ECONOMIC MODEL FOR HEIGHT DETERMINATION OF HIGH-RISE BUILDINGS

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ABSTRACT

At present, no clear concise method of optimal height determination for high-rise buildings is being practiced.

The primary scope of this dissertation is to see if a practical model, decision making process and list of external factors for examination can be generated for use by developers that will expose, organize, analyze and manage the factors determining optimal building height for high-rise buildings. Optimal building height is defined by the author as the height at which the private investor's return on investment is maximized, based on maximizing the use of capital resources for a given project.

The generated model will be capable of examining proposed and existing high-rise buildings to ascertain if their respected heights are in fact optimal building height from an economic point of view. External factors not included in the model will then be exposed and analyzed to see what impact they have on optimal building height criteria.

The model's practical applicability will be tested by examining two existing high-rise case studies located around the Boston area. Conclusions and the future research will be based on the model's applicability in real practice.

Thesis Supervisor: **Reinhard Goethert**
Title: **Research Associate**

To my late grandfather, Spiros Giannos, whose simple perspective on life and wisdom has affected deep within me a new and fresh dimension in viewing the world and the people within. I am to him forever grateful.

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INTRODUCTION

1.1 WHAT IS A HIGH-RISE BUILDING?

Defining how high a building must be before it can be considered or classified a "high-rise building" is generally a relative matter determined by the context and terms of perception.

Other definitions are not based on height, nor number of floors but are based on whether or not the design, operation, or urban impact are influenced by the quality of tallness; and yet another definition is based on the point at which elevators are introduced for vertical transportation.

The author's definition of a high-rise building is simply the height at which gearless elevators will be required to transport individuals from ground level to designated floor levels above. Generally this occurs at four to five stories and above.

1.2 WHY HIGH-RISE BUILDINGS?

If we were to have no further growth in population with no further urbanization (the shift from rural to urban living), and if there were no increase in industrialization, then conceivably the only new high-rise buildings we would need would be those required as replacements. Therefore, the fact is that high-rise buildings are primarily the consequence of industrialization and urbanization.

To answer the question: "why high rise buildings exist?" lies within four basic reasons:

1. **Tall commercial office buildings in large cities are needed for business in our industrial society.**
2. **The disappearing of agricultural land from encroaching suburbs.**
3. **Cost and energy savings involved in transportation and other urban services.**
4. **Geographical constraints around urban contexts.**

1. The development of high-rise buildings is not the intensive use of real estate alone, it is the expression of the social revolution of employment. To run our factories we need effectiveness of communication. In high-rises grouped in the city, a million white collar workers can be

grouped close to one another. They can exchange opinion, transact business, acquire information, obtain expert advise, receive legal opinion etc...This is what makes the skyscraper and creates the skyline: the need for agglomeration and commercial togetherness.

2. In the past no consistent planning was given as to where those millions of office workers would live. The natural tendency was to maintain as much of the rural atmosphere as possible. This lead to the development of suburbs. This has led in turn to the disappearance of agricultural land. The best land is usually closest to the city (one of the reasons for its location in the first place). But agricultural land was losing the battle with spreading suburbs. One of the alternatives to this spread was high-rise buildings. It represented an efficient use of urbanized land.

3. The spreading suburbs involved a successively growing net of transportation and other urban services. Eventually one reached a limit. Neither time, cost, or energy justify the spread. Similarly for other urban services such as water supply, sewage, fire, and police.

4. Another reason is geographical constraints around urban contexts. Examples influencing the existence of high-rise buildings is Manhattan Island in New York and the San Francisco Peninsula which create harbors. As centers of commerce their development had to be skyward because of the near-surrounding wall of water.

Therefore, we cannot avoid high buildings if we want to accommodate all the people who want to and should live and work in the city. They are here, and here to stay: a fact of life, produced by the way we chose our society to be structured.

Other factors that encouraged the existence of high rise building are listed in the Appendix, Section 1.

1.3 ARE THERE ALTERNATIVES?

The alternative skyward growth is more and more taking two forms. One attempts to change the building form while the other the urban form.

CHANGING THE BUILDING FORM:
Low rise, high-density development, particularly residential, has been a culturally acceptable way of urban life for centuries in may places. If carefully planned, as high rise buildings, they might provide a practical alternative to tall buildings.

CHANGING THE URBAN FORM:
Practical alternatives to dense urban forms with many high-rise buildings is the decentralization of commercial centers. Many urban development plans have been designed to limit downtown commercial development, and thereby limit the concentration of commercial high-rise buildings in one area, by establishing smaller "nodes" or points of concentration, throughout a larger, decentralizized urban region. The intent is to decentralize (and also more easily control) urban growth by spreading out commercial development at various point locations which will then become "magnets" for small-scale development. There may still be high rise buildings at these nodes, but they will be few in numbers and less densely built.

Other interesting alternatives might be underground-cities, underwater-cities or even space-cities. All have merit for discussion with some more practical than others. Economic, sociological and psychological factors play an important role in each of the alternative approaches. Careful analysis, understanding and conclusions would be appropriate before considering implementing such alternatives for future generations.

It's the author's belief, however, that at least for our generation, the trend to build higher and higher than ever before within our future cities is a real one. It's for this reason this research is dedicated to the issue of optimal height and the factors that influence it.

The future of our cities uniquely dependent upon the fashion in which we utilize vertical space. Far too often valuable urban land is either under or over utilized in terms of its vertical space. Under utilized urban land represents the under employment of available vertical space and therefore an insufficient utilization of urban land resources. On the other hand to over utilize urban land represents the over utilization of urban land resources better used elsewhere.

It's to the advantage of concerned developers to pursue for a method in which factors determining the height of high-rise buildings can be exposed, analyzed, organized, and managed in a way that would better utilize urban land resources, and thus maximize the owner's return on investment.

2.0 BASIC ECONOMIC PRINCIPLES BEHIND OPTIMAL BUILDING HEIGHT

The purpose of this chapter is to provide a foundation on the theoretical principles the proposed optimal building height model for high rise buildings is predicated on.

The research will begin by analyzing the basic economic principles of optimization behind the proposed model for developers. The basic economic principles analyzed are the following:

- **Total cost versus total revenue curves**
- **Total profit curve**
- **Marginal analysis and profit maximization**
- **Marginal revenue (cash flow) and marginal cost (investment)**
- **Fixed costs (investments) and marginal costs (investment)**

2.1 TOTAL COST-REVENUE AND TOTAL PROFIT CURVES

Theoretically a high rise building's optimal height level can be calculated in a variety of ways. These processes are predicated on the basic economic principle of the difference between what a developer earns in a form of revenue and what a developer puts out in the form of costs.

Total profits = Total Revenue - Total Costs

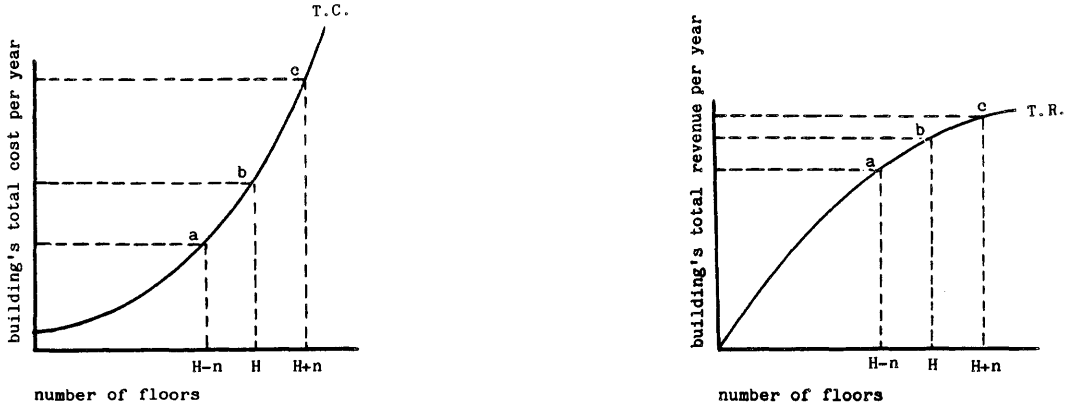
A developer is very concerned whether his returns on investment turns out to be a profit or a loss. We shall assume throughout this research that the developer seeks to maximize his total profits. We know that total profit depends on the cost and revenue combination the developer selects for the high rise building project.

The revenue and costs per floor that a high rise building receives can be illustrated in graphic form. As the number of floors increase so do costs and revenue. (see Fig. 2.1)

Notice that total costs at zero are not zero. The building incurs fixed costs per year even if its produces no revenue. An example of fixed costs are loan payments and real estate taxes. On the other hand, the amount of labor the building requires for maintenance and the amount of operating expenses it needs depends on how much space is rented. These are examples of variable costs, which naturally increase as height increases. Graphically we can now bring into a single diagram the total revenue curve and the total cost curve. Total profit which is the difference between total revenue and total cost, appears in the diagram as the vertical distance between T.R. and T.C. For example when the building is at H number of floors total cost would be so much and total revenue would be so much.

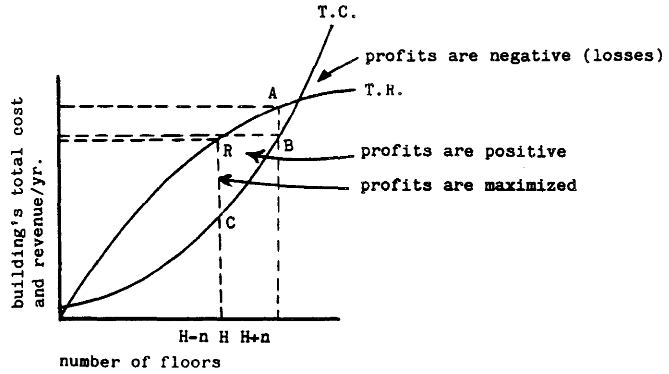
In this graphic view, the client wants to maximize total profit, which is the vertical distance between the T.R. curve and T.C. curve. The total profit curve is just below that. We see that it reachs its maximum value at M floor level.

The total profit curve is shaped like a hill. Though such a shape is not inevitable, we expect a hill shape to be typical for the following reason. If the client maintains a height for his building below or above the optimal level he will most certainly not be maximizing his profits. This is so because incurred costs verses revenue per increase or decrease of floors do not change proportionately. Consequently, the total profit curve will rise from zero (or negative) levels at a very small height, to positive levels in between; and finally, it will fall to negative levels when height gets too large. Thus, the total profit curve will normally be a hill.

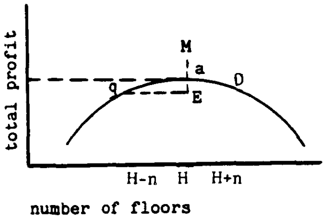


total cost curve

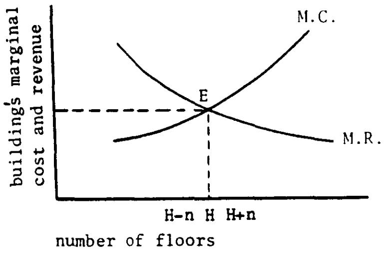
total revenue curve



total cost revenue curve



total profit curve



marginal cost and revenue curve

FIG. 2.1 Total Cost-Revenue and Profit Curves Total Marginal Cost and Marginal Revenue Curve

2.2 MARGINAL ANALYSIS AND PROFIT MAXIMIZATION

If the developer really knew the exact shape of the profit curve, choosing the optimal level of height would be a simple task. He would only have to locate a point at the top of the profit curve. However, developers rarely if ever have so much information, so a different technique for finding the optimum is required. That technique is marginal analysis.

To see how marginal anlysis helps solve the developers problem, we introduce a new concept called marginal profit. Marginal profit is the addition to total profit that results when the developer adds one floor to the total building height.

Total profits - Total profits = Marginal profit
(from H floors) (from H-1 floors)

The marginal rule for finding the optimal level of height is easy to understand: If the marginal profit from increasing height by one floor is positive, then the floor levels should be increased. If the marginal profit from increasing the height by one floor is negative, then the floor levels should be decreased.

The profit hill gives us a graphical interpretation of the "marginal profit equals zero" condition. Marginal profit is defined as the additional profit that accrues to the client when height rises by one floor.

Marginal profit is the slope of the total profit curve.

With this geometric interpretation in hand, we can easily understand the logic of the marginal profit rule. At a point such as Q, in Fig. 2.1, where the total profit curve is rising, marginal profit (=slope) is positive. Profits cannot be maximal at such a point, because we can still increase profits by moving farther to the right. A developer that decided to stick to a point Q would be wasting the opportunity to inrease profits by increasing height; similarly, the developer cannot be maximizing profits at a point like D, where the slope of the curve is negative, because there marginal profit (=slope) is negative. If optimal building height analysis results at point D. the developer can raise its profits by decreasing the height. Only at point M. where the total profit curve is neither rising nor falling. can the client possibly be at the top of the profit hill rather than in one of the sides of the hill. And point M is precisely where the slope of the curve--and hence the marginal profit is zero. A height decision cannot be optimal unless the corresponding marginal profit is zero, (the scope of the total profit hill).

One common misunderstanding that arises from marginal analysis for optimality is the idea that it seems foolish to go to a point where marginal profit is zero. Isn't it better to earn a positive marginal profit. Of course, it is better to have a positive total profit than zero total profit by a zero value on the marginal profit curve merely indicates that all is apparently well, that total profits may be at its maximum.

