A Multi-Criteria Model for Corporate Property Evaluation

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Abstract. **A critical concern for corporations pursuing geographical expansion strategies involves property evaluation. In order for expansion to be successful, corporations must identify cities and properties that offer a good fit with the firm's corporate strategy. Unfortunately, little has been written to aid corporations in making complex property selection decisions. This paper presents a model that combines the concepts of strategic management, the management science technique of goal programming, and micro computer technology to provide managers with a more effective and efficient method for evaluating property and making selection decisions.**

Introduction

> We're here because the corporate accountants were in a cost cutting binge and this building was a steal from a structural standpoint. My problem is I can't find decent managers who want to live in this town. I've had to settle for second best and even so turnover is too high. A larger part of our labor relations problem results from the quality of our supervision and because we haven't had the continuity we should. When you look at what these troubles have cost us over the past five years, this building wasn't a bargain.[10]

Over the years one of the most prominent corporate growth strategies has been geographical expansion. One factor that has made geographical expansion attractive as a growth strategy is the saturation of existing markets where the firm currently operates. Geographical expansion offers firms access to new markets and opportunities to utilize economies of scale. However, in order for expansion to be successful these firms must identify properties that offer a good fit with the firm's internal strengths and weaknesses.

As illustrated above, many firms that do pursue geographical expansion as a strategy do not always select the best site. Often this is because they do not fully understand the multiple relationships when locating in a new business environment. This lack of understanding is further compounded by the fact that many existing property evaluation methods are deficient. This paper expands on previous corporate property evaluation methods by applying a computer optimization model to property acquisition in a way that has not been done before. The paper also contributes to the literature by presenting a model that combines the concept of strategic management, the management science technique of goal programming, and microcomputer technology to provide corporations with a more effective and efficient method for property evaluation.

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Corporate Property Evaluation

Previous literature regarding corporate property evaluation has generally focused on financial methods that analyze how site-specific variables will influence potential costs and revenues from the site. These methods include the ratio method, the analog method, the gravity model, regression models, and cashflow analysis (see Nourse [18]). Unfortunately these methods sometimes do not take into account all the possible considerations for the site such as the firm's overall corporate strategy, critical external factors, and critical internal site features. These methods also do not utilize state of the art computer technology to simultaneously evaluate all alternative properties.

To improve current corporate property evaluation methods, this paper draws upon the business strategy literature and utilizes goal programming in order to provide managers with a computer-based multi-criteria model on which to base property selection decisions. The multi-criteria model also improves on previous computerized models by using the strategic management concept to structure the selection problem. Previous models have required selection problems to be already semistructured and do not break the selection problem into a two-stage process where a geographical area (a specific city) is selected in Stage 1 and the best available property within the city is selected in Stage 2 (see, for example, [28]).

The Multi-Criteria Model

The field of business strategy deals with the process of matching or fitting the organization with its changing environment in the most advantageous way. This includes adapting the organization itself (via internal changes) to fit the external environment or in some cases changing the external environment (via geographical expansion) to fit the internal environment. The Multi-Criteria model, shown in Exhibit 1, uses several strategic management models (see [1], [6], [7], [24], [25]) to fit the corporation with the city and specific property (within the selected city) that best meets its geographical expansion needs.

Determination of City and Property Critical Success Factors

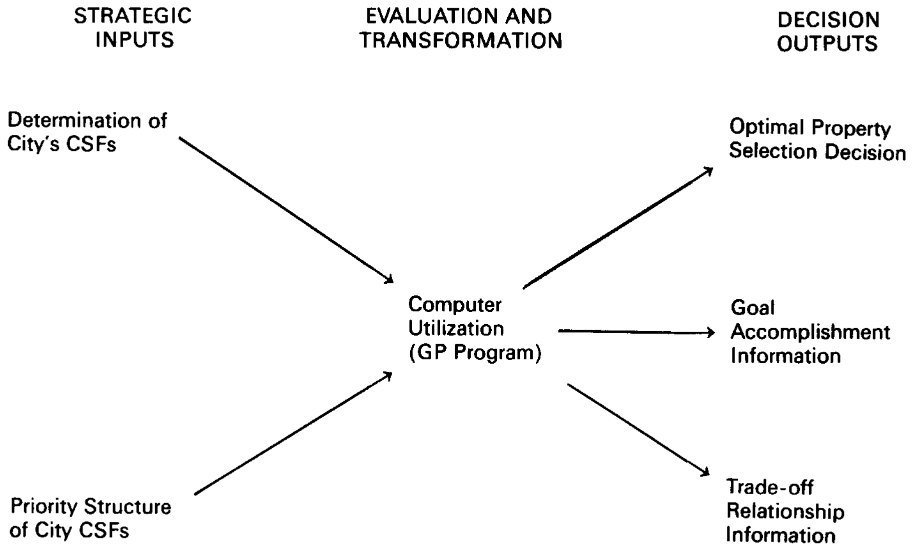
The Multi-Criteria model has two stages. The purpose of Stage 1 is to determine what external environmental factors a city should have to fit most advantageously with the corporation's internal environment. These external environmental factors are referred to as the city's Critical Success Factors (CSFs) since they are critical to the expansion site's future success.

