \tag{4}$$

Where, x_{ij} is a decision variable, d_i^-, d_i^+ is the vector underachievement and overachievement for target selection factor objective $i, i = 1,2,...,m$ and party $j, j = pd, B, gov$, which respectively represent the private developer, the house buyer and the government. p_k is the priority of the goal $k, k = 1,2,...,K, \alpha$ is the target goal for soft constraint (value that decision maker fix to achieve), β is the limit source for hard constraint.

MODEL FORMULATION

There are only three parties considered in this study, which are the government, the private developer and the house buyer from middle income earner.

Formulating the Objective Function and its Constraints

The objective function and its constraints are formulated as linear equations. There are two constraints involved in general goal programming; soft constraint and hard constraint. The hard constraints relates to the resources available and mainly subject to the factors behind the house price that is include land price [11], material cost [11],[12], labor cost [11],[13], construction cost [11],[12], location of house (i.e. distance of house to workplace, school and retailing outlet), as well as government and service tax (GST) (i.e. burdened to the private developer). Instead, soft constraint is more flexible, which is the constraint that we would like to occupy, such as the house price.

The private developer's house price target is in the range of RM250, 000 to RM400, 000 (data acquired from interview with the housing developers):

$$x_{1pd} + d_1^- - d_1^+ = 250,000 \tag{5}$$

$$x_{1pd} + d_2^- - d_2^+ = 400,000 \tag{6}$$

Meanwhile, the government has targeted house price in the range of RM100,000-RM400,000 [4]:

$$x_{1gov} + d_3^- - d_3^+ = 100,000 \tag{7}$$

$$x_{1gov} + d_4^- - d_4^+ = 400,000 \tag{8}$$

While the buyer from middle income earner prefer to buy a house in the range of RM250,000-RM350,000 [14]:

$$w_k x_{lB} + d_5^- - d_5^+ = 250,000 \tag{9}$$

$$w_k x_{lB} + d_6^- - d_6^+ = 350,000 \tag{10}$$

With $k = 1,2,3$

Where, x_{1pd} is the private developer's house price target, x_{1gov} is the government house price target, and x_{1B} is the buyer's house price target with weightage, w_k.

1 unit turnover will give a 20% of the profit to the private developer, while the government who are not driven to maximize profit will only hope that they get back the cost of land assessed [15]. The interviewee pointed that the private developer will profit from the cash flow. TC below represents total cost development of one unit of house. However, the government total cost development is different from the private developer total cost development. This is because there is fund incentive up to 20% for government's housing program [4].

$$TC + 20\% x_{1pd} \leq x_{1pd} \tag{11}$$

With the data obtained from the private developers, land cost, x_2, generally contributes about 20% of total cost. This statement is supported by [12].

$$x_{2pd} \leq 0.2TC \tag{12}$$

Labour x_3 and materials x_4 are included in construction cost [12]. While 23% of the cost is obtained from construction cost, thus it can be represented as below (data from interview). GST also charged on construction as it involves the service from constructor and engineer [16].

$$x_{3pd} + x_{4pd} \leq 0.23TC + GST \tag{13}$$

$$x_{3gov} + x_{4gov} \leq 0.23TC + GST \tag{14}$$

Abdullah posits that material cost, x_5 usually contributes about 40% to 60% from total cost, and the cost can be vary based on the type of work and the way the construction is held [17]. The government, which implement the

GST states that the house is exempted from GST except for the material for building [16]. Therefore, the limitation of material cost should be as follows:

$$x_{5pd} \leq 0.77TC + GST \tag{15}$$

$$x_{5gov} \leq 0.77TC + GST \tag{16}$$

Buyer are utility maximize at lowest cost, which the objective of buying goods are at the lowest cost [18]. Teck Hong Tan posited that the house buyers are willing to pay 29.03% higher if their house is located near to the school [19]. They are also willing to pay 15.50% and 31.42% higher if the house is located near to the workplace and if it is near to the retailing outlet, respectively. Thus, this study uses weightage for buyer, as it is considered as satisfaction or willingness of buyer to pay for a house. The weightage is in percentage of 105%, 103%, and 102% for retailing outlet, school, and workplace respectively. However, those weightage are only for numerical example for the house buyer model, due to data limitation.

$$x_{6B} + x_{7B} + x_{8B} \leq 1 \tag{17}$$

$$w_1 x_{6B} + w_2 x_{7B} + w_3 x_{8B} \geq 0 \tag{18}$$

Where, x_{6B}, x_{7B}, x_{8B} represent the location of house that near to retailing outlet, near to school and near to workplace. Equation (17) represents the house profile that the house buyer will choose, that is either near to school, near to workplace or near to retailing outlet. Thus, the weightage is included in equation (18).