2.3 MARGINAL REVENUE (CASH FLOW) AND MARGINAL COSTS (INVESTMENT)

If the developer does not know what its total profit curve looks like, how can he determine whether marginal profit is positive, negative, or zero? To answer this, refer back to the profit hill which was constructed from the total revenue (T.R.) and the total cost (T.C.) curves. Observe that there is another way of finding the profit-maximizing solution. We want to maximize the vertical distance between T.R. and T.C. curves. This distance, we see is not maximal at a height of Q, because there the two curves are growing farther apart. If we move farther to the right, the vertical distance between them (which is the total profit) will increase. Conversely, we have not maximized the vertical distance between T.R. and T.C. at a height level such as D, because there the two curves are coming closer together. We can add to profits by moving farther to the left (reducing height).

The conclusion from the graph, then, is that total profit (the vertical distance between T.C. and T.R.) is maximized only when the two curves are neither growing farther apart nor coming closer together; that is, when their slopes are equal.

The slopes of the two curves marignal revenue and marginal cost permit us to say that profit can be maximized only at an output level at which marginal revenues is approximately equal to marginal cost.

M.R. = M.C.

Marginal revenue is the addition to total revenue resulting from the addition of one floor to total height. Geometrically, marginal revenue is the slope of the total revenue curve.

Marginal cost is the addition to total cost resulting from the addition of one floor to total height. Geometrically, marginal cost is the slope of the total cost curve.

Total profits = total revenue - total costs
Marginal profit = marginal revenue - marginal cost
When marginal profit = 0 we have M.R. = M.C.

Sometimes marginal revenue and marginal cost curves do not have the smooth shapes as shown in Fig. 2.1, and they may intersect more than once. In such cases, while it remains true that M.C. = M.R. at the height level that maximizes profits, there may be other height levels at which M.C. is also equal to M.R. but at which profits are not maximized.

2.4 FIXED COSTS (INVESTMENTS) AND MARGINAL COSTS (INVESTMENTS)

The pivotal role of marignal costs in the determination of the optimal level of floor height explains why the distinction between fixed costs and variable costs is so important. The reason is that marginal fixed cost is always zero. This fact follows directly from the definition of marginal fixed cost as the additional fixed costs attributable to increasing height by one floor. Since fixed costs do not change when height is increased. (or decreased), marginal fixed cost must be zero. This is important because it tells us that changes in a buildings fixed costs do not affect marginal fixed cost (which is always zero), and hense do not affect the marginal cost (M.C.) curve.

Since changes in fixed costs do not affect the marginal cost curve. they cannot affect the developer's choice of a profit-maximizing height level.

This can be very confusing because one may ask, does the developer really not care about substantial changes in fixed costs? The answer is that the developer does care very much. It is not indifferent to changes in fixed costs, and will do everything in its power to keep them as low as possible (to "cut down on the overhead"). A rise in fixed costs can cause developers to lose money and may cost the building managers their jobs. The point, however is. that:

> Changes in fixed costs will change the amount of profit that the developer earns, and might even turn profits to losses. But they do not give the developer any reason to change its price-floor height decision.

Fixed costs, it would appear, are totally irrelevant to optimal decision making. This conclusion, however is subject to one important qualification. If fixed costs become too high, the developer will be better off in the long run if he closes the building's doors and saves the fixed costs.

3.0 SELECTED ECONOMIC MODELS

3.1 MAXIMUM RATE OF RETURN MODEL
(KINGSTON AND CLARK)

Very little literature on the issue of optimal building height is currently available. The most ambitious analysis of the problem was undertaken in 1930 by J. L. Kingston and W. C. Clark, in which they adopted maximum return on investment as the appropriate criterion for the optimum height of high rise office buildings.

The model they adopted was:

$$\mathbf{rh = Ih/Vh > ri \quad (rh \neq i)}$$

where
r = return on investment
I = total revenue
V = total investment
h = building height in stories

rh $>$ ri indicated that the return on a building of h stories is greater than the return on a building of any alternative height, i.

Rate of return is therefore maximized at the height where marginal rate of return (mrr) just equals average return (ar), and pure profits of a.b.c.d. are achieved. Opportunity cost is assumed to be k.

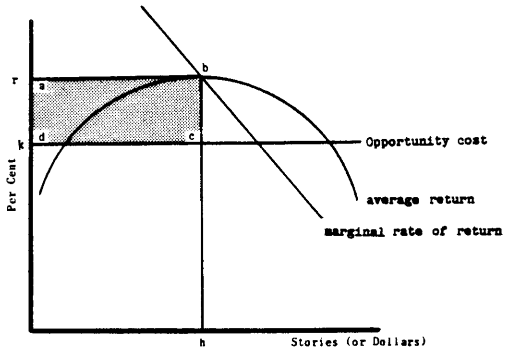


Fig. 3.1 Determination of Optimum Building Height, Maximum Rate of Return Criterion.

3.2 MINIMUM RATE OF RETURN MODEL
(KEAST AND RANDALL)

In the same year in which Kingston and Clark published their findings, there appeared a second study which dealt with the determination of building height. This second study, authored by W. R. Keast and A. B. Randall, advanced a concept of minimum rate of return as the criterion for building height determination. The "minimum" building height was defined as that height at which a given rate of return (opportunity cost) is generated. In this respect Keast and Randall recognized the existence of opporutnity cost, which Kingston and Clark did not. Keast and Randall, however, failed to define opportunity costs as such.

The model they adopted was:

$$rh = Ih/Vh - k$$

where r = **rate of return on investment**

I = **total net revenue**

V = **total investment**

h = **building height in stories**

k = **some predetermined minimum rate of return or opportunity cost**

The minimum rate of return criterion indicates a building of h' stories, generating a return equal to opportunity cost, k. A return of k is achieved at the height at which opportunity cost is just equal to average return (ar), and no pure profits are achieved.

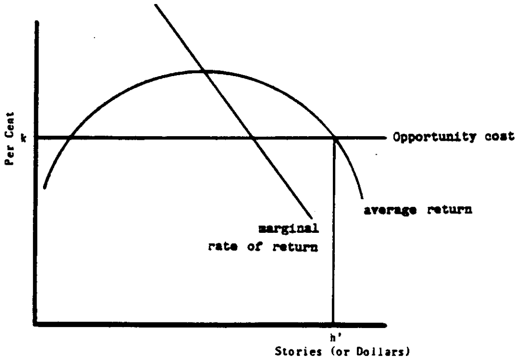


Fig. 3.2 Determination of Optimum Building Height. Minimum Rate of Return Criterion.

3.3 CRITERIA AND MODEL EMPLOYED IN PRACTICE (BERGER)

Jay S. Berger, the author of a doctoral dissertation at the Graduate School of Business Administration, University of California, Los Angeles, in 1967, concluded through interviews conducted in Los Angeles, that a modified version of this criterion is generally employed in practice.

> "It was found that building height, per se, is not a prime consideration in most cases involving the conception of high rise office and apartment buildings. Instead, building height is generally determined as a secondary decision, arrived at after determination of the amount of gross building space to be provided."

The amount of gross building space to be provided is generally determined by floor area ratio (F.A.R.) zoning regulations or by the strength of the market for the area.

> "The specific height of a majority of high rise projects is not considered a factor influencing the profitability of high rise developemnt until later stages of the decision-making process. Only after building density, floor dimensions, and the proportion of the building site to be covered are determined, is consideration given to the impact of height on cost and revenues. At that time, there may be some modification of floor dimensions and site coverage, and in a very few cases, some revisions of the original determination of building density."

With these findings Berger concluded that in virtually all cases, the criterion for feasibility of the project is whether or not investor expectations in regard to some predetermined rate of return will be achieved. The height determination model utilized in practice, then is closer to the minimum rate of return criterion than the concept of maximum rate of return, and can be expressed as:

$$rh = Ih/Vh = k$$

where r = return on investment

I = total net cash flow

V = total investment

h = building height in stories

k = some predetermined rate of return, or opportunity cost

In terms of Figure 3.2, a high rise building project (and therefore a building of a given height) is deemed acceptable in practice so long as average return (ar) is equal to or exceeds opportunity cost k. Within this range any specific building height would be arrived at by chance.

3.4 MARGINAL ANALYSIS MODEL
(BERGER)

The model suggested by Berger was:

$$k = Ih-Ih-1/Vh-Vh-1$$

where **k = opportunity cost**
I = total net cash flow
V = total investment
h = building height in stories

From Figure 3.4, optimum building height would be achieved with a building of h" stories, resulting in profits of eghd. Since the minimum rate of return model equates total rate of return with opportunity cost, no profits, in the economic sense are earned on a building of h' stories. Pure profits of abcd are earned on a building of h' stories, when maximum rate of return is used as the criterion for optimum height determination, but eghd > abcd. Maximum rate of return as a criterion would tend to result in underdevelopment, which the minimum rate of return criterion would tend to result in overdevelopment. The deficient of the latter criterion is easily appreciated. The deficiency of the former is essentially that, whether investment is variable, maximum rate of return is an inappropriate profit-maximizing criterion. More propertly, maximum rate of return on invested capital is the appropriate profit maximization criterion and is achieved through marignal analysis.

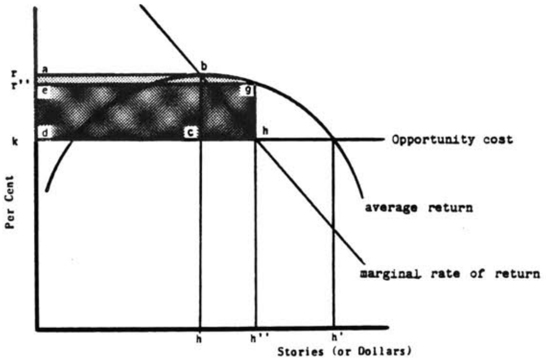


Fig. 3.4 Determination of Building Height. Maximum Rate of Return Criterion. Mimumum Rate of Return Criterion. and Marginal Analysis.

3.5 CONCLUSIONS

These economic models, and rightfully so, solve height determination based on the amount of return on investment to the private investor.

Berger's arguments leading to the marginal analysis model are real and should be noted as such. With this in mind the goal is to take these height determination models, along with their economic principles, and provide a similar model that can be utilized in the development profession for a clear and conscise method in determining optimal building height for high-rise developments.

The following chapters exposes, organizes, analyzes, and manages the factors determining optimal building height.

4.0 PROPOSED OPTIMAL BUILDING HEIGHT MODEL

4.1 SUMMARY OF DEVELOPER'S MODEL

The proposed model not only acknowledges the current practice for height determination but also incorporates familiar tools developers employ in determining the financial feasibility of new and existing developments.

The current methods in use to determine building heights indicates that developers do not employ economic height models in and around the Boston area. Building heights are established by the marketability of the gross square feet, the floor plate of the new development and whatever is deemed allowable in terms of building height.

Failure to consider height determination as part of the determination of building densities is a contradiction. Developers interviewed acknowledged the impact of height on such factors as direct and indirect total development costs, building efficiency and rental rates--all vital factors in determining project profitability--but rarely incorporate such considerations in their determination of building densities.

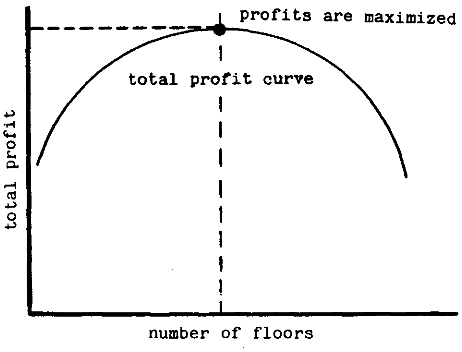
In addition, the model's applicability can disprove a general myth that the higher the building the greater proportions of revenue it will generate.

The different processes and motives used to analyze proposed versus existing projects through range-interpolation and range-marginal analysis methods will be explained in detail later in this chapter.

The new height determination model suggested is also based on the 1930 Kingston and Clark original adoption that optimal building height criteria is achieved when the private investor's return on investment is maximized.

$$\mathbf{rh = Ih/Vh > ri. \quad (rh \not> i)}$$

where **r = return on investment**
I = total net revenue
v = total investment
h = building height in stories



$rh > ri$ indicated that the return on a building of h stories is greater than the return on a building of any alternative height. i.

The model fullfills a very practical need in which developers can utilize for more accurate decision-making committments for high-rise developments.

Developers, like other professions, have motives that are varied and complex. Given the choice, some developers might prefer to control the tallest building rather than the most profitable one. Some may be influenced by envy, others by the desire to "do good." Thus, any attempt to summerize the objectives of developers in terms of a single factor (profit) is bound to be an oversimplification.

In addition the detailed requirements for maximizing profits are more easily stated than adhered to. In deciding on how much to invest, on what price to set rents, or on how much to allocate for the operating expenses, the range of available alternatives is enormous. Couple this with the issue of optimal height and it becomes very complex. Information for each alternative is often expensive and difficult to acquire. As a result, when a developer's committment decides on a $20 million high rise construction budget it rarely compares the consequences of that decision in any detail with the consequences of the possible alternative such as a reduction or increase in floor levels which, in turn might increase or reduce the developers return on investment. Rather, developers normally study with care only the likely effects of the proposed decision itself: what sort of building will he obtain for that money? How costly will it be to operate the building? How much revenues is it likely to obtain from the sale or rent of the building's set height?

The developer's concern is with whether the decision will produce results that satisfy his standards of acceptability--whether its risks will not be unacceptably low, and so on. Such analysis does not necessarily lead to the maximum possible profit, because, though the decision may be good, some of the alternatives that have not been investigated may be better. Decision making that seeks acceptable solutions has been called satisficing to contrast with optimizing. Decision making in industry and government is often of the satisficing variety. This is also true with the art of development.