Features of a property's external environment can be identified at two levels: (1) The general environment, consisting of technological factors, political factors, economic factors, physical factors [17] and social factors [4], and (2) the task environmental [26] which, for corporations, includes potential customers, suppliers, competitors, and regulatory groups. The Multi-Criteria model examines specific variables that fall within the scope of the environmental factors listed above. External variables associated with the city in which a property is located are listed below:

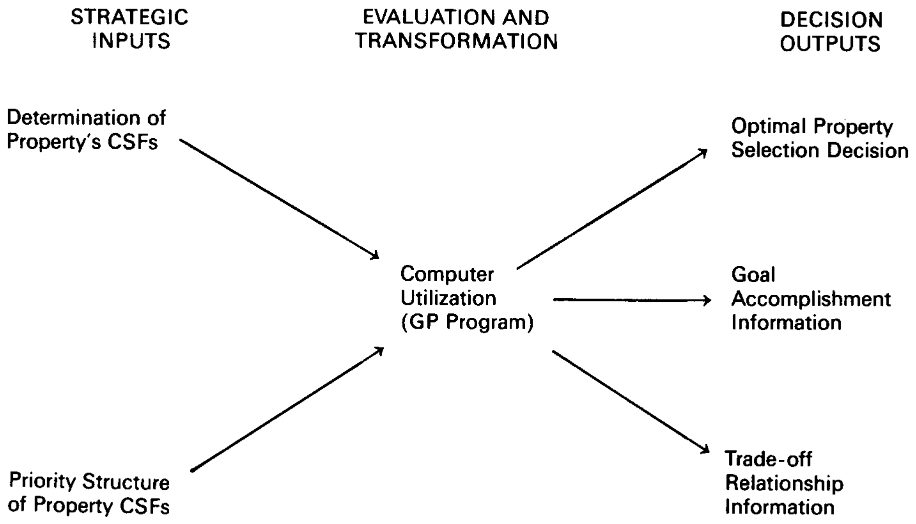
(1) Economic factors include the projected growth rate of the trade area, yearly retail sales per square foot, insurance costs, utility rates, tax rates,

Exhibit 1
The Computer Based Multi-Criteria Model for Corporate Property Evaluation

Stage 1—City Selection



Stage 2—Property Selection



potential consumer expenditures in the city, labor costs and the overall economic condition.

(2) Social factors include variables such as crime rate, work ethics, career expectations, average education of the potential workforce, size and quality of labor pool, level of union activity in the area, and overall community atmosphere.

(3) Political factors include the tax rate, probability of property tax relief, probability of state income tax relief, zoning laws, environmental laws, willingness of local officials to expediate the land use and permit process, legal regulations concerning utility services, hazardous waste regulations, and any other government regulations or restrictions that could affect operations.

(4) Technical factors include variables such as related cost factors, product and service quality, the general rate of technological change, raw materials, and innovation.

(5) Physical factors include climate, the probability of natural disaster, accessibility—proximity to transportation, proximity to suppliers, proximity to universities and research facilities, proximity to existing company facilities, proximity to recreational areas and other entertainment, and utility costs.

(6) Task Environment factors include projected customer base, market growth, untapped demand, the prices that existing facilities in the subject locale command, market overlap, and number and strength of competitors.

The purpose of Stage 2 of the model is to determine what attributes a future property, within the city selected in Stage 1, should have to fit most advantageously with the corporation's internal environment. These attributes are referred to as the property's Critical Success Factors (CSFs) since they are also critical to the expansion site's future success. The determination of the property CSFs is based on attributes that make current properties successful and on the corporation's overall strategy.

Literature dealing with property evaluation [15, 18, 19, 21] suggests that attributes associated with a property include site features such as: size, price per square foot, total cost, physical layout, renovation requirements, lease-buy options, accessibility, visibility, proximity to major traffic generators, traffic volume, options for expansion to adjoining buildings or vacant lots, prestige of location, neighborhood characteristics, projected customer base in trade area, market growth in trade area, untapped demand in trade area, the prices that existing facilities in the subject locale command, and number and strength of competitors in trade area, the crime rate in immediate area surrounding the property, and parking space. Many of these variables have been identified in the corporate property evaluation literature [3, 8, 9, 13, 14, 15, 16, 18, 21, 23, 27].

