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An Equal-Priority Zero-One Goal Programming Model for Condominium Selection Based on Buyer Preferences

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ABSTRACT

Choosing a condominium requires buyers to compare alternatives that differ in price, financing, accessibility and dwelling features, and no single option is likely to meet every preference. This study formulates an Equal-Priority Zero-One Goal Programming (ZOGP) model for a discrete condominium-selection problem in Kuala Lumpur. A questionnaire completed by 36 prospective buyers was used to obtain representative aspiration levels for nine criteria, while secondary property data were used to form a shortlist of eight completed condominiums. Because the criteria are measured in different units, undesirable deviations were normalised by their aspiration levels before being combined in the objective function. The binary model was solved in LINGO with exactly one alternative required to be selected. Seri Maya Condominium was chosen, giving a minimum objective value of 0.2491667. Seven of the nine aspiration levels were satisfied; the purchase price exceeded its RM600,000 target by RM10,000 and the monthly loan exceeded RM2,000 by RM465. Range-based sensitivity tests showed that the selected alternative remained unchanged across the tested purchase-price and parking targets, and for public-transport distance targets between 400 and 700 m. The model therefore provides a structured way to identify the best compromise among the shortlisted alternatives under a common set of buyer aspirations.

Keywords: Buyer Preferences, Condominium Selection, Goal Programming, Optimisation, Zero-One Goal Programming

INTRODUCTION

Buying a condominium is a long-term financial decision, and the choice rarely depends on a single property feature. Buyers compare affordability with location, access and the characteristics of the dwelling itself. Housing studies describe purchase price, recurring costs, unit features, facilities and accessibility as recurring considerations in residential decisions (Nizam et al., 2025; Thaldumrong, 2024; Xie et al., 2025). These criteria do not always move in the same direction. A lower-priced unit

may be smaller or less accessible, while a condominium with a larger floor area or a more convenient location may require a higher financial commitment. Similar trade-offs have been reported in studies of housing preferences and real-estate investment behaviour (Gumasing & Niro, 2023; Thaldumrong, 2024). For a buyer comparing several available developments, the problem is therefore one of choosing an acceptable compromise rather than finding a property that is best on every criterion.

Property websites make comparison easier by bringing together information on price, location and physical attributes, and they are often used during the initial search process (Çevik, 2025). The final decision, however, may still depend heavily on personal judgement when several criteria have to be considered at the same time. Multi-Criteria Decision-Making (MCDM) methods have been applied to property and building decisions to impose more structure on this comparison. Housing-related studies have used ranking and evaluation methods such as AHP, TOPSIS and ELECTRE, among others (Pozdílková & Pozdílek, 2023; Castillo & Yepes, 2025; Villalba et al., 2024). These approaches are useful when alternatives are compared using several attributes. The present problem is slightly different, where the buyer also specifies aspiration levels, and the decision must select exactly one condominium from a finite set while allowing some targets to be missed when no alternative satisfies them all.

Goal Programming (GP) is suited to problems in which several targets must be pursued simultaneously and compromise is expected. Zero-One Goal Programming (ZOGP) extends this structure to discrete choices by restricting the decision variables to binary values (Gaspars-Wieloch, 2021; Gunawan et al., 2023). When no goal is placed above another in a priority hierarchy, the undesirable deviations can be assessed together under a non-pre-emptive, equal-priority structure (Bolarinwa et al., 2024; Gunawan et al., 2023). ZOGP has been used in discrete selection settings outside residential property, including supplier and packaging decisions, smart-city project selection, maintenance technology selection and information-platform planning (Gunawan et al., 2023; Wu & Chen, 2021; Suriyawong et al., 2022; Yang et al., 2022). Within the housing studies reviewed for this research, the emphasis was instead mainly on ranking-based MCDM approaches. This leaves room for a target-based binary optimisation formulation for condominium selection.