The following pages in this chapter provide the developer with a new economic model for height determination.

It starts by exposing the familiar feasibility analysis tools, currently used in the development process. They are organized and managed in a format that would eventually seek optimal height determination. These tools are:

total development cost	**(capital budget)**
direct and indirect costs	
operating pro forma	**(static)**
return measures	**(static)**
operating pro forma	**(dynanmic)**
return measures	**(dynamic)**

They are organized and managed in chart form to examine cost-revenue and return measures for high-rise developments.

This is immediately followed by an analysis of the tools identified above. (4.2)

Next, basic decision making principles used in the model through two methods of optimal height determination, (extreme-range interpolation method and range-marginal analysis method), provide the private investor with sound height decisions. (4.3)

Finally, all of the above are synthesized to produce hypothetical applications for existing and proposed high-rise developments. (4.4)

4.2 TOOLS USED IN DEVELOPMENT OF MODEL
OPTIMAL BUILDING HEIGHT MODEL
TOTAL DEVELOPMENT COST (CAPITAL BUDGET)

DIRECT COSTS	H-n	H Given	H+n
LAND ACQUISITION			
DEMOLITION AND SITE WORK			
CONSTRUCTION			
Residential			
Commercial			
Retail			
Parking			
Other			
ALLOWANCES (TENANT FIT OUT)			
Residential			
Commercial			
Retail			
Other			
SITE IMPROVEMENT			
PUBLIC IMPROVEMENTS			
OTHER			
SUBTOTAL			
CONTINGENCY (6%)			
TOTAL DIRECT COSTS			

INDIRECT COSTS	H-n	H Given	H+n
CONSTRUCTION FEES			
Developer's Fees (@2%+)			
Architectural & Engineering Fees (@4%) (Design & Inspection)			
Project Administration (@2%)			
Legal (@1%)			
Accounting (@1%)			
Other			
TENANT CONCESSIONS			
CARRYING CHARGES AND FINANCING			
Insurance & Construction Bonds (@1%)			
Commitment Fees			
- Construction Loan (@1%)			
- Permanent Financing (Points)(@ 2% TDC)			
Loan Carry			
- Land			
- Interest during construction (Amount, months, average balance (%), rate)			
Leasing & Marketing			
Other			
RENT-UP DEFICIT			
OTHER			
SUB-TOTAL			
CONTINGENCY (6%)			
TOTAL INDIRECT COSTS			

	H-n	H Given	H+n
TOTAL DIRECT COSTS **+** **TOTAL INDIRECT COSTS**			
TOTAL DEVELOPMENT COSTS			
or (total replacement costs)			
CONSTRUCTION PERIOD			
TYPE OF FINANCIAL ARRANGEMENTS			
(amount, term, interest)			
1. Predevelopment financing			
2. Short term construction loans			
3. Long term mortgages			
4. Equity funds			
LESS EQUITY			
TOTAL PERMANENT LOAN AMOUNT			
(amount, term, interest)			
DEBT SERVICE/YR.			
Interest			
Principle			
Balance			
Payment			

OPTIMAL BUILDING HEIGHT MODEL
OPERATING PRO FORMA
(STATIC)

(Stabilized Pro Forma, Set-Up, Operating Statement)

	H-n	FIRST YEAR OPERATION (STATIC) H Given	H+n
GROSS INCOME			
Residential			
Commercial			
Retail			
Parking			
Other			
Less Vacancy Allowance (@ 5%)			
EFFECTIVE GROSS INCOME			
Operating Expenses			
Management			
Maintenance, Payroll, Security			
Utilities (water, sewer, garbage)			
Insurance			
Miscellaneous			
Real Estate Taxes			
Other			
NET OPERATING INCOME			
(Net income before debt service, free and clear) Net Income Before Financing			
Less DEBT SERVICE (interest and amortization, constant, level payment) (amount, rate, term)			
BEFORE TAX CASH FLOW			
Net Income After Financing			
TAX EFFECT			
+ amortization			
- depreciation			
Taxable Income			
Less Tax Payment (assume 50% bracket)			
AFTER TAX CASH FLOW			
Net Income After Taxes			

OPTIMAL BUILDING HEIGHT MODEL
RETURN MEASURES
(STATIC)

		FIRST YEAR OPERATION (STATIC)	
1. **CAPITALIZATION OF INCOME**	H-n	H Given	H+n

$$\frac{\text{Cash Flow}}{\text{Capitalization Rate}} = \text{VALUE}$$

2. **RATES OF RETURN**

a) Return in Total Assets (ROTA)

$$\frac{\text{Net Operating Income}}{\text{Total Development Cost}} = \text{ROTA}$$

b) Return on Equity (ROE)
also "cash on cash"

$$\frac{\text{Before Tax Cash Flow}}{\text{Equity Invested}} = \text{ROE}$$

c) $\frac{\text{After Tax Cash Flow}}{\text{Equity Invested}} = \text{ROE}$

OPTIMAL BUILDING HEIGHT MODEL
RETURN MEASURES (continued)
(STATIC)

	H-n	FIRST YEAR OPERATION (STATIC) H Given	H+n
3. **DEBT-SERVICE COVERAGE**			
$\frac{\text{Net Operating Income}}{\text{Total Mortgage Payment}} = \textbf{D.S.C.}$			
4. **OPERATING EXPENSE RATIO**			
$\frac{\text{Operating Expense}}{\text{Effective Gross Income}} = \textbf{O.E.R.}$			
5. **VACANCY AND COLLECTION LOSS RATIO**			
6. **BREAK-EVEN RATIO**			
$\frac{\text{Operating Expenses \& Debt Service}}{\text{Gross Potential Income}} = \textbf{B.E.R.}$			

OPTIMAL BUILDING HEIGHT MODEL
RETURN MEASURES (continued)
(STATIC)

H-n H Given H+n

DISCOUNTING CASH FLOWS

a) Present Value (one payment)

$$P = F \left[\frac{1}{(1+i)^n} \right]$$

$$An^{stream} = \sum_{n=1}^{N} \left[\frac{1}{(1+i)^n} \right] \times Fn$$

b) Net Present Value

NPV = P - equity invested

c) Internal Rate of Return

set NPV = 0 and solve for i

An^{stream} = Present value of an annuity of n payments
P = Annual Interest
F = Future Value
n = Time; (Years)

OPTIMAL BUILDING HEIGHT MODEL
OPERATING PRO FORMA
(DYNAMIC)

(Stabilized Pro Forma, Set-Up, Operating Statement)

(DYNAMIC)

	1st Yr	2	3	4	5	6	7	8	9	10
GROSS INCOME										
Residential										
Commercial										
Retail										
Parking										
Other										
Less Vacancy Allowance (@ 5%)										
EFFECTIVE GROSS INCOME										
Operating Expenses										
Management										
Maintenance, Payroll, Security										
Utilities (water, sewer, garbage)										
Insurance										
Miscellaneous										
Real Estate Taxes										
Other										
NET OPERATING INCOME										
(Net income before debt service, free and clear) Net Income Before Financing										
Less DEBT SERVICE (interest and amortization, constant, level payment) (amount, rate, term)										
BEFPRE TAX CASH FLOW										
Net Income After Fianancing										
TAX EFFECT										
+ amortization										
- depreciation										
Taxable Income										
Less Tax Payment (assume 50% bracket)										
AFTER TAX CASH FLOW										
Net Income After Taxes										

OPTIMAL BUILDING HEIGHT MODEL
RETURN MEASURES
(DYNAMIC)

1st Yr. 2 3 4 5 6 7 8 9 10

1. **CAPITALIZATION OF INCOME**

$$\frac{\text{Cash Flow}}{\text{Capitalization Rate}} = \text{VALUE}$$

2. **RATES OF RETURN**

a) Return in Total Assets (ROTA)

$$\frac{\text{Net Operating Income}}{\text{Total Development Cost}} = \text{ROTA}$$

b) Return on Equity (ROE)
also "cash on cash"

$$\frac{\text{Before Tax Cash Flow}}{\text{Equity Invested}} = \text{ROE}$$

c) $$\frac{\text{After Tax Cash Flow}}{\text{Equity Invested}} = \text{ROE}$$

OPTIMAL BUILDING HEIGHT MODEL
RETURN MEASURES (continued)
(DYNAMIC)

1st Yr. 2 3 4 5 6 7 8 9 10

3. **DEBT-SERVICE COVERAGE**

$$\frac{\text{Net Operating Income}}{\text{Total Mortgage Payment}} = \textbf{D.S.C.}$$

4. **OPERATING EXPENSE RATIO**

$$\frac{\text{Operating Expenses}}{\text{Effective Gross Income}} = \textbf{O.E.R.}$$

5. **VACANCY AND COLLECTION LOSS RATIO**

6. **BREAK-EVEN RATIO**

$$\frac{\text{Operating Expenses \& Debt Service}}{\text{Gross Potential Income}} = \textbf{B.E.R.}$$

OPTIMAL BUILDING HEIGHT MODEL
RETURN MEASURES (continued)
(DYNAMIC)

1st Yr.	2	3	4	5	6	7	8	9	10

DISCOUNTING CASH FLOWS

a) Present Value (one payment)

$$P = F\left[\frac{1}{(1+i)^{n}}\right]$$

$$An^{stream} = \sum_{n=1}^{N}\left[\frac{1}{(1+i)^{n}}\right] \times Fn$$

b) Net Present Value

NPV = P - equity invested

c) Internal Rate of Return

set NPV = 0 and solve for i

An^{stream} = Present value of an annuity of n payments
P = Annual Interest
F = Future Value
n = Time; (Years)

4.2 TOOLS USED IN DEVELOPMENT OF MODEL

4.2.1 TOTAL DEVELOPMENT COSTS (CAPITAL COST BUDGET)

Total project costs include direct costs (for land and construction) and indirect costs (for professional services, tenant allowances, direct administration of marketing, miscellaneous administration, land, and interest and financing charges).

Construction costs include both site improvements and direct building costs. Site improvements include grading and excavation, paving, storm drainage, sanitary sewar, water service, lighting, signs, and land-scaping. Direct building costs cover foundations, floors on grade, the superstructure (above-grade structures), roofing, exterior walls, partitions, wall finishes, floor finishes, ceiling finishes, communications systems, fixed equipemnt. HVAC (heating, ventilation, and air conditioning), sprinklers, plumbing, electrical works, and special project features (fountains, sculptures, etc.). The contractor's fee is often included in direct costs, but it and/or the construction management fee can be included in indirect costs.

Indirect costs must be added to land, site improvements, and direct construction costs to arrive at the total project costs They are a significant portion of overall project costs.

Professional services include fees for architects, engineers, consultants who prepare drawings for tenant improvements, landscape architectes, and interior designers. A small contingency is often provided for professional services.

The developer's overhead attributable to the project amounts to be expended for accountants, the project director, the construction manager, leasing brokers and agents, legal services, advertising, and promotion, other leasing fees, lease-up expenses, taxes, and insurance--is included in indirect costs.

Contingency reserves are critically important; they cover changes and costs not specifically anticipated but normally occuring during the development process. A contingency amount is generally established for indirect costs, which is in addition to a contingency included in the contractor's direct cost and an overall contingency fund.

Interest and financing expenses associated with construction loans and other interim financing are additional indirect costs. They include charges for interest during construction, appraisals, legal fees, construction loan fees (or points), permanent loan fees, mortgage banker fees, inspection fees, settlement costs, escrow fees, and a contingency for other interest and financing charges (including, if appropriate, an interest reserve to carry to the project until it is leased to the point where the project will carry itself).

4.2.2 FINANCIAL ARRANGEMENTS

A development project requires financing for many direct and indirect costs. To meet costs the private developer must obtain at least four types of financing: (1) funds for predevelopment activities, (2) short-term loans to finance construction before the permanent or long-term mortgage becomes effective, (3) long-term mortgage loans to provide the basic funds, and (4) equity financing for the share of the cost and initial funding not covered by the morgage. Commitments for all four are necessary before construction can begin.

The developer involved in a complex public/private project needs much more front-end money. His staff must spend much more time identifying the most viable concept and negotiating specific agreements for the project. A project involving both the public and private sectors demands careful assessment of its characteristics and thus more plans, design, and feasibility studies than privately sponsored projects.

Larger projects are increasingly using partial or total public funding for predevelopment and some portions of development. To ensure both the city and the developer of professional studies useful in defining a feasibile joint project, it has become the practice for the public partner to fund these preliminary studies. The results of the studies become public property, and the information in them facilitates subsequent negotiations between the parties.

Short-term construction loans provide working capital during project development. They are usually advanced in installments based on the lender's evaluation of progress or on completion of predetermined stages of the project. Because interest rates on construction loans are higher than for long-term mortgage loans, developers often stage construction in short phases so that components of the project can be converted to long-term financing as soon as possible. It also minimizes interest payments during construciton. The term of the construction loan is established to allow completion of the project before the loan is repaid, to provide time for the developer to convert the construction loan into a permanent loan, or to refinance the mortgage if necessary.

First mortgages provide the primary financing for almost all projects. Typically, the first mortgages provide up to 75 percent of the appraised value of the project, to be repaid with interest in installments over period of 25 to 35 years or more. The property and improvements are pledged as collateral or security for the mortgage loan. Specific terms of mortgages vary according to current economic conditions, requirements of state laws, practices of individual lenders, and the type of project being financed. Because a mortgage is based on the appraised value of the project, the amount of the mortgage loan is not related to the direct costs of construction. Instead, it is based on the income stream generated by the project and its appraised value. In some cases, the 75 percent mortgage also covers part of the indirect costs as well.