In both stages of the model a firm would only examine those critical factors that are most important to the future city or property's success. In the Multi-Criteria model these critical factors are first ranked in order of importance. For example, if low cost per square foot is a critical success factor, and a major goal of the firm is to locate where there is high projected market growth and property tax relief, the firm might rank cost per square foot as its highest external factor priority, then market growth, property tax relief, and so on until all the critical success factors have been included in the model. Once the CSFs are ranked, the next step is to weight them for each city or property that is examined. A weighting scale somewhat similar to the one suggested by Hax and Majluf [11] can be used to assign weights to those important CSFs that cannot be precisely quantified. The five-point weighting scale used in the Multi-Criteria model is:

1 = An extremely unattractive CSF
2 = A mildly unattractive CSF
3 = An even or neutral CSF
4 = A mildly attractive CSF
5 = An extremely attractive CSF

This rating scale allows those CSFs that cannot be quantified with great precision to be rated relative to the same CSFs of other cities or properties under consideration. For example, property layout cannot be quantified as easily or with the precision as the number of competitors in a market. Thus, property layout of a potential property is rated relative to the property layout of other sites under consideration (where a rating of 5 is extremely attractive and a rating of 1 is extremely unattractive).

Evaluation and Site Selection

During the second step of Stage 1 of the model, several alternative cities are identified. Relevant information about each city is then entered into the goal programming part of the model. The model will evaluate the information and determine which city provides the best environment for geographical expansion.

The GP formulation of the Multi-Criteria model is shown in Appendix 1. To use this model, a decisionmaker must decide the number of cities (i.e., the alpha parameter in the model) in to which a firm wants to expand simultaneously. While most firms expand into only one new city at a time, this model can easily accommodate multiple expansion problems. In the Multi-Criteria model, the variables or unknowns (i.e., x_j) that are being determined are the best strategically fitting city attributes. The strategic fit is described in the model as mathematical constraints, composed of the previously mentioned weighting scale values (i.e., a_{ij}) for each city CSF that management defines as desirable. Management must also define the relative importance, via a priority or ranking (i.e., P_{ki}) for each of the city CSFs.

Once the model is formulated it can be computer loaded or the data for the model may be more easily obtained by merging files from data sources into a variety of GP software packages (see Bitran [4] Kiziltan and Yucaoglu [12]). The use of computer technology allows decisionmakers to generate city selection solutions even when a substantial number of city CSFs are included in the model.

The informational output of the Multi-Criteria model is quite extensive and goes far beyond any simple tabular solution. The model provides the best strategically fitting property(s) for expansion and also provides information on how well the choice satisfied the prioritized goals established by management on the CSFs. In addition, the Multi-Criteria model provides trade-off information of the CSFs that can help improve city selection decisions. For example, the model can define the exact trade-off values for alternative properties. These trade-off values can be used to revise the priority structure to improve the city selection choice. In other words, the model offers information that can be used by managers to suggest refinements in the model for a better solution. Indeed, one real advantage of using the Multi-Criteria model is that minor changes in the model's parameters can be easily made and a new solution can be quickly generated with the computer. Tabular methods, on the other hand, might require a substantial investment in time and effort for revision and recalculation of a new solution.

The trade-off information generated from the goal programming step of the model also can reveal where subjective weighting scale values should be revised or reevaluated to improve the solution. By calling attention to critically important weighting scale values, management can spend their time more efficiently evaluating the validity of these select, subjectively derived values.

Once the best city for expansion is identified, the above step can be repeated for Stage 2 of the model in order to evaluate several alternative properties within the selected city.

Application of the Multi-Criteria Model

To illustrate how the Multi-Criteria model works, a case study is presented in which a U.S. corporation wants to evaluate twenty potential cities across the U.S. in order to determine which city (i.e., *alpha* = 1) offers the best environment for expansion. Once the best city is selected, twenty properties within the city will be evaluated in order to determine which property (i.e., *alpha* = 1) should be purchased.

Exhibit 2
Data for Retail Case Study Application

				Alternative City Contribution toward Goal (a_{ij})			
Selection Criteria Objective	Unit of Measure	Desired Goal ($Beta_1$)	Ranked Priority (P_k)	Cleveland Ohio (x_1)	Atlanta Georgia (x_2)	Denver Colorado (x_3)	Phoenix Arizona (x_{20})
Potential demand for retail goods in the city	Millions of dollars	200	1	200	200	150	165
Total competitive space in city	Sq. Feet	0	2	600,000	450,000	400,000	550,000
Average price per square foot	Dollars	0	3	130	150	110	135
Protected growth rate of city	Yearly Percentage	20	4	2	8	4	6
Number of potential location sites within the city	Actual Number	100	5	30	35	20	25
Accessibility to suppliers	1–5 scale	5	6	3.5	4	3	3.5
Labor costs	Dollars	3.35	7	6.00	5.50	5.00	6.50
Property tax rate	Percentage of Appraisal	0	8	2	2.5	2	2.5