This study develops an Equal-Priority ZOGP model using representative buyer aspiration levels obtained from a questionnaire survey. Nine criteria are considered: purchase price, monthly loan commitment, maintenance fee, distance to public transport, distance to a main road or highway, unit size, number of bedrooms, parking availability and facilities provided. The model evaluates eight shortlisted completed condominiums in Kuala Lumpur. Since the criteria are expressed in different units, the undesirable deviations are normalised before they enter the objective function. The aim is not to rank every condominium in the Kuala Lumpur market. Rather, the formulation identifies the alternative with the smallest total normalised undesirable deviation among the eight properties considered under the common aspiration profile used in this study.

THE PROPOSED METHOD

Data and Case Setting

Primary and secondary data were used to build the model. The questionnaire produced 36 valid responses from prospective condominium buyers and was used to identify both the relevant selection criteria and their preferred aspiration levels. For each criterion, the response category with the largest percentage was adopted as the representative aspiration level. The resulting targets are shown in Table

1. They form a group-level preference profile rather than a separate optimisation model for each respondent. Five criteria are treated as minimisation goals because lower values are preferred, while the remaining four are maximisation goals.

Table 1

Selection Criteria, Aspiration Levels and Goal Directions

Category	Criterion	Aspiration level	Direction
Financial	Purchase price (RM)	600,000	Minimise
Financial	Monthly loan (RM)	2,000	Minimise
Financial	Maintenance fee (RM)	399	Minimise
Accessibility	Distance to public transport (m)	500	Minimise
Accessibility	Distance to main road/highway (m)	500	Minimise
Dwelling attribute	Unit size (sq ft)	900	Maximise
Dwelling attribute	Number of bedrooms	3	Maximise
Dwelling attribute	Parking spaces	1	Maximise
Dwelling attribute	Facilities provided	10	Maximise

Secondary property information was taken from PropertyGuru Malaysia. The questionnaire-derived preferences were used during the screening process, and completed developments with values matching or close to those preferences were retained when exact matches were unavailable. Eight alternatives were shortlisted: Vista Kiara (A1), Seri Maya (A2), The Z Residence (A3), The Saffron (A4), Trinity Lemanja (A5), Idaman Puteri (A6), The Fennel (A7) and Laman Suria (A8). Tables 2 and 3 contain the numerical values used as coefficients in the optimisation model. The comparison assumes the common financing environment stated in the report, including a 3.5% interest-rate assumption; buyer-specific creditworthiness is not modelled.

Table 2

Financial and Accessibility Data for the Condominium Alternatives (Alt.)

Alt.	Price (RM)	Loan (RM)	Fee (RM)	Public transport (m)	Road/highway (m)
A1	595,000	2,404	440	10	100
A2	610,000	2,465	277	320	75
A3	615,000	2,485	280	550	400
A4	600,000	2,424	440	320	700
A5	539,999	2,182	330	900	350
A6	585,000	2,364	506	550	350
A7	620,000	2,505	430	90	72
A8	560,000	2,263	415	200	600

Table 3

Dwelling-Attribute Data for the Condominium Alternatives

Alt.	Unit size (sq ft)	Bedrooms	Parking	Facilities
A1	1,400	3	1	19
A2	1,365	3	2	13
A3	1,234	3	2	14
A4	1,087	3	2	15
A5	960	3	2	13
A6	2,200	4	2	7
A7	1,237	3	1	7
A8	936	2	1	11

Mathematical Formulation

Let $J = \{1, 2, ..., 8\}$ denote the condominium alternatives and $I = \{1, 2, ..., 9\}$ the selection criteria. The set of minimisation goals is $G_m = \{1, 2, 3, 4, 5\}$, while $G_M = \{6, 7, 8, 9\}$ contains the maximisation goals. For criterion i and alternative j, a_{ij} denotes the criterion value listed in Tables 2 and 3, and b_i is the aspiration level in Table 1. Each condominium is represented by a binary variable x_j, where $x_j = 1$ if alternative j is selected and $x_j = 0$ otherwise. The non-negative variables d_i^- and d_i^+ measure under-achievement and over-achievement of aspiration level i, respectively.