Long-term equity financing provides the difference between the cost of the project and the mortgage loan. Methods of acquiring equity funds depend almost entirely on the developer, who will shape the venture to fit his particular financial objectives. The developer may rely on his own financial resources, or he may form a partnership or joint venture with one or more associates or corporations interested in investing or speculating in real estate. A general partnership may be expanded to include limited partners who do not share in the liability or in the management of the partnership but who wish to invest in real estate. Syndicates of investors who employ an agent to obtain investment opportunities may be involved in equity financing. Institutional lenders, real estate corporations, and real estate investment trusts (REITs) offer other sources of equity financing. Another mechanism is sale and leaseback; the developer sells the entire project to an investment group or institutional lender with provisions for a long-term leaseback (usually 20 to 30 years) with possible extensions. Land can also be sold and leased back through a long-term ground lease (51 to 99 years) to reduce the total equity requried.

The method used to obtain equity financing will be determined by the strength of major tenants, the financial objectives of the developer, and the nature of the particular project. Often development entities have different equity partnerships or corporate joint ventures for specific components of a particular project, as well as for the overall project. The specific financial relationships usually evolve over time as relationships with major lenders and major tenants are defined. For larger projects, the corporate form of participation may be favored for its protection from personal liability, although partnerships are more advantageous for tax purposes. Corporations can act as general partners in a partnership, and the developer may chose this form for protection.

4.2.3 FINANCIAL PRO FORMA ANALYSIS

The financial pro forma analysis constitutes an important tool for evaluating the financial merits of a project. It combines estimates of all capital and operating costs and revenues to paint a financial picture of the entire project in operation. Its object is to indicate the profitability of a successful project by indicating expected income, operating expenses, and net operating income.

The pro forma analysis is best accomplished after cost estimates have been prepared and after basic assignments of responsibilities for construction and operation have been agreed upon. Most developers, however, insist on various degress of pro forma analysis much earlier to evaluate alternatives, using broad assumptions if necessary.

Included in the analysis are estimates of cost, revenues, and financing terms. Operating costs are based on the type of management and maintenacne required for each component of the project. Specialists estimate the costs using national and local costs, recognizing that complex development projects often entail operating costs that are not found in typical buildings. Similarly, revenues for each component are based on national and local trends. The financing terms and conditions that will be requried by the long-term mortgagee and any points or fees requried by lenders according to conditions of the money market must be anticipated.

The estimator's judgements about these costs and revenues are the basic assumptions for the analysis. These asumptions must be recorded as part of the anlaysis because they are often critical to a project's feasibility.

4.2.4 RETURN ON INVESTMENT MEASURES

The financial feasibility of proposed and existing developments are measured, to a limited extent, by several ratios. These ratios show the relationship among the various parts of the cash flow statement. From the investor's standpoint, analyzing the cashflow statement is useful both as a way to anticipate future conditions and as a starting point for planning action that will influence the future cash flow.

The following section in this chapter analyzes these return measures, explains their limitations and indicates which ratios investors are using for decision making criteria.

1. **Capitalization of Income**

Capitalization of income is a method of estimating a property's value by considering annual cash flow as a percentage of a reasonable rate of return on an investment. The formula is:

$$\frac{\textbf{Cash flow}}{\textbf{Capitalization rate}} = \textbf{Value}$$

The annual cash flow from an investment is determined by deducting all operating and fixed expenses from the gross income. If expenses exceed income, a negative cash flow is the result.

The capitalization rate is the rate of interest that is considered a reasonable return on the investment. This process converts net operation income into an estimate of market value:

$$\frac{\textbf{N.O.I.}}{\textbf{Sales Price}} = \textbf{Capitalization rate}$$

The reasonable return on the investment reflects the following three factors.

1. The typical owner's expectations about the financial benefits from this type of property.
2. The nature and level of income that can be expected from other investment opportunities available to the typical investor, such as other real estate investments and nonreal estate investments (e.g., common stocks, preferred stocks, and corporate bonds).

3. The financial considerations involved in the purchase of the income-earning property.

2. Rates of Return

Rates of return are the relationships between the annual net income generated by the project and the invested capital. There are 3 methods in determining rates of return.

A. Return on Total Assets, (R.O.T.A.)

Return on total assets is a ratio widely used by developers to indicate how much income before debt service is being earned on total invested capital. It is also a measure of current profitability to the investor. The importance of this ratio lies in the fact that lenders desire some indication of a property's total return. Unless an owner is earning a reasonable profit property management and maintenance may suffer.

From the perspective of investors and lenders, this ratio is viewed as an indication of profitability and should be judged relative to the return on total investment on comparable properties, however, this yield will fluctuate over time on all properties depending on the changes in inflation, interest rates, the supply and demand for housing, and many other factors affecting the national as well as local economy.

B. Return on Equity, (R.O.E.)

Return on equity measures the current cash dividend earned by investors on the equity invested in a project. While lenders are generally more concerned with the ability of a property to generate sufficient revenue to cover debt service, it is also recognized that if investors do not receive some reasonable return on equity there is potential for deferral of maintenance and repair on the improvement that could jeopardise the security for a loan. Therefore, the extent of a current yield to investors can be used as an indication of the incentive for investors to maintain the property.

As was the case with the R.O.T.A., the R.O.E. will vary with economic conditions. There is no fixed standard against which this relationship may be compared. It should be comparable to currrent yields being realized by investors who own similar properties. It could also correspond to dividend yeilds earned on some common stocks, depending on the type of property being analyzed. R.O.E. can be measured before or after tax cash flow.

3. Debt Service Coverage Ratio (D.S.C.)

The debt service coverage ratio is the level of net operating income divided by the annual mortgage payment. This financial ratio indicates whether the property is able to generate a level of net operating income large enough to cover the full mortgage payment. If the numerical value of this ratio is less than one, the mortgage payment is greater than the amount of effective gross income remaining after operating expenses have been paid. If the ratio exceeds one, the property is capable of meeting all of its operating expenses and the mortgage payment and still provide the investor with a positive level of before-tax cash flow. Conceptually, the minimum acceptable debt service coverage ratio for the investor should be equal to one, plus enough cash to provide for that investor's expected rate of return before taxes. However, a common rule of thumb is that a debt service coverage ratio of one and a quarter or more on residential income property is acceptable but, as financial and market factors change, venders may require a higher debt service coverage ratio. Finally, the magnitude of the ratio changes with different classes of investments.

4. Operating Expenses Ratio (O.E.R.)

The operating expense ratio is the level of operating expenses divided by gross income, either potential gross income or effective gross income. The numerical value of the operating expense ratio generated by potential gross income. This difference is obvious because vacancy and collection losses are usually positive, making effective gross income a smaller number than potential gross income when these losses are subtracted out. In appraisal analysis, the operating expense ratio is important as a check on the efficiency of operation of the subject property. The underlying assumption is that the subject property should have an operating expense ratio similar to that of the comparable properties in the local market.

For the typical investor, the operating expense ratio indicates the property's capability of generating income large enough to cover the full operating expenses. Ideally, the investor should seek a property with the smallest possible operating expense ratio. At the extreme, the investor would want the operating expenses to be as close to zero as possible without jeopardizing the physical maintenance of the building and the desirability of the units within that building. Generally, the operating ratio is considered to be acceptable within a certain range. The typical operating expense ratio for residential income-producing properties should be within a range of 35 to 40 percent of gross potential income. However, the acceptable operating expense ratio depends on the type of property. For certain types of investment, the ratio can be as large as 50 percent. An operating expense ratio that exceeds this percentage should warn the typical investor that the property may not be capable of generating enough effective gross income to provide a net operating income large enough to meet the mortgage payment, or that the property is being managed inefficiently.

On the other hand, the operating expense ratio could be very low. Even though this would appear to be favorable, the investor should seek information about the reasons for the low rate. The seller could be operating a sound, high-quality building that requires few repairs and is energy efficient. But, the low operating expense ratio could occur if the seller is deferring maintenance, cutting back on utilities, and reducing reserves for replacing short-lived items. In this latter situation, the investor would be buying high future operating expenses. As a safety measure, the investor should obtain information about the operating expense ratio for comparable properties to use as a check on the subject property.

5. Vacancy and Collection Loss Ratio

This ratio bears a close relationship with vacancy rates reported by managers of other similar complexes in locations similar to the subject property.

To estimate vacancy and collection loss, the appraiser considers the following items of information:

1. The vacant rate by type of residential unit or type of commercial space.
2. Rent payment problems such as nonpayment or partial payment of rent.
3. Special concessions made to the tenant that have a monetary value.
4. Losses due vandalism or theft.

This ratio is highly sensitive to local econonic conditions and signals when housing or other investment property has reached a saturation point, or a point of oversupply that may be critical to the market absorption of any new units. Lenders are aware of vacancy rates in their lending areas and constantly monitor and update this information.

Although no hard-and-fast industry ratio exist for vacancy rates, it is generally believed that when residential income properties consistently run vacancies in excess of 5 to 7 percent of potential revenue, they may be risky ventures and have difficulty in meeting debt service. Similarly, any attempt on an investor's part to use a ratio below 5 percent will also be questioned closely by a lender.

6. Break-Even Ratio (B.E.R.)

The numerator of this financial ratio is the sum of operating expenses and the mortgage payment. In other words, the numerator of the ratio identifies all expense items plus the mortage payment that must be made from the income generated by the property. The denominator of the ratio is either potential or effective gross income. If the value of this ratio is greater than one, the investor knows that the property is not generating a level of gross income adequate to pay the expenses incurred in the operation and the purchase of the property. If the ratio is less than one, the property is generating an income stream large enough to cover all operating expenses and the debt service, as well as to maintain some level of vacancy within the property.

After the break-even ratio is calculated it can be subtracted from 100 percent to find the vacancy and collection loss percentage that the property can withstand before a zero return is generated for the investor.

Obviously, the investor desires the lowest possible break-even, or default, ratio. The typical acceptable breakeven ratio on a residential income-producing property is in the range of 80 to 85 percent of potential gross income. This level of the ratio would allow enough remaining cash to cover an unexpected increase in the vacancy rate and to provide a positive cash flow to the investor before income tax impacts are calculated.

DISCOUNT CASH FLOWS

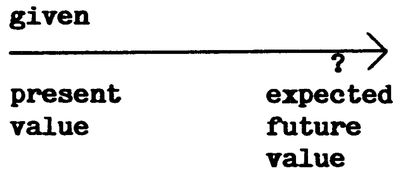
A. The Concept of Present Value is based on the idea that money has time value. Time value simply means that if an investor is offered the choice between receiving $1 today or receiving $1 in the future, he will always to receive the $1 today. This is because the $1 received today can be invested in some opportunity and will earn interest, which is preferable to receiving only $1 in the future. In this sense money is said to have time value.

Hence, in determining how much should be paid today for an investment that is expected to produce income in the future, an adjustment called discounting must be made to income received in the future to reflect the time value of money.

1. When compounding, we are concerned with determing the future value of an investment, as done for operating pro forma projections.
2. When discounting, we are concerned with just the opposite concept, that is, what present value or price should be paid today for a particular investment assuming a desired rate of interest to be earned.

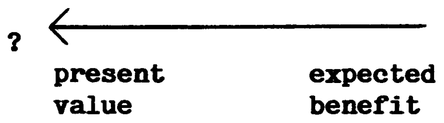
Single Compound Amount Formula (SCA)

1. $F = Pv\ (1+i)^n$



Single Present Worth Formula (SPW)

2. $P = F\ 1/(1+i)^n$
value



B. Present Value of Benefit Streams

Many types of investment proposals involve receipts of multiple benefits over a period of years. Such an investment benefit stream is called an annuity. (See Appendix, Section 8.4 for additional detailed uniform discount and compound formulas.)

An irregular annuity, for the most part, has irregular payments. In such a case, the method used to evaluate the stream of benefits is to find the present value of each benefit separtely as if it were a single investment situation. These present values are then summed to find the total present value for the annuity. To summarize, the present value of an annuity of n payments of An is:

$$An^{stream} = P1 + P2 + P3 + \ldots\ldots\ldots\ldots Pn$$

$$= F\left[\frac{1}{(1+i)^{1}}\right] + F\left[\frac{1}{(1+i)^{2}}\right]$$

$$= F\left[\frac{1}{(1+i)^{3}}\right] + \ldots\ldots\ldots\ldots F\left[\frac{1}{(1+i)^{n}}\right]$$

This can be restated as:

$$= \sum_{n=1}^{N}\left[\frac{1}{(1+i)^{n}}\right] \times Fn$$

where

An^{stream} = present value of an annuity of n payments
P = present value at year n
F = future value at year n
$\frac{1}{(1+i)^{n}}$ = present value factor for n years at i rate of interest

C. Net Present Value, (N.P.V.)

One method we may use to make accept-regret decisions for investments is called the net present value approach. Mechanically, it is very simple. Any investment whose benefits have a present value less than the cost of acquiring the benefits will be rejected. All other investments whose present values exceed their costs will be accepted. The difference between value and cost is called the net present value.

NPV = PV - equity invested
= (P1 + P2 + P3 +.....Pn) - equity invested

$$= F\left[\frac{1}{(1+i)^{1}}\right] + F\left[\frac{1}{(1+i)^{2}}\right] + F\left[\frac{1}{(1+i)^{3}}\right] + F\left[\frac{1}{(1+i)^{n}}\right] - \text{equity invested}$$

D. Internal Rate of Return (I.R.R.)

An alternative approach that can be used to make the investment decision is the calculation of return instead of the present value of the investment. This process, known as the internal rate of return technique, also utilizes a discounting factor.