The goal programming model for house price determination of this study is shown as below:

$$x_{1pd} + d_1^- - d_1^+ = 250,000 \tag{19}$$

$$x_{1pd} + d_2^- - d_2^+ = 400,000 \tag{20}$$

$$x_{1gov} + d_3^- - d_3^+ = 100,000 \tag{21}$$

$$x_{1gov} + d_4^- - d_4^+ = 400,000 \tag{22}$$

$$w_k x_{1B} + d_5^- - d_5^+ = 250,000 \tag{23}$$

$$w_k x_{1B} + d_6^- - d_6^+ = 350,000 \tag{24}$$

$$TC + 20\% x_{1pd} \leq x_{1pd} \tag{25}$$

$$x_{2pd} \leq 0.2TC \tag{26}$$

$$x_{3pd} + x_{4pd} \leq 0.23TC + GST \tag{27}$$

$$x_{3gov} + x_{4gov} \leq 0.23TC + GST \tag{28}$$

$$x_{5pd} \leq 0.77TC + GST \tag{29}$$

$$x_{5gov} \leq 0.77TC + GST \tag{30}$$

$$x_{6B} + x_{7B} + x_{8B} \leq 1 \tag{31}$$

$$w_1 x_{6B} + w_2 x_{7B} + w_3 x_{8B} \geq 0 \tag{32}$$

$$k = 1,2,3$$

$$MinZ = d_1^- / 250,000 + d_2^+ / 400,000 + d_3^- / 100,000 + d_4^+ / 400,000 + d_5^- / 250,000 + d_6^+ / 350,000 \tag{33}$$

RESULT AND DISCUSSION

Using Lingo (Version 10.0), the problem solved and the satisfactory house price with respect to the hard constraints as the private developer's house price is RM454, 050.00, the government house price is RM322, 880.00, and the house buyer's house price is in range of RM238, 000.95 to RM245, 100.00. This is due to variation of weightage used in the model. From the result, we can see that the house price in the range of RM280, 000-RMRM460, 000.00 is the price that could be accepted by three of them. However, we can see a big gap between the private developer satisfactory house price and the buyer's satisfactory house price that is about two times the buyer's satisfactory house price. The difference is about RM216, 050. 00. Thus, it might create another unsold real property as the price offered by the private developer is quite far from house buyer's satisfactory price. This is due to the implementation of GST that less or more could affect the house price even though the nation informed that housing is GST free. The tax that is charged on the materials and other services is shouldered solely by the developer, as the developer cannot claim back from the government. For consequently the developer will rise the house price in order to cover up the tax and maintain the profit.

After all, the satisfactory house price obtained is based on the needs and preferences of the parties (i.e. the private developer, the house buyer, and the government). The result implies different satisfactory house price between the parties as they have different preferences or difference goals.

CONCLUSION AND WAY FORWARD

Goal programming as an approach to identify satisfying solution can be used when the situation confronts with multi objectives. This approach is actually realistic approach as in the real world itself is full of human that varies by their behavior. The complicated behavior proves that the needs, objectives and satisfaction of one and the others could be different. The behavior of human is actually hard to be modeled. However goal programming provides a platform to model the complexity in house price determination. A mathematical model needs variables to project a desirable result, as in our study, the variables turn into preferences and goals, while the desirable result is the more precise house price.

Significantly, house developers could profit from our finding, as it provides the house price that is preferred by the house buyer after taking into consideration the factors or preferences from each decision makers. However, the house price in our study is only the satisfactory house price for each decision makers. The decision makers have their own satisfactory house price, until then, this study only enlighten the individual part depends on the decision makers' objectives or preferences.

The proposed model will be extended to cooperative form to make a comprehensive decision by introducing cooperative equation in the model, which is the problems in future research. It is expected to view the decision impact if the cooperation between the decision makers happens. Is the cooperation could be more beneficial or instead? In addition, due to the lack of data in this study for the housing buyer perspective, this study will be completed in action of data collection from middle income group who are eligible to buy PR1MA house. The data that we are going to collect is on the perspective of the house buyer, about which house price they are afford to own and several preferences that are worth with the price. Thus the data will be employed to complete the developed goal programming model of house price in this study.

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