In Exhibit 2 the assessment of each city's CSF is based either on objective dollar or percentage information, or is subjectively determined by senior management. A total of eight selection criteria are used. The eight selection criteria are structured in the Multi-Criteria model as the parameters in the goal constraints. The actual desired goals (i.e., $Beta_i$) are usually set at an idealistic level of perfection that can rarely be achieved. The Multi-Criteria model will seek a solution that minimizes deviation from those impossible $Beta_i$ goals by selecting the property (and therefore city) whose selection criterion comes closest to the B_i. As shown in Exhibit 2, the CSFs for accessibility to suppliers is set at 5, while the other factors such as total competitive space are set at an ideal level of 0. The ranked priorities (P_k) of the goals are based on the importance of each CSF relative to the other CSFs. While a single specific ranking is used in this example, it may be desirable to perform P_k sensitivity analysis (Anthony, Dearden and Vancil [2]) to see if other rankings will improve the resulting solution).

Based on the information in Exhibit 2, the Multi-Criteria model for the corporate city selection problem can be formulated as presented in Appendix 2. Each of the x_j decision variables in the model represents a different city from which one is to be selected. An IBM

Exhibit 3
Multi-Criteria Model Solution for Case Study Application

Selection Criteria Objective	Ranked Priority (P_k)	Solution Generated (d^- d^+)	Goal Accomplishment and Interpretation on Model Selection of Atlanta, Georgia (X_2)
Potential demand for retail product in the city	1	0	Selection fully satisfies potential demand goal of $200M
Total competitive space in city	2	450,000	Selection does not fully satisfy total competitive space goal (450K greater than goal of 0 sq. ft.)
Average price per square foot	3	150	Selection does not fully satisfy average price per sq. ft. goal ($150 greater than goal of $0)
Projected growth rate of city	4	12	Selection does not fully satisfy projected growth goal (12% short of 20% goal)
Number of potential location sites within the city	5	65	Selection does not fully satisfy potential location site goal (65 sites short of 100 site goal)
Accessibility to suppliers	6	1	Selection does not fully satisfy potential location site goal (65 sites short of 100 site goal)
Labor costs	7	2.15	Selection does not fully satisfy labor cost goal ($2.15 above $3.35 goal)
Property tax rate	8	2.5	Selection does not fully satisfy property tax rate goal (2.5% above goal of 0%)

370 that utilizes a FORTRAN program based on Bitran's zero-one programming procedures [5] can be used to solve the city selection problem.

Of the twenty cities from which to select, the Multi-Criteria model selected Atlanta (i.e., x_2) as the best strategically fitting city for corporate expansion. A complete breakdown of the goal accomplishment in this selection is presented in Exhibit 3. The goal deviation and its interpretation in Exhibit 3 are very useful post-decision information. The solution-generated deviation provides detailed information on how much deviation there will be between the needs of the corporation and the selected city's contribution to filling those needs.

The post-solution information provided by the Multi-Criteria model can also be extended by considering the dual solution to the problem and performing a sensitivity analysis on select desired goal parameters (*Beta*'s). The selection of one city over another invariably involves trade-offs between the selection criteria. The dual variable values for each of the selection criteria provides very detailed trade-off information. A sensitivity analysis can be performed on each of the selection criteria goals that may be of special interest to the corporation's management.

In Exhibit 4, the *Beta*'s dual solution and sensitivity analysis values of the specific selection criteria objective of "Potential Demand for Retail Goods" are presented. The

Exhibit 4
Dual Solution Values and Sensitivity Analysis of "Potential Demand for Retail Goods" Objective

Selection Criteria Objective	Dual Variable Values	Sensitivity Analysis Boundaries for "$200 Million" Objective of Potential Demand for Retail Goods
Potential demand for retail product in the city	0	—
Total competitive space in city	0	—
Average price per square foot	$5.00	(≥190 M)
Projected growth rate of city	10%	(≥195 M)
Number of potential location sites within the city	0	—
Accessibility to suppliers	0	—
Labor costs	$0.10	(≥190 M)
Property tax rate	0	—

dual solution values provide trade-off information on the amount of deviation that can be reduced from the existing solution if a change in the $200 million potential demand for retail goods goal is permitted. If the corporation would be willing to decrease their potential demand for retail goods goal of a minimum of $200 million to only $190 million, an alternative city selection is possible that would improve the strategic fit even better than the Atlanta selection. The dual value of $0.50 for the selection criteria of "Average price per square foot" in Exhibit 4 indicates that a decrease of $0.50 per square foot is possible for each $1 million decrease in potential retail demand. The sensitivity analysis defines boundaries under which the changes can be made in the selection criteria. We can see in Exhibit 4 that the dollar demand requirement for the selection criteria of "Potential Demand for Retail Goods" can be decreased from $200 million to a boundary limit of $190 million (or a $10 million decrease). The result of such a decrease would be a new city selected that would reduce negative deviation (or decrease the average price per square foot) by $5.00 (i.e., $0.50 × 10).