To appply the internal rate of return (IRR) technique, the investor must have an estimate of cash flow, equity increase through mortgage balance reduction, and the future benefits price of the investment. However, the investor does not need to state a discounting interest rate (as is the case in the present-value technique). The discounting rate is the unknown to be estimated in this procedure.

$$0 = \text{Equity} - \sum_{n=1}^{N} \left[\frac{1}{(1+i)^{n}}\right] Fn \ + \text{Tax effect (year n)} \ + \text{future benefits (year n)}$$

The calculation of the internal rate of return is not simple. Currently, the sophisticated investor uses computer technology to solve this problem. If computer modeling is not accessible, the problem can be solved by a process of elimination

1. A discounting factor is chosen;
2. Then it is incorporated into the formula;
3. Finally it is utilized to calculate the present value of future returns to be received.

If the present value of future benefits is less than the initial equity, the discount factor that was chosen is too large. If the present value of the benefits is greater than the initial equity, the discount factor that was chosen is too small.

By a process of elimination, a discount factor can be identified that brings about an equity between the future returns and initial costs of the investment.

Limitations on Ratio Analysis

Although the ratios discussed are widely used in investment decision making, they are subject to the following limitations.

1. The ratios can be distorted by many factors. For example, understating operating costs (such as excluding management fees) can deflate the operating expense ratio.
2. It is difficult to generalize about whether a particular ratio is "good" or "bad." For example, a high debt coverage ratio may look good to the lender but may indicate that the investor is under-leveraged.
3. Most investments have some "good" and "bad" ratios. Consequently, it is often difficult to tell whether the investment is financially feasible.

Ratio analysis is useful despite these problems, but investors should make adjustments where necessary. Conducted with good judgment, this type of analysis can provide useful insights into an investment's operations.

Which Criteria are Investors Using?

Recent studies on real estate investment decision making criteria reveal a diversity in rate-of-return criteria and valuation methods. Why are shortcuts used despite the evidence in favor of discounted cash flow methods? The answer may be that they provide reliable information on which to make investment decisions.

The development of computerized discounted cash flow models have reduced the calculation problems for investors. In a survey of real estate return measures. Robert J. Wiley found that 91 pecent of the investors used some form of before-tax return while 54 percent used some after-tax measure. Wiley's survey included seventy-two life insurance companies, forty-nine REITs, and thiry-seven real estate corporations. Table 16-8 shows the type of before- and after-tax measures used by the respondents.

Wiley also found that:

1. Return on equity is emphasized. Only 10 percent of the surveyed companies specifically identified the purchase price rather than initial equity investment as the basis for their rate of return measures. This suggests that most real estate equity investors analyze their real estate investment proposals in relation to the

equity investment.

2. The emphasis is placed on cash flows. The survey indicates that the most widely used relative return measures involve cash flow instead of gross income or net income. The use of cash flow return measures implies that debt service payments are deducted from net operating income in measuring periodic investment returns. The large percentage of investors reporting the use of after-tax cash flow measures and tax shelter measures reflects their concern with depreciation and other tax related features attendant to ownership of investment properties.

3. There is widespread use of discounted cash flow models. While the single most important return measure (on both before- and after-tax bases) was cash flow divided by initial equity investmet (the equity dividend rate and after-tax rate), a large percentage of the investors reported using some form of after-tax discounted cash flow model; the internal rate of return was the most popular variation. Also, 32 percent used some form of time-adjusted return measures on a before-tax basis.

Before-Tax Investment Return Criteria

	% of 72 Insurance Companies	% of 49 REITs	% of 37 Corporations	% of all Respondents
Gross income/purchase price	13	6	11	10
Net income/initial investment	40	35	30	36
Before-tax cash flow/ initial equity invst.	54	69	49	58
Payback period (time to recapture initial equity invst)	11	8	14	11
Investment yield (time-adjusted rate of return on initial equity invst)	40	27	24	32
Other measures used	6	12	3	7
No before-tax measure	7	2	24	9

AFTER-Tax Investment Return Criteria

	% of 72 Insurance Companies	% of 49 REITs	% of 37 Corporations	% of all Respondents
Earnings after tax (1st yr)/initial equity invst	11	8	19	12
After-tax cash flow (1st yr)/initial equity invst	46	12	46	25
Payback period	7	8	11	8
Time-adj. rate of return	32	10	16	22
Net present Value	7	2	11	16
Internal Rate of return	29	8	8	18
Profitablity index	0	2	3	1
Tax-shetler benefits	19	12	24	18
Other measures	1	0	5	2
No after-tax measure	40	67	27	46

Source: Robert J. Wiley, "Real Estate Investment Analysis: An Empirical Study," *The Appraisal Journal*, 44 (October 1976), 586-92.

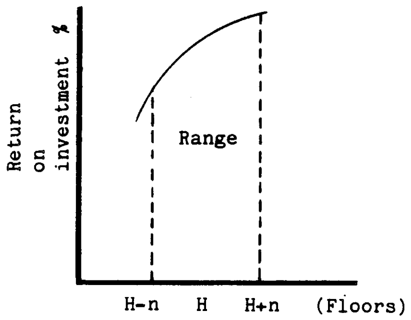
4.3 BASIC DECISION MAKING PRINCIPLES USED IN MODEL

4.3.1 EXTREME-RANGE INTERPOLATINO METHOD

If the results on the return on investment measures within the designated range are the following:

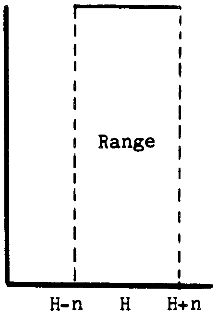
1A	$(H-n) < (H) < (H+n)$	It would be advantagous for the owner, if possible, to increase the number of floors in order to increase his profits.
B	$(H-n) = (H) < (H+n)$	It would be advantagous for the owner, if possible, to increase the number of floors in order to increase his profits.
C	$(H-n) < (H) = (H+n)$	The owner has an option to stay anywhere within H and H+n range and still experience maximum profits.
2	$(H-n) = (H) = (H+n)$	The owner has an option to stay anywhere within H-n and H+n range and still experience maximum profits. It might be possible that maximum profits can still be provided outside the range.
3A	$(H-n) > (H) > (H+n)$	It would be advantagous for the owner to decrease the number of floors in order to increase his profits.
B	$(H-n) = (H) > (H+n)$	The owner has an option to stay anywhere within H and H-n range and still experience maximum profits.
C	$(H-n) > (H) = (H+n)$	Then it would be advantagous for the owner to decrease the number of floors in order to increase his profits.
4A	$(H-n) < (H) > (H+n)$ where $(H-n) < (H+n)$	It would be advantagous for the owner to maintain the existing height in order to experience maximum profits.
B	$(H-n) < (H) > (H+n)$ where $(H-n) = (H+n)$	It would be advantagous for the owner to maintain the existing height in order to experience maximum profits.
C	$(H-n) < (H) > (H+n)$ where $(H-n) > (H+n)$	It would be advantagous for the owner to maintain the existing height in order to experience maximum profits.

RETURN ON INVESTMENT MEASURES & FLOOR LEVELS WITHIN DESIGNATED FLOOR RANGE FOR HIGH RISE BUILDING PROJECTS

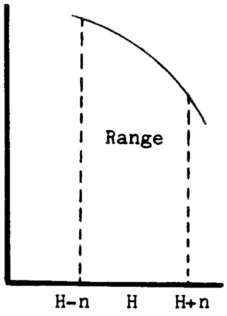


1A$(H-n) < (H) < (H+n)$
B$(H-n) = (H) < (H+n)$
C$(H-n) < (H) = (H+n)$

*O.B.H.=outside range

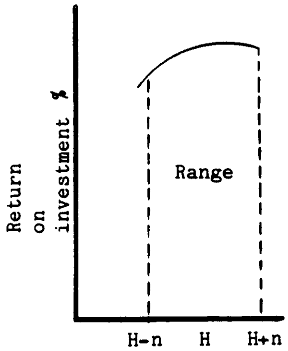


2A$(H-n) = (H) = (H+n)$



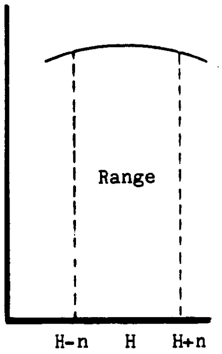
3A$(H-n) > (H) > (H+n)$
B$(H-n) = (H) > (H+n)$
C$(H-n) > (H) = (H+n)$

*O.B.H.=outside range



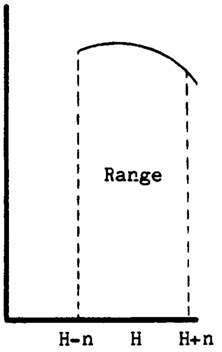
4A$(H-n) < (H) > (H+n)$
where
$(H-n) < (H+n)$

*O B.H.=inside range
near existing
height H



B$(H-n) < (H) > (H+n)$
where
$(H-n) = (H+n)$

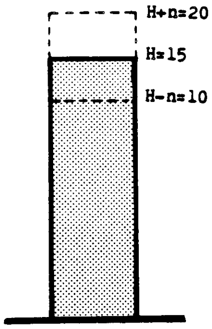
*O B.H.=inside range
near existing
height H



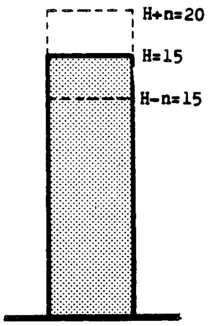
C$(H-n) < (H) > (H+n)$
where
$(H-n) > (H+n)$

*O B.H.=inside range
near existing
height H

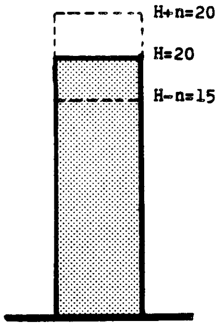
*optimal building height



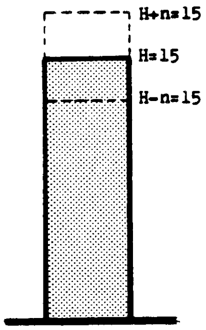
1A $(H-n) < (H) < (H+n)$



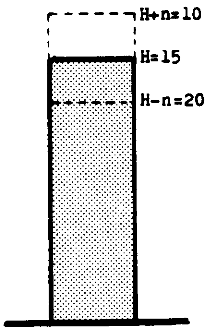
B $(H-n) = (H) < (H+n)$



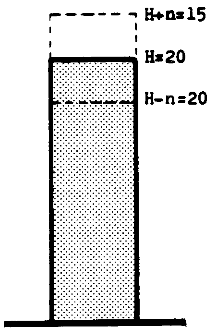
C $(H-n) < (H) = (H+n)$



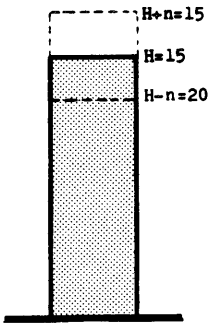
2 $(H+n) = (H) = (H-n)$



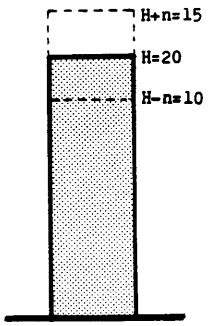
3A $(H-n) > (H) > (H+n)$



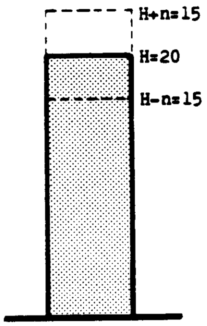
B $(H-n) = (H) > (H+n)$



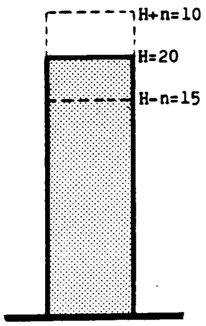
C $(H-n) > (H) = (H+n)$



4A $(H-n) < (H) > (H+n)$
where
$(H-n) < (H+n)$

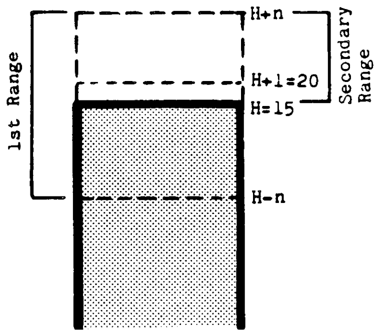


B $(H-n) < (H) > (H+n)$
where
$(H+n) = (H-n)$

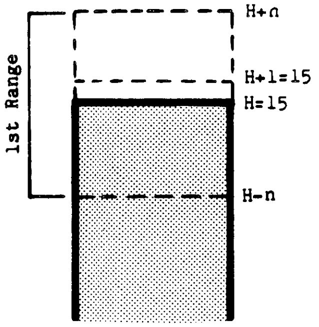


C $(H-n) < (H) > (H+n)$
where
$(H-n) > (H+n)$

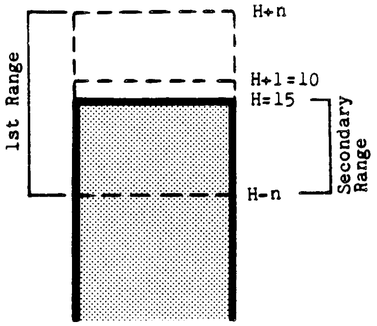
4.3.2 RANGE-MARGINAL ANALYSIS METHOD



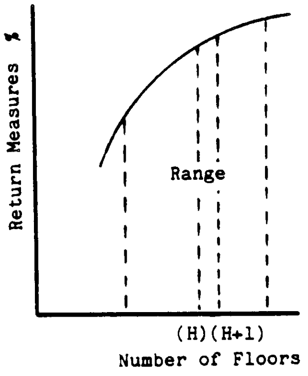
(H+1) > (H)