Each aspiration is written as the goal constraint in Equation 1.

$$\sum_{j \in J} a_{ij} x_{ij} + d_i^- - d_i^+ = b_i \tag{1}$$

For the five minimisation goals, only positive deviation is undesirable because it represents a value above the target. For the four maximisation goals, only negative deviation is penalised because it represents a value below the required aspiration level. Raw deviations cannot be added directly because the criteria use different numerical scales and units. The model therefore divides each undesirable deviation by its own aspiration level. Equation 2 gives the Equal-Priority ZOGP objective used in the study.

$$\min Z = \sum_{i \in G_m} \frac{d_i^+}{b_i} + \sum_{i \in G_M} \frac{d_i^-}{b_i} \tag{2}$$

Exactly one condominium must be selected. This requirement is imposed by Equation 3, while Equation 4 gives the variable-domain conditions.

$$\sum_{j \in J} x_j = 1 \tag{3}$$

$$d_i^-, d_i^+ \geq 0;\ x_i \in \{0, 1\} \tag{4}$$

Using the aspiration levels in Table 1, the objective function is instantiated as shown in Equation 5. All nine terms have the same nominal priority after normalisation; no pre-emptive hierarchy is imposed.

$$\min Z = \frac{d_1^+}{600000} + \frac{d_2^+}{2000} + \frac{d_3^+}{399} + \frac{d_4^+}{500} + \frac{d_5^+}{500} + \frac{d_6^-}{900} + \frac{d_7^-}{3} + d_8^- + \frac{d_9^-}{10} \quad (5)$$

Model Implementation

The complete binary model was implemented in LINGO. The coefficients in the nine goal constraints were taken directly from the decision matrix, the aspiration levels from Table 1, and the hard constraint restricted the solution to one condominium. LINGO was then used to minimise the normalised undesirable deviations. A range-based sensitivity analysis was carried out after the baseline solution. One representative aspiration level from each goal category was varied at a time while the remaining targets were held fixed.

RESULTS AND DISCUSSION

Baseline Selection and Goal Achievement

The baseline optimisation selected A2, Seri Maya Condominium, with x2 = 1 and all other binary variables equal to zero. The minimum objective value was Z = 0.2491667. Table 4 compares the selected condominium with the nine aspiration levels. Seven goals are satisfied in the preferred direction. The exceptions are purchase price and monthly loan commitment, both of which are financial minimisation goals.

Table 4

Goal Achievement for the Selected Seri Maya Condominium

Criterion	Target	Achieved	Undesirable deviation	Status
Purchase price (RM)	≤ 600,000	610,000	10,000	Not achieved
Monthly loan (RM)	≤ 2,000	2,465	465	Not achieved
Maintenance fee (RM)	≤ 399	277	0	Achieved
Public transport distance (m)	≤ 500	320	0	Achieved
Road/highway distance (m)	≤ 500	75	0	Achieved
Unit size (sq ft)	≥ 900	1,365	0	Achieved
Bedrooms	≥ 3	3	0	Achieved
Parking spaces	≥ 1	2	0	Achieved
Facilities	≥ 10	13	0	Achieved

Seri Maya is priced at RM610,000, which is RM10,000 above the purchase-price aspiration of RM600,000. Its estimated monthly loan of RM2,465 is RM465 above the RM2,000 target. These are the only undesirable deviations in the baseline solution. After normalisation, the objective value is obtained from 10,000/600,000 + 465/2,000 = 0.2491667. The maintenance fee of RM277 remains below its RM399 limit. Accessibility is also within both stated targets: the condominium is 320 m from public transport, 180 m inside the 500 m aspiration, and 75 m from the nearest main road or highway,

425 m inside that target. For the dwelling attributes, the 1,365 sq ft unit exceeds the minimum floor-area aspiration, three bedrooms meet the target exactly, and the two parking spaces and 13 facilities both exceed their respective minimum levels.