Once this trade-off information is identified the next step of the model is to analyze it in the context of the specific firm that is under examination. In the retail example it is assumed that the retail business generates an additional 1.5% in profits from each additional dollar of potential demand for retail goods. If this is the case, the firm would lose $150,000 ($10 million potential demand × 1.5% profit) in profits from the $10 million loss in potential demand. In return for losing the $10 million in potential demand the firm would save $5 per square foot in rent which calculates out to a total saving of $125,000 ($5.00 × 25,000 sq. ft.) in rent. Thus, the firm should forego the opportunity to reduce its rent by $5.00 a square foot and should choose Atlanta as its expansion city. If the square footage savings had been more than the lost profits from potential demand, then the model would have been rerun and the next set of trade-off information would be analyzed using the same method as described above. It is important to note that the exact numbers and percentages used to put each of the trade-off values into profit and loss terms will be contingent on the firm under study. But these calculations can easily be made once the Multi-Criteria model generates the exact trade-off values that need to be evaluated.

After a city selection is made, the dual solution values and sensitivity analysis can be performed for each of the eight selection criteria in this problem if desired. As can be seen from the "Potential Demand for Retail Goods" criteria, this information would provide detailed trade-off values for any or all existing possible combinations of selection criteria.

Once a city selection is made, specific properties within the selected city can be evaluated. For the purposes of this case study thirteen selection criteria are used. The thirteen selection criteria are shown in Exhibit 5. Once again the criteria are structured in the Multi-Criteria model as the parameters in the goal constraints and are set at an idealistic level of perfection that can rarely be achieved. The Multi-Criteria will seek a solution that minimizes deviation from those impossible $Beta_i$ goals by selecting the property whose selection criterion comes closest to the B_i.

Based on the information in Exhibit 5, the Multi-Criteria model for the corporate property selection problem can be formulated as presented in Appendix 3. Of the twenty properties from which to select, the Multi-Criteria model selected the Jackson property (i.e., x_{20}) as the best strategically fitting property for corporate expansion. A complete breakdown of the goal accomplishment in this selection is presented in Exhibit 6.

In Exhibit 7, the *Beta*'s dual solution and sensitivity analysis values of the specific selection criteria objective of "Size" are presented. The dual solution values presented in

Exhibit 5
Data for Retail Case Study Application: Stage 2

				Alternative Site Contribution toward Goal (a_{ij})			
Selection Criteria Objective	Unit of Measure	Desired Goal ($Beta_1$)	Ranked Priority (P_k)	Hampton Property (x_1)	Stuart Property (x_2)	Lee Property (x_3)	Jackson Property (x_{20})
Zoning	1–5 scale	5	1	5	5	4	5
Size (minimum)	Sq. Feet	25,000	2	20,000	30,000	26,000	25,000
Potential consumer expenditures in trade area	Millions of dollars	50	3	20	30	25	35
Projected growth rate of target market	Yearly percentage	20	4	2	8	3	10
Accessibility	1–5 scale	5	5	3	5	4	4
Visibility	1–5 scale	5	6	4	5	5	5
Prestige of location	1–5 scale	5	7	3	4	3	5
Total competitive space in trade area	Sq. Feet	0	8	200,000	150,000	225,000	300,000
Price per square foot	Dollars	0	9	130	150	140	160
Number of parking spaces	Number	5,000	10	500	1,000	2,000	2,500
Physical layout	1–5 scale	5	11	5	4	4	4
Renovation requirements	Dollars	0	12	10,000	60,000	50,000	30,000
Crime rate	1–5 scale	5	13	3	4	4	3

Exhibit 7 represent the amount of deviation that could be reduced from each of the desired goals for a change of one thousand square feet of space required from the selected Jackson property (i.e., x_{20}). If the firm purchasing the property would be willing to increase their "Size" goal of a minimum of 25,000 sq. ft. to only 26,000 sq. ft., an alternative selection of property is possible that would improve the strategic fit even better than the Jackson property. The dual value of 2% for the selection criteria of "Potential Growth Rate" in Exhibit 7 indicates that an increase of the potential growth rate is possible for each 1,000 sq ft. increase in minimum space required. We can see in Exhibit 7 that we can increase the minimum sq. ft. requirement for the selection criteria of "Size" from 25,000 to a boundary limit of 27,000 (or a 2,000 sq. ft. increase). The result of such an increase would