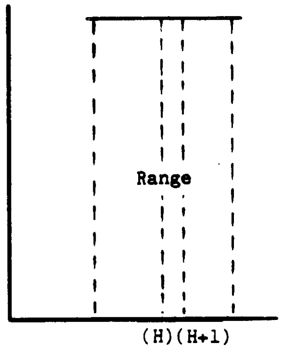


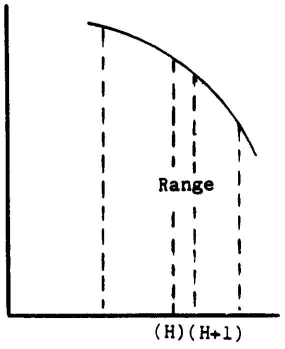
(H+1) = (H)

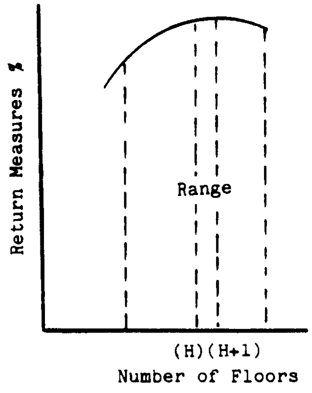


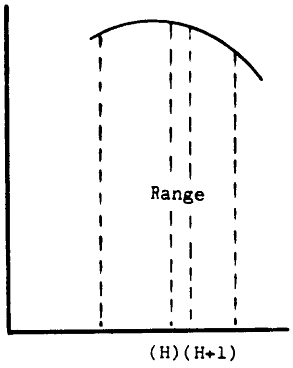
(H+1) < (H)











4.4 HYPOTHETICAL APPLICATIONS FOR HIGH-RISE DEVELOPMENTS

4.4.1 PROPOSED HIGH-RISE DEVELOPMENTS

EXTREME RANGE-INTERPOLATION METHOD

For purpose of illustration, consider a hypothetical proposed high rise residential building project with rentable units. When the design is established and a height has been determined based on given parameters such as: what is marketable, F.A.R. (floor area ratio) zoning regulations, land values, available funding, structural windloading criteria or other; then the developer would like to know if that proposed height chosen is the height in which his profits are maximized.

The following steps explain the basic decision-making process when analyzing the returns on investment at various floors for a proposed high rise project to determine optimal building height through the extreme range-interpolation method.

1. Clearly identify the proposed building height which was based on the designer's interpretation of set parameters. Preliminary design development drawings such as elevations or sections should provide you with this information.
2. Determine a range, with the client's consent that would indicate the number of floors one is willing to go above or below the proposed building height. The number of floors within the range also will depend on the proposed number of floors. For example, a proposed building height of 30 stories might reasonably include a floor range of 5 floors above and below for examination. On the other hand a proposed building height of 60 stories might include a range of 10 floors above or below for examination. This decision is sensitive to the exact same issues that determined the proposed height.
3. Clearly identify the established range. (See Fig. 4.1)

   Level H+n = The highest floor level within designated range
   Level HGiven = The proposed floor level height
   Level H-n = The lowest floor level within designated range
4. Calculate the return on investment measures for the proposed building height using the standard method of feasibility analysis. Direct capital cost breakdown figures of total development for the proposed

H height will be provided by the general contractor chosen by the bidding process. Indirect capital costs are based on a percentage of the total direct costs. Using vital data from the operating pro forma statement calculate all the returns on investment measures.

5. Calculate the returns on investment at the extreme locations of the designated range, H+n and H-n. The direct capital cost breakdown figures for the extreme levels of the designated range should be requested from the same general contractor that provided figures for proposed height H. This additional data should be also requested at the same time capital cost data for proposed height H is requested.

6. Examine H+n and H-n return on investment measures with H return on investment measures.

7. Calculate the return on investment measures for each floor level within the extreme locations of the designated range through interpolation. This method will save time and money for the client by by-passing additional necessary capital cost, operating pro forma and return measures calculations for each specific floor level within range.

   (For purpose of organization regarding capital cost, operating pro forma and return measure calculations, tabulate figure across the board in a comparable way to sense the impact and relationship of one figure to another for the designated floor heights. See proposed model.)

8. Analyze all the return measures for each specific height and select optimal height or best choice from tabulated data. Optimal building height is the height at which the private investor's return on investment is maximized. It's possible that optimal building height may not fall within the designated range, therefore you then choose best alternative within range and inform client of this.

9. List and analyze the external factors influenced from the proposed height H to the increased or decrease optimal height level.

   Vital external factors requiring attention are:

   --marketability

   --available funds

   --public support

--political support

--environmental impact of neighborhood and city

--zoning regulations

--traffic, parking

--infrastructure

--pedestrian

--other

10. Present client with a package including the following results:

--optimal building height level or best choice within range

--alternative return on investment measures within range

--list and analysis of vital external factors

--height recommendations based on owner's objectives

--capital cost budget, operating pro forma statement with return measure results for 1st year's operation, (static anlyasis) and years 2 to 10, (dynamic analysis) if requested by owner

--other

4.8.2 RANGE-MARGINAL ANALYSIS METHOD

Using the same hypothetical proposed project as before, lets assume that the direct capital cost figures at H+n and H-n are not available because they would consume too much time to calculate or would be too costly. The question then becomes how do you determine optimal building height within these limitations. Here, a different technique for finding the optimal height is required. That technique is marignal analysis.

The following steps explain the basic decision-making process when analyzing the return on investment measures at various floors for the proposed high rise project through the range-marginal analysis method.

1-4. Same as steps 1-4 of the extreme-range interpolation method.

5. Ask same general contractor, in addition to the direct capital costs for the proposed height H, the direct capital cost figures for adding one additional floor to the proposed height H. His cost estimating expertise should provide you with the construction cost breakdown immediately. Indirect capital costs are based on a percentage of the total direct costs. These percentages are the result of accummulated empirical data on high rise buildings.
6. Using vital data from the operating pro forma statement calculate all the return on investment ratio measures for proposed height H.
7. With the additional capital cost data for adding one additional floor to the proposed height H, calculate the return on investment measures for H+1.
8. Examine the return on investment measures for H and H+1.
9. If the return on investment measures for H+1, are greater than the return on investment for H, then:

   --optimal building height is above the proposed height H

   --the floors should be increased

   In such a situation, take the cost of the one additional floor and multiply it by the number of floors one is willing to go above H, (this level should be H+n). Add this cost to the total capital cost for the proposed building of height H. Then calculate the return on investment for H+n. (See Fig. 4.2)

   If the return on investment measures for H+1 is less than the return on investment measures for H, then:

   --optimal building height is below the proposed height H,

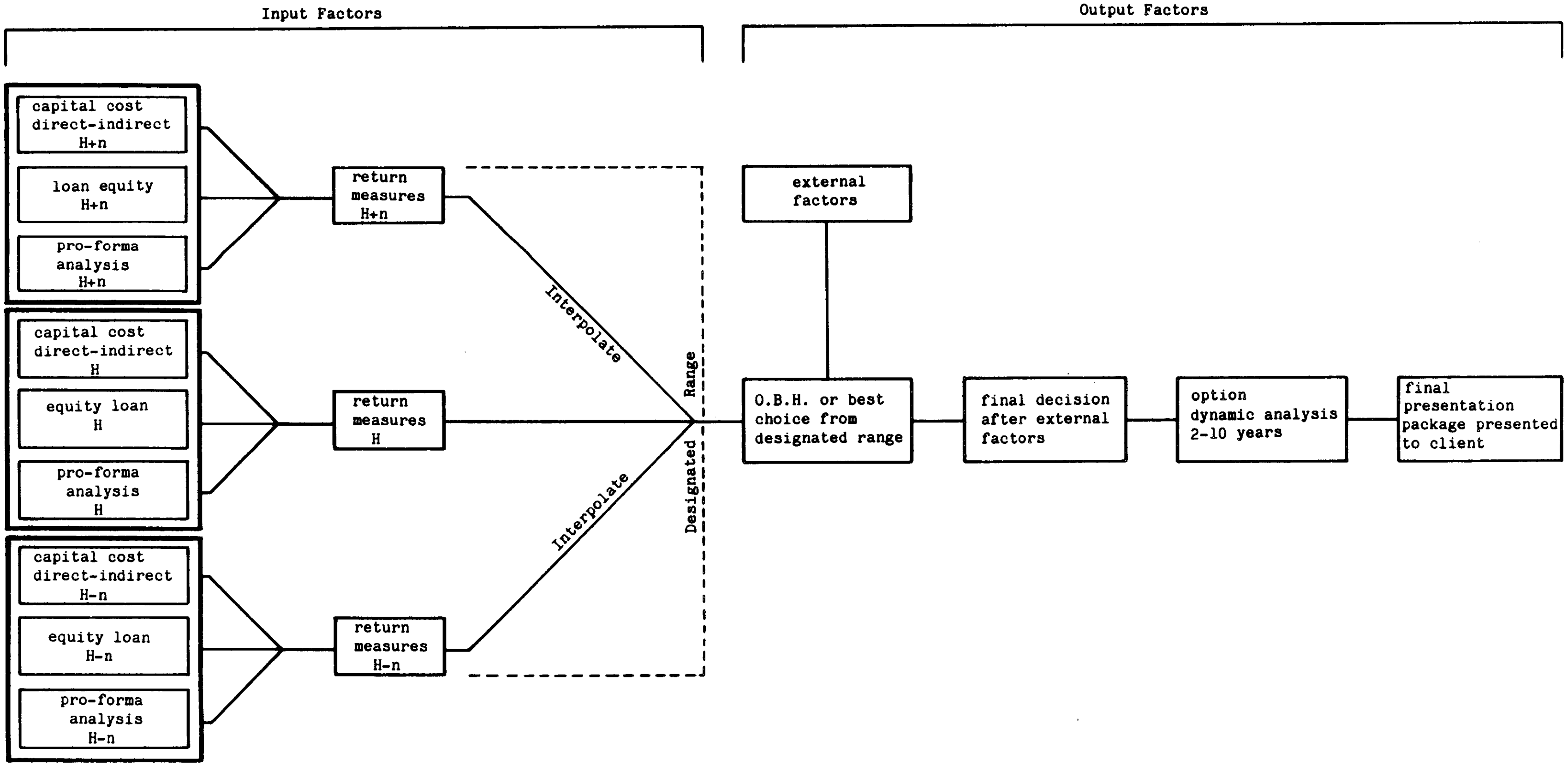
--and the floors should be decreased.

In such a situation take the cost of the one additional floor and multiply it by the number of floors one is willing to go below H height. (This level should be H-n.) Subtract this cost from the total capital cost for the proposed building of height H.

10. Calculate the return on investment measures for either H+n or H-n depending on which height is applicable.

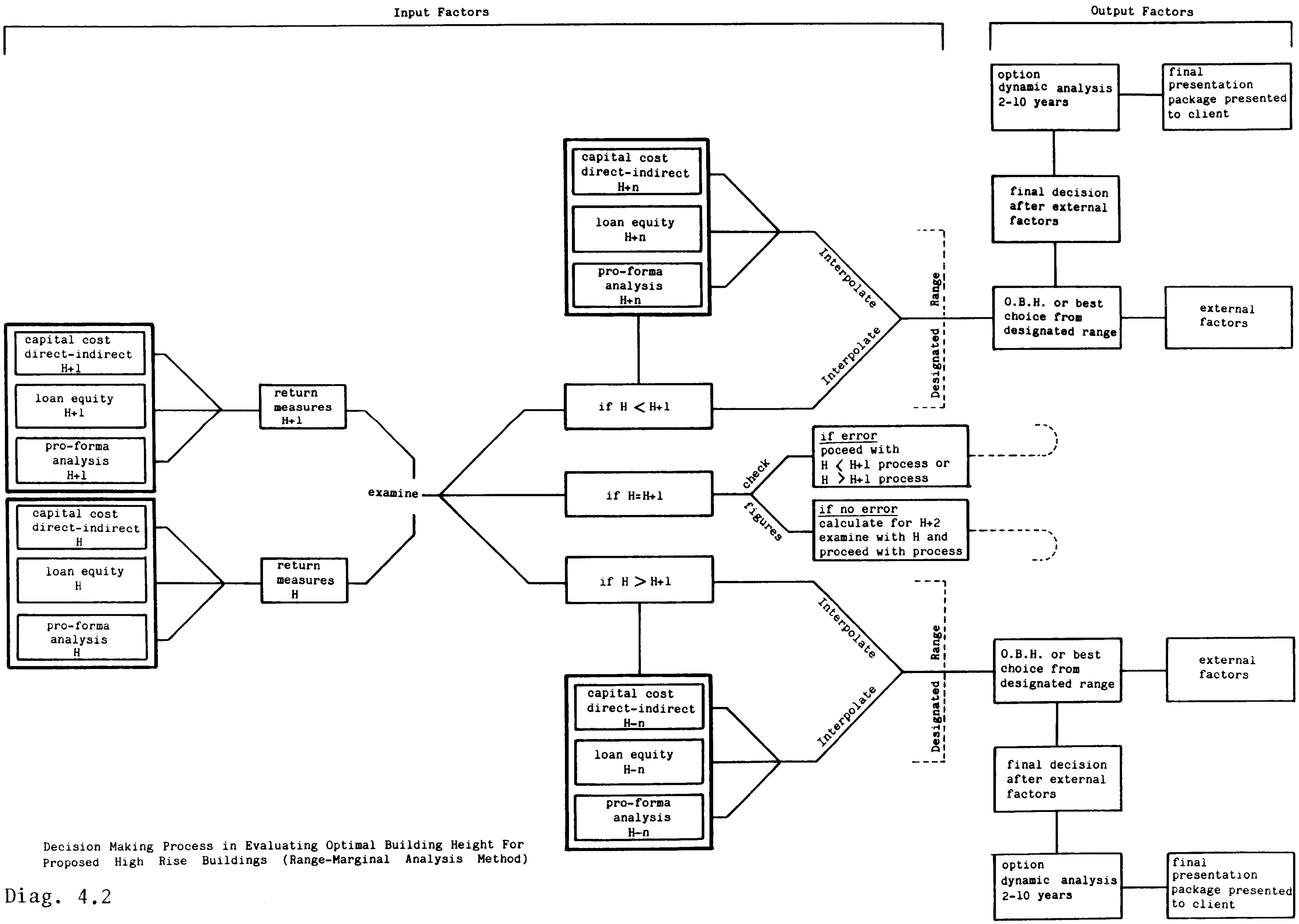
11. Calculate the return on investment measures for each floor level within the secondary range by interpolation. This method will save time and money for the client by by-passing additional necessary capital cost, operating pro forma and return measure calculations for each specific floor level. (For purpose of organization regarding capital cost, operating pro forma and return measure calculations, tablulate figures across the board in a comparable way to sense the impact and relationship of one figure to another for disgnated floor heights. See the proposed model).