The result should not be read as evidence that Seri Maya is superior on every criterion. It is the alternative with the smallest combined normalised undesirable deviation for the aspiration profile used here. Several other condominiums perform better on individual attributes. The ZOGP formulation instead makes the trade-off explicit: a candidate can miss one or more targets and still be selected if its total penalised deviation is lower than that of the other shortlisted alternatives. This is the practical role of the equal-priority structure in the present case.

Range-Based Sensitivity Analysis

The sensitivity analysis varied one aspiration level at a time. Three representative criteria were tested: purchase price for the financial category, distance to public transport for accessibility, and parking availability for dwelling attributes. The accessibility criterion is reported here as public-transport distance because the numerical switching pattern in the optimisation runs corresponds to the public-transport values in the decision matrix. The tested ranges and observed selections are summarised in Table 5.

Table 5

Summary of the Range-Based Sensitivity Analysis

Criterion	Tested aspiration levels	Selected alternative(s)	Observed Seri Maya stability
Purchase price	RM500,000–RM1,000,000; RM50,000 steps	Seri Maya throughout	Entire tested range
Public-transport distance	100–900 m; 100 m steps	• Vista Kiara: 100–300 m; • Seri Maya: 400–700 m; • Trinity Lemanja: 800–900 m	400–700 m
Parking availability	1–5 spaces; 1-space steps	Seri Maya throughout	Entire tested range

Changing the purchase-price target did not alter the selected condominium within the tested interval. Seri Maya remained selected from RM500,000 to RM1,000,000. The objective value fell from 0.4525000 at RM500,000 to 0.2325000 at RM650,000, after which further relaxation of the price target did not reduce the objective within the reported runs. Parking produced a similar selection pattern. Seri Maya remained selected for targets from one to five spaces. The objective stayed at 0.2491667 for targets of one and two spaces because the condominium provides two spaces, then increased as the required number rose above two.

The public-transport aspiration had a different effect. Vista Kiara was selected for targets of 100–300 m, Seri Maya for 400–700 m, and Trinity Lemanja for 800–900 m. The baseline target of 500 m therefore lies inside an observed stability interval of 400–700 m for Seri Maya. This interval is based on the tested 100 m increments rather than an exact switching boundary. Taken together, the sensitivity results show that the baseline recommendation is stable to the purchase-price and parking changes

examined in this study, but it is more responsive to changes in the accessibility aspiration. The recommendation remains conditional on the eight shortlisted alternatives and the other aspiration levels being held fixed.

CONCLUSION

An Equal-Priority ZOGP model was developed to select one condominium from eight shortlisted alternatives using a common set of buyer aspiration levels. The formulation combines five minimisation goals and four maximisation goals, with undesirable deviations normalised so that criteria measured in Ringgit Malaysia, metres, square feet and counts can be considered in the same objective. Under the baseline aspiration profile, LINGO selected Seri Maya Condominium with an objective value of 0.2491667. Seven goals were achieved in the preferred direction. The remaining deviations were a RM10,000 excess in purchase price and a RM465 excess in monthly loan commitment. The sensitivity analysis also shows the limits of that recommendation. Seri Maya remained selected throughout the tested purchase-price and parking ranges, but the chosen alternative changed when the public-transport aspiration moved outside the observed 400–700 m stability interval. The result is therefore specific to the shortlisted Kuala Lumpur condominiums, the group-level aspiration values, the static property data and the financing assumptions used in the study. Future work may use a larger set of buyers and properties, incorporate criteria such as neighbourhood safety, environmental quality, traffic conditions and developer reputation, or allow individual buyers to enter their own aspiration levels in an interactive decision-support tool.

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