Exhibit 6
Multi-Criteria Model Solution for Case Study Application: Stage 2

Selection Criteria Objective	Ranked Priority (P_k)	Solution Generated (d^- d^+)	Goal Accomplishment and Interpretation on Model Selection of Jackson Property (X_{20})
Zoning	1	0	Selection fully satisfies the zoning requirements goal
Size	2	0	Selection fully satisfies the size requirements goal
Potential Consumer Expenditures	3	−15	Selection does not fully satisfy the potential customer expenditure ($15 M short of $50 M goal)
Potential Growth Rate	4	−10	Selection does not fully satisfy growth rate goal (10% short of 20% goal)
Accessibility	5	−1	Selection does not fully satisfy the accessibility goal (1 CSF point short of 5-point goal)
Visibility	6	0	Selection fully satisfies the visibility goal
Prestige	7	0	Selection fully satisfies the prestige goal
Competitive Space	8	300,000	Selection does not fully satisfy the competitive space goal (300,000 more sq. feet than the goal of 0)
Price (per Sq. foot)	9	160	Selection does not fully satisfy the price per square foot goal ($160 per sq. ft. more than the goal of $0)
No. of Parking Spaces	10	−2,500	Selection does not fully satisfy the parking space goal (2,500 parking spaces short of 5,000 goal)
Physical Layout	11	−1	Selection does not fully satisfy the physical layout goal (1 CSF point short of 5-point goal)
Renovation Requirements	12	30,000	Selection does not fully satisfy renovation requirement goal ($30,000 more than goal of $0)
Crime Rate	13	−2	Selection does not fully satisfy the crime rate goal (2 CSF points short of 5-point goal)

Exhibit 7
Dual Solution Values and Sensitivity Analysis of "Size" Objective

Selection Criteria Objective	Dual Variable Values	Sensitivity Analysis Boundaries for "Size" Objective of 25,000 Square Feet
Zoning	0	—
Size	0	—
Potential Consumer Expenditures	0	—
Potential Growth Rate	2%	(≤27,000)
Accessibility	1	(≤28,333)
Visibility	0	—
Prestige	0	—
Competitive Space	15,000 sq ft.	(≥22,000)
Price (per sq. foot)	$10	(≥24,000)
No. of Parking Spaces	0	—
Physical Layout	0	—
Renovation Requirements	0	—
Crime Rate	0	—

be a new property selected that would reduce negative deviation (or increase the potential growth rate) by 4% (i.e., 2 × 2).

Once again the next step of the model is to transform the trade-off values into profit and loss terms. In this example it is assumed that the extra 2,000 square feet would end up costing the firm more money the first year than would be generated from the additional space. It can also be assumed that after two years of 4% extra market growth, the additional space would more than pay for itself through increased sales. In this case the model should be rerun changing the "Size" selection criteria to 27,000 square feet. After the new trade-off information is generated the new trade-off relationships can be evaluated using the method outlined above.

The dual solution values and sensitivity analysis can be performed for each of the thirteen selection criteria in this problem if desired. As can be seen from the "Size" criteria, this information would provide detailed trade-off values for any or all existing possible combinations of selection criteria.

Once the best property is identified other more financially orientated models (such as the net present value model, ratio method, or cashflow analysis) can be used to check the overall financial feasibility of the selected property. This can be done to control for the unlikely event that none of the alternative properties are financially feasible at the time of the property evaluation (for example, such an event could happen if interest rates were unusually high). These financial methods can also be used to determine at what price the selected property becomes financially feasible.

Summary

The decision of geographical expansion is a critical and complex issue for the corporation that must be dealt with on a continuing basis by top managers. This article has presented a computer-based multi-criteria model for corporate property evaluation that offers several advantages over previous models. These advantages include:

1. use of a two-stage model for evaluating alternative expansion cities first, and then evaluating specific properties within the selected city;
2. provision of trade-off information revealing where subjective weighting scale values should be revised or reevaluated to improve the site selection;
3. simultaneous consideration of all decisionmaking criteria (i.e., internal and external factors) to derive an optimal selection;
4. ordinary ranked prioritization of decisionmaking criteria;
5. easy-to-change critical success factor and objective factor estimates (i.e., model parameters) and solving for a new solution with little or no effort from management.

While the Multi-Criteria model presented in this paper provides a powerful decisionmaking tool for city and property selection, the information it generates with duality and sensitivity analysis possesses some limitations. One of the limitations is that the dual solution values are limited to a single change. That is, multiple changes in selection criteria values will not necessarily result in desirable changes reflected in all of the dual decision values. A second limitation is that changes beyond the boundaries defined by sensitivity analysis cannot be interpreted from the dual solution values. Such changes can be determined by using the model as a simulation tool. That is, the change can be observed by making a parameter change in the model and resolving the problem to see the simulated effect of the change in the new solution. These limitations, and others that are commonly discussed when using the methodologies presented in this paper (see [22]) limit the interpretation of the information from the model, but not its use in property selection. Despite these limitations, the careful application of the methodologies proposed in this paper will reveal accurate and useful planning information that is not currently available to corporate property acquisition managers.