12-14 Steps 12-14 are the same as steps 8-10 of extreme-range interpolation method for proposed high rise buildings.



Decision Making Process in Evaluating Optimal Building Height For
Proposed High Rise Development (Extreme Range-Interpolation Method)

Diag. 4.1



Decision Making Process in Evaluating Optimal Building Height For Proposed High Rise Buildings (Range-Marginal Analysis Method)

Diag. 4.2

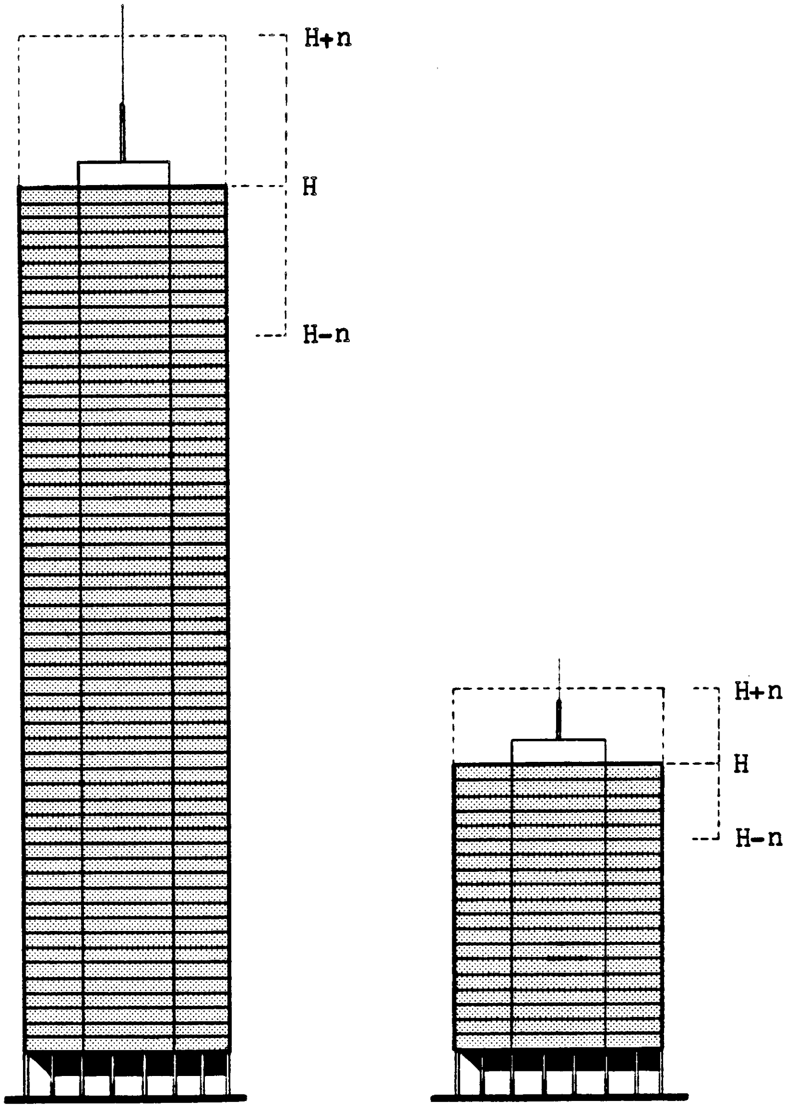


Fig. 4.1 Designated Range Analysis For Proposed High Rise Developments of 20 and 60 Stories High.

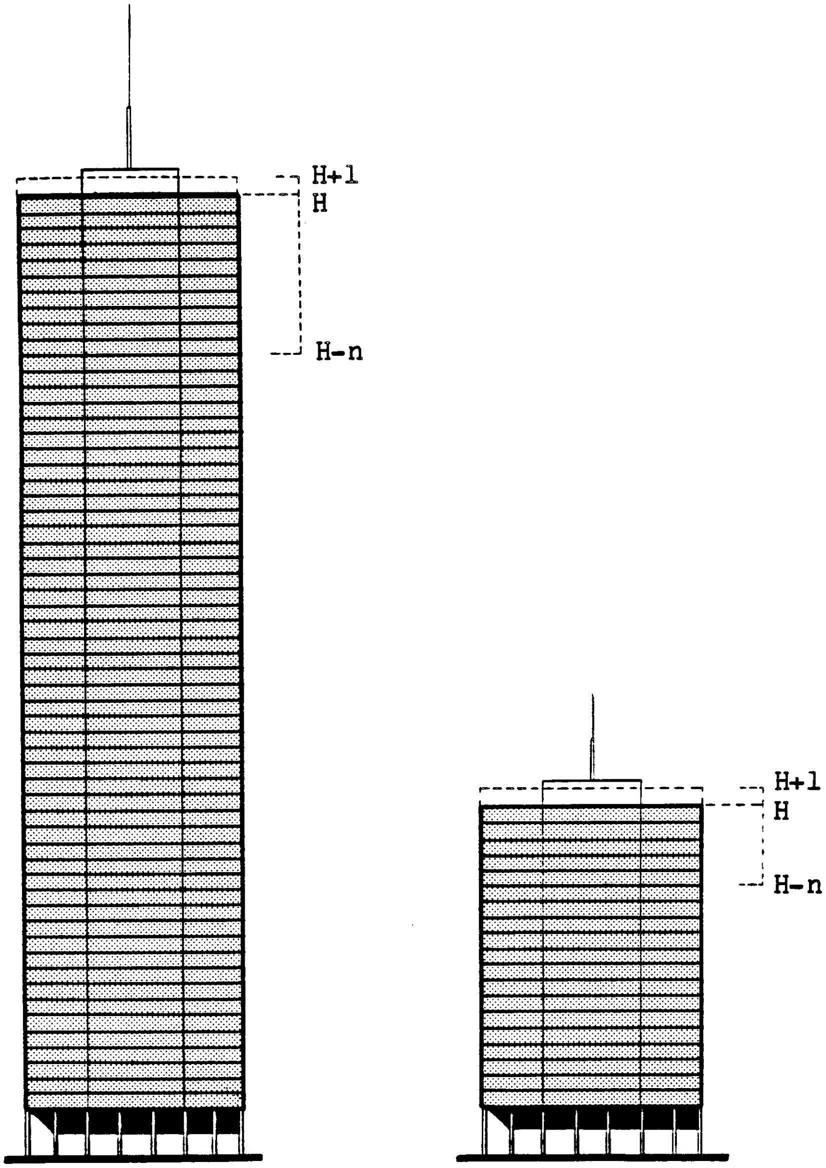


Fig. 4.2 Designated Range Analysis For Proposed High Rise Developments of 20 and 60 Stories High.

4.4.2 EXISTING HIGH-RISE DEVELOPMENT (At Time of Sale)

EXTREME-RANGE INTERPOLATION METHOD

For purpose of illustration, consider a hypothetical existing high-rise residential building project with pentable units. A real estate developer is considering buying the project. Based on his investment and an operating pro forma statement analysis the project seems to be profitable, but the developer wants to know if, with this particular high-rise building, his profits are maximized? The way in which this can be determined is based on determining if the building is at optimal building height level at the particular time the developer is considering the purchase. (Original capital cost data here is not necessary.)

The following steps explain the decision-making process when analyzing the return on investment measures at various floors for the existing high-rise project to determine optimal height through the extreme range-interpolation method.

1. Clearly identify the existing height of the project. This can be done by examining the original architectural drawings or by visiting the development and counting the number of floors.
2. Determine a range that would indicate the number of floors one is willing to investigate for optimal height. The number of floors within the range will depend on whether the real estate developer is interested in just determining if the existing height is optimal height, or if the real estate developer is interested in also determining what level is optimal height.

3.0 If the real estate developer is only interested in determining if the existing height is optimal height then: (See Diag. 4.6)

3-1 Clearly identify the established range. (See Fig. 4.6)

Level H+1 = the floor level above existing height H

Level HGiven = the existing floor level height

Level H-1 = the floor level below existing height H

3-2 Calculate the return on investment measures for the existing height H using the standard method of feasibility analysis.

Capital cost break down figures of project are not necessary. In this case the figures are replaced by the agreed sales price of the development from the owner to the real estate developer who is interested in buying the project. Using the available operating pro forma statement data from the owner calculate all the return on investment ratio measures.

3-3 Calculate the return on investment measures for H+1 and H-1. To calculate the sales price for H+1 and H-1, take the gross square footage of the building for existing height H and determine the average sales price per square foot.

Add or subtract the gross square foot of the floor level to be increased or decreased from the gross square foot of existing height H to get the gross square feet for H+1 and H-1. Then multiply the gross square feet for H+1 and H-1 with the average sales price per square foot. Accordingly, this will give you the new sales price for H+1 and H-1.

3-4 Examine H+1 and H-1 return on investment measures with existing height H return on investment measures.

If (H+1) < (H) < (H-1): Then existing height H is not optimal
(H+1) > (H) > (H-1) building height
If (H+1) < (H) > (H-1): Then existing height H is optimal building height

(For purpose of organization regarding sales price, operating pro forma and return measures calculations, tabulate figures across the board in a comparable way to sense the impace and relationship of one figure to another. See proposed model. The total development cost will be replaced with the total sales price.

3-5 Make decision: is project is worth buying or not? This decision is based on:

--How large return on investment measures are for existing height H.

--If existing height H is optimal building height level.

3-6 External factors/motives that influence your buying decision are the following:

--To maximize profits

--To minimize profits--tax shelter

--Location potentials
--Strong market demand
--Other

4.0 If the real estate developer is interested in determining what level is optimal height for the existing development at time of sale, then determine a range that would indicate the number of floors one is willing to investigate for optimal height. The number of floors within the range will also depend on what the existing height number of floors is. For example, an existing building height of 30 stories might reasonably include a floor range of 5 floors above and below for examination. On the other hand an existing building height of 60 stories might include a range of 10 floors above or below for examination. This decision is depended on the motives for finding optimal height for existing projects; such as buying an under-developed project and building additional floors to achieve optimal height and thus maximize your return measures. (See Diag. 4.7)

4-1 Clearly identify the established range. (See Fig. 4.7)

Level H+n = The highest floor level within designated range
Level HGiven = The existing floor level height
Level H-n = The lowest floor level within designated range

4-2 Same as 3-2 of the extreme-range interpolation method.

4-3 Calculate returns on investment at extreme locations of the range, H+n and H-n.

To calculate the sales price for H+n and H-n take the gross sq. ft. of the building for H and determine the average sales price per square foot.

Add or subtract the gross sq. ft. of the floor levels to be reduced or increased from the gross sq. ft. of H height to get to the extreme points H+n and H-n, then multiply the gross square foot for H-n and H+n with the average sales price per square foot. This will give you the new sales price for H+n and H-n.

4-4 Examine H+n and H-n return on investment measures with H return on investment measures.

4-5 Determine the return on investment measures for the floor levels within the extreme locations of the range by interpolation. This step will save time and will allow the developer a chance to make a quick decision about buying the project or looking for another. (For purpose of organization regarding sale prices, operating pro forma and returns on investment measures, tabulate your figures across the board in a comparable way to sense the impact and relationship to one figure to another. See proposed model. The total development cost will be replaced with the total sales price.)

4.6 Make decision if project is worth buying or not. This decision will be based on:

- **--How large return on investment measures are for existing height.**
- **--If existing height H is optimal building height level.**
- **--If it is practicle to build or eliminate floors in order to acheive optimal height.**

External motives that influence your buying decisions are the following:

- **--To maximize profits**
- **--To minimize profits--tax shelter**
- **--Location potential**
- **--Strong market demand**
- **--Other**

RANGE-MARGINAL ANALYSIS METHOD

Using the same hypothetical existing high-rise project as before, we can save some time by reducing the process by one step. This method of solving for optimal building height is known as marginal analysis.

The following steps explain the decision-making proces when analyzing the return on investment measures at various floors for the existing high-rise project through the range-marginal analysis method.