References

[1] K. E. Andrews. *Business Policy: Text and Cases.* Homewood, Ill.: Richard D. Irwin, 1965.
[2] R. Anthony, J. Dearden and R. F. Vancil. Key Economic Variables. In *Management Control Systems*, 138–43. Homewood, Ill.: Irwin, 1972.
[3] W. Applebaum. Methods for Determining Store Trade Areas, Market Penetration and Potential Sales. *Journal of Marketing Research* (1966), 80–97.
[4] G. Bitran. Theory and Algorithms for Linear Multiple Objective Programs with Zero-One Variables. *Math. Programming* 17 (1979), 362–90.
[5] D. Bradley and R. Wilkie. *The Concept of Organization.* Glasgow: Blakie, 1974.
[6] L. A. Digman. *Strategic Management: Concepts, Decisions, Cases.* Plano, Tex.: Business Publications, Inc., 1986.
[7] W. F. Glueck. *Business Policy and Strategic Management.* New York: McGraw-Hill, third edition 1980.
[8] A. M. Hammer. Metropolitan Planning and the Location Behavior of Basic Office Firms: A Case Study. *Review of Regional Studies* 4 (1974), 41–42.
[9] S. H. Hancock. Site Selection: Reno & Lake Tahoe. *Successful Meetings* 37 (1988), 177–80.
[10] C. F. Harding. Company Politics in Plant Location: Can You Avoid It? *Industrial Development* (September/October 1982), 19–20.
[11] A. C. Hax and N. S. Majluf. The Use of the Industry Attractiveness Business Strength Matrix in Strategic Planning. *Interfaces* 13 (1983), 54–71.
[12] G. Kiziltan and E. Yucaoglu. An Algorithm for Multiobjective Zero-One Linear Programming. *Management Science* 29 (1983), 1444–53.

[13] C. B. Leinberger. Corporate Real Estate: Other Criteria Affect High-Tech Decisions. *National Real Estate Investor* 27 (1985), 56–60.
[14] Derr. Leonhardt. (1984) Environmental Aspects of the Site Location Decision. *Industrial Development* (July/August 1984), 23.
[15] C. McIntyre and J. E. Emmanuel. The Expandable Office Building. *Journal of Property Management* 53 (1988), 14–17.
[16] J. Mercurio. Store Location Strategies. In R. L. Davies and D. S. Rogers, *Store Location and Assessment Research*, 237–62. New York: Wiley, 1984.
[17] R. Miles. *Macro Organizational Behavior*. Calif.: Goodyear, 1980.
[18] H. O. Nourse. *Managerial Real Estate: Corporate Real Estate Asset Management*. Englewood Cliffs, N.J.: Prentice Hall, 1990.
[19] Phyllis Osaki. Property Aquisition, Renovation Provide Benefits. *National Real Estate Investor* 31 (1989), 100.
[20] D. E. Schendel and C. W. Hofer. *Strategic Management: A New View of Business Policy and Planning*. Boston: Little Brown, 1979.
[21] R. W. Schmenner. *Making Business Location Decisions*. Englewood Cliffs, N.J.: Prentice Hall, 1982, 25.
[22] M. J. Schniederjans. *Linear Goal Programming*. Princeton, N.J.: Petrocelli Books, Inc., 1984.
[23] D. P. Segal. Retail Site Selection. In Robert A. Silverman, editor, *Corporate Real Estate Handbook*, 175–86. New York: McGraw-Hill, 1987.
[24] G. A. Steiner. *Strategic Planning: What Every Manager Must Know*. New York: Free Press, 1979.
[25] A. A. Thompson, Jr. and A. J. Strickland, III. *Strategy Formulation and Implementation*. Plano, Tex.: Business Publications, 1980.
[26] J. D. Thompson. *Organization in Action*. New York: McGraw-Hill, 1967.
[27] Sylvia Tiersten. Savvy Facilities Planners See Profits in Land Deals. *Electronic Business* 14 (1988), 114–16.
[28] R. R. Trippi. A Decision Support System for Real Estate Investment Portfolio Management. *Information and Management* 16 (1989), 47–54.

Appendix 1
Corporate Property Goal Programming Model Formulation

Minimize $\sum_{k=1}^{K} P_K(d^+ + d^-)$

subject to: $\sum_{j=1}^{n} x_j = \alpha$

$$\sum_{j=1}^{n} a_{ij} x_j + d_i^- - d_i^+ = \beta_i \qquad \text{(for } i = 1,2, \ldots, m,)$$

and

$$x_j = 0 \text{ or } 1 \qquad \text{(for } j = 1,2, \ldots, n,)$$

$$d_i^-, d_i^+ > 0 \qquad \text{(for } i = 1,2, \ldots, m,)$$

where

x_j: decision variables, such that { $x_j = 1$: locate in city or property j, from $j = 1,2, \ldots, n$ cities or properties; $x_j = 0$: do not locate in city or property j;

d_i^-, d_i^+: vectors of underachievements and overachievements of targeted location factor objectives i, $i = 1, \ldots, m$;

P_k: vector of k, $k = 1, \ldots, K$ ordinal ranks where $P_1 > P_2 > > > > P_K$;

a_{ij}: matrix of critical success factor weightings for the i targeted location factor objectives when the j city or property is selected;

β_i: vectors of i, $i = 1, \ldots, m$ targeted location factor objectives.

Appendix 2
Formulation of Corporate Property Multi-Criteria Model for Case Study Application

Minimize $Z = P_1 d_1^- + P_2 d_2^- + P_3 d_3^- + P_4 d_4^- + P_5 d_5^- + P_6 d_6^- + P_7 d_7^- + P_8 d_8^-$

subject to: $X_1 + X_2 + X_3 \ldots + X_{20} = 1$

$200X_1 + 200X_2 + 150X_3 + \ldots + 165X_{20} + d_1^- - d_1^- = 200$

$600{,}000X_1 + 450{,}000X_2 + 400{,}000X_3 + \ldots + 550{,}000X_{20} + d_2^- - d_2^- = 0$

$130X_1 + 150X_2 + 110X_3 + \ldots + 135X_{20} + d_3^- - d_3^- = 0$

$2X_1 + 2X_2 + 4X_3 + \ldots + 6X_{20} + d_4^- - d_4^- = 20$

$30X_1 + 35X_2 + 20X_3 + \ldots + 25X_{20} + d_5^- - d_5^- = 100$

$3.5X_1 + 4X_2 + 3X_3 + \ldots + 3.5X_{20} + d_6^- - d_6^- = 5$

$6.00X_1 + 5.50X_2 + 5.00X_3 + \ldots + 6.50X_{20} + d_7^- - d_7^- = 3.35$

$2X_1 + 2.50X_2 + 2X_3 + \ldots + 2.5X_{20} + d_8^- - d_8^- = 0$

and $X_j = 0$ or 1; $\quad d_1^- . d_1^- > 0$

Appendix 3
Formulation of Corporate Property Multi-Criteria Model for Case Study Application: Stage 2

Minimize $Z = P_1 d_1^- + P_2 d_2^- + P_3 d_3^- + P_4 d_4^- + P_5 d_5^- + P_6 d_6^- + P_7 d_7^- + P_8 d_8^- + P_9 d_9^- + P_{10} d_{10}^- + P_{11} d_{11}^- + P_{12} d_{12}^- + P_{13} d_{13}^-$

subject to:

$$X_1 + X_2 + X_3 \ldots + X_{20} = 1$$
$$5X_1 + 5X_2 + 4X_3 + \ldots + 5X_{20} + d_1^- - d_1^- = 5$$
$$20{,}000X_1 + 30{,}000X_2 + 26{,}000X_3 + \ldots + 25{,}000X_{20} + d_2^- - d_2^- = 25{,}000$$
$$20X_1 + 30X_2 + 25X_3 + \ldots + 35X_{20} + d_3^- - d_3^- = 50$$
$$2X_1 + 8X_2 + 3X_3 + \ldots + 3X_{20} + d_4^- - d_4^- = 20$$
$$3X_1 + 5X_2 + 4X_3 + \ldots + 4X_{20} + d_5^- - d_5^- = 5$$
$$4X_1 + 5X_2 + 5X_3 + \ldots + 5X_{20} + d_6^- - d_6^- = 5$$
$$3X_1 + 4X_2 + 3X_3 + \ldots + 5X_{20} + d_7^- - d_7^- = 5$$
$$200{,}000X_1 + 150{,}000X_2 + 225{,}000X_3 + \ldots + 300{,}000X_{20} + d_8^- - d_8^- = 0$$
$$130X_1 + 150X_2 + 140X_3 + \ldots + 160X_{20} + d_9^- - d_9^- = 0$$
$$500X_1 + 1000X_2 + 2000X_3 + \ldots + 2500X_{20} + d_{10}^- - d_{10}^- = 5000$$
$$5X_1 + 4X_2 + 4X_3 + \ldots + 4X_{20} + d_{11}^- - d_{11}^- = 5$$
$$1000X_1 + 50{,}000X_2 + 50{,}000X_3 + \ldots + 30{,}000X_{20} + d_{12}^- - d_{12}^- = 0$$
$$3X_1 + 3X_2 + 4X_3 + \ldots + 3X_{20} + d_{13}^- - d_{13}^- = 5$$

and $X_j = 0$ or 1: $d_1^-, d_1^- > 0$