1. Same as Step 1 of the extreme-range interpolation method.
2. Same as Step 4.0 of the extreme-range interpolation method.
3. Same as step 4-1 of the extrame-range interpolation method.
4. Calculate returns on investment for H-1.

   To calculate the sales price of the existing building for H-1 take the gross square foot of the building for H and determine the average sales price per square foot.

   Subtract the gross square foot of the floor level to be reduced from the gross square foot of H height to get to level H-1. Then multiply the gross square foot for H-1 with the average sales price per square foot. This will give you the new sales price for H-1. Calculate the return on investment measures for H and H-1.

   If (H-1) $>$ (H) Then existing building is not at optimal level. Optimal level is at H-1 height or below.
   (See Fig. 4.8)

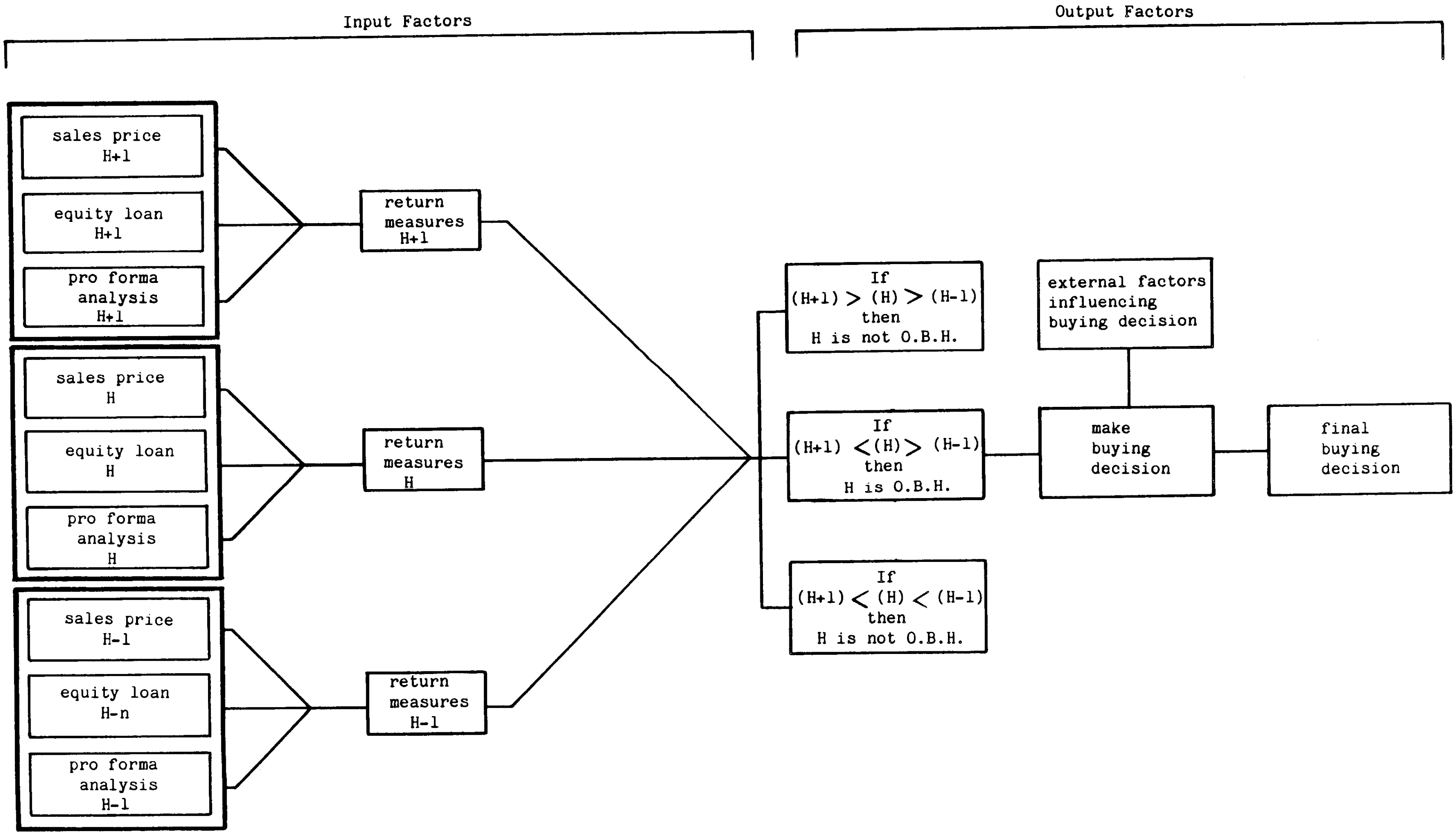
   If (H-1) $<$ (H) Then existing building is not at optimal level. Optimal level is at H height or above.
   (See Fig. 4.9)

5. Once you have determined if optimal level falls above or below H then calculate the return on investment measures for that extreme range only, either H+n or H-n.

   To calculate the sales price for H+n or H-n take the gross square footage of the building for H and add or subtract the gross square footage of the floor levels to be increased or decreased from the gross square footage of height H to get to levels H+n or H-n.

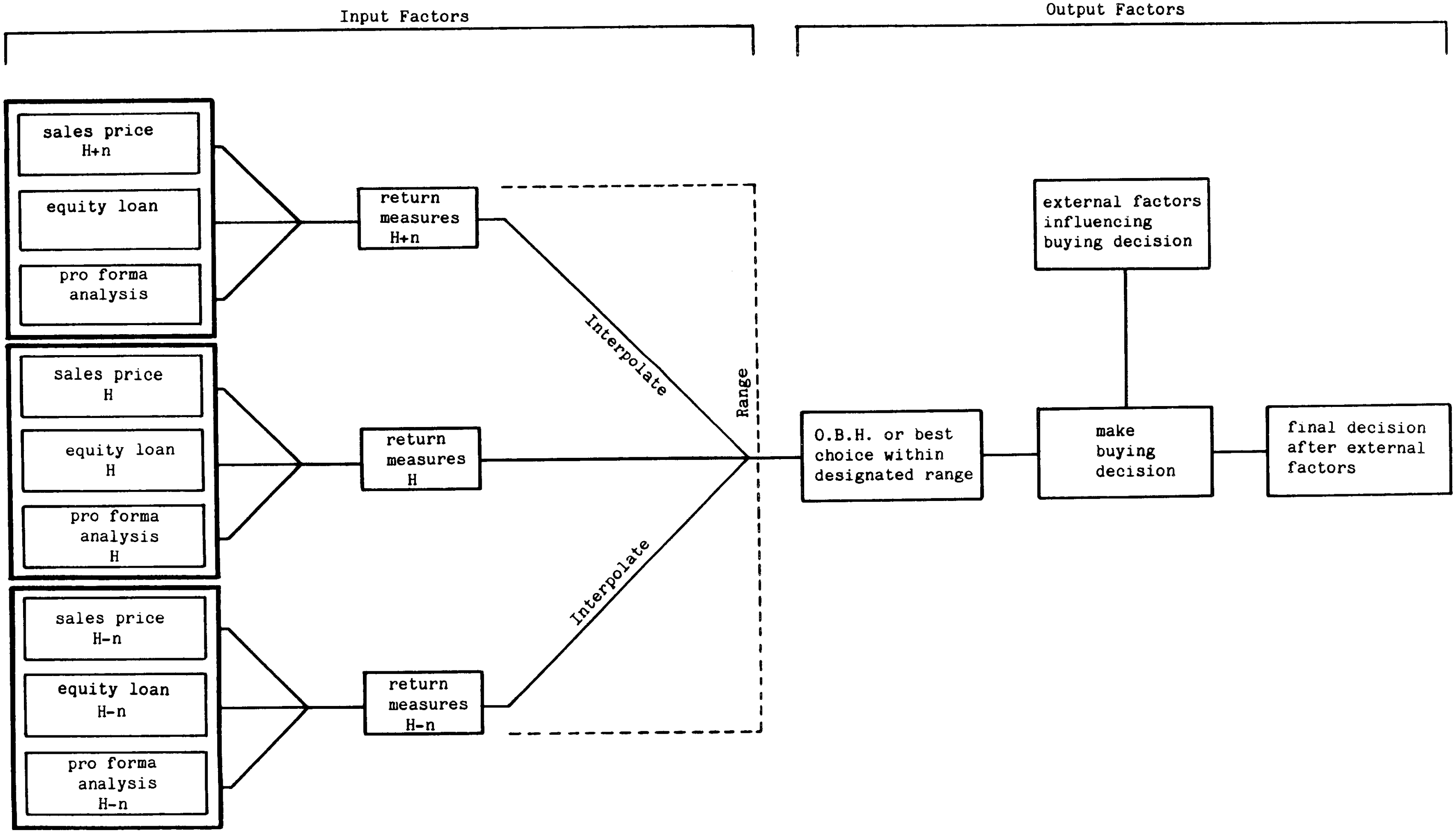
   Then multiply the gross square footage for H+n or H-n with the average sales price per square footage, this will give you the new sales price for the H+n or H-n.

6. Examine H+n or H-n return on investment measures with H and H-1 return on investment measures.
7. Determine the return on investment for the floor levels within the extreme location of the range by interpolation. This step will save time and will allow the developer a chance to make a quick decision about buying the project or looking for another. (For purpose of organization regarding returns on investment figures across the board in a comparable way to sense the impact and relationship of one figure to another. See proposed model. The total development cost will be replaced with the total sales price.)
8. Step 8 is same as Step 4-6 of the extreme range-interpolation method.



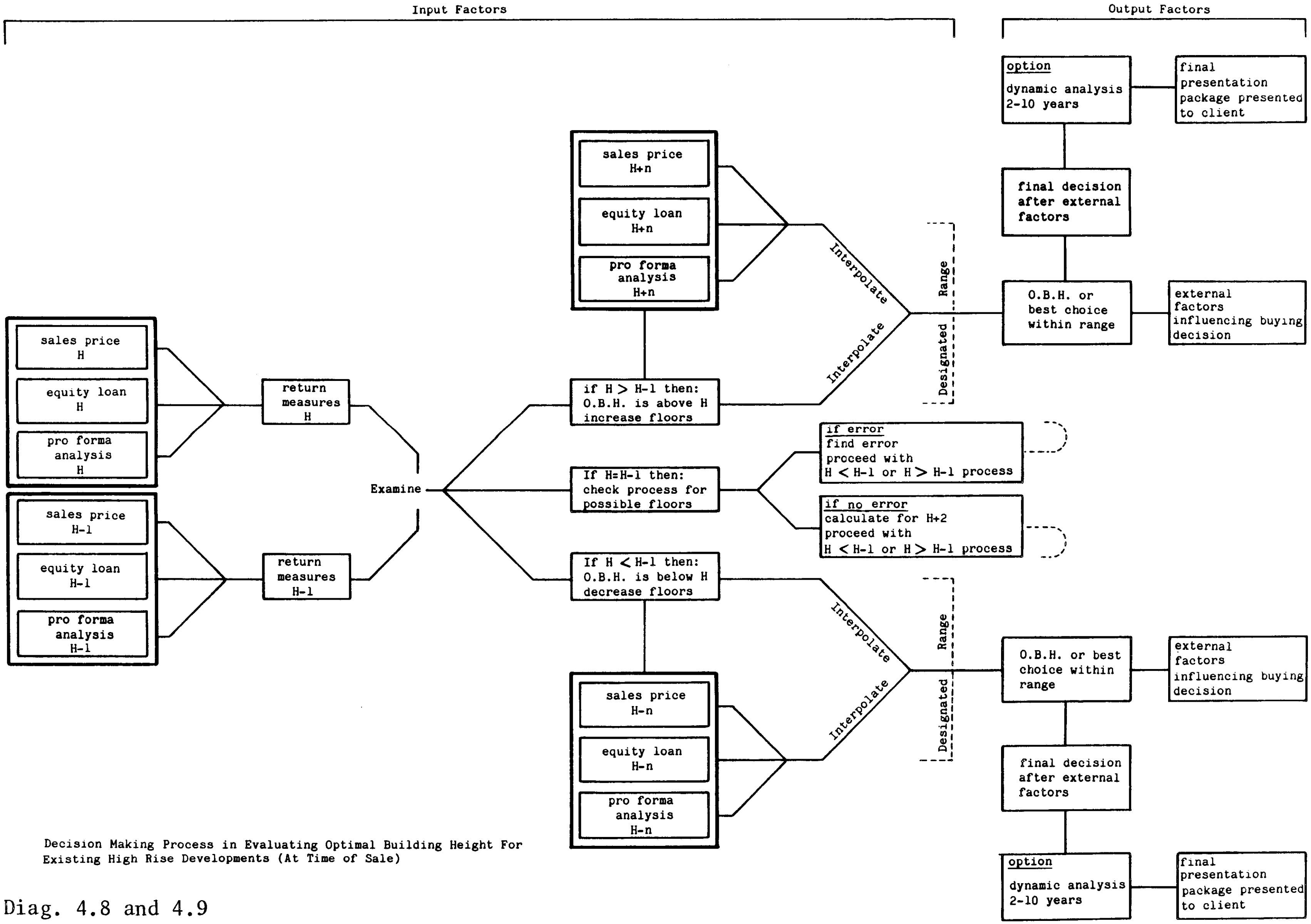
Decision Making Process in Evaluating Optimal Building Height to Determine if it is at Optimal Height (At Time of Sale)

Diag. 4.6



Decision Making Process in Evaluating Optimal Building Height For Existing Developments (At Time of Sale)

Diag. 4.7



Decision Making Process in Evaluating Optimal Building Height For Existing High Rise Developments (At Time of Sale)

Diag. 4.8 and 4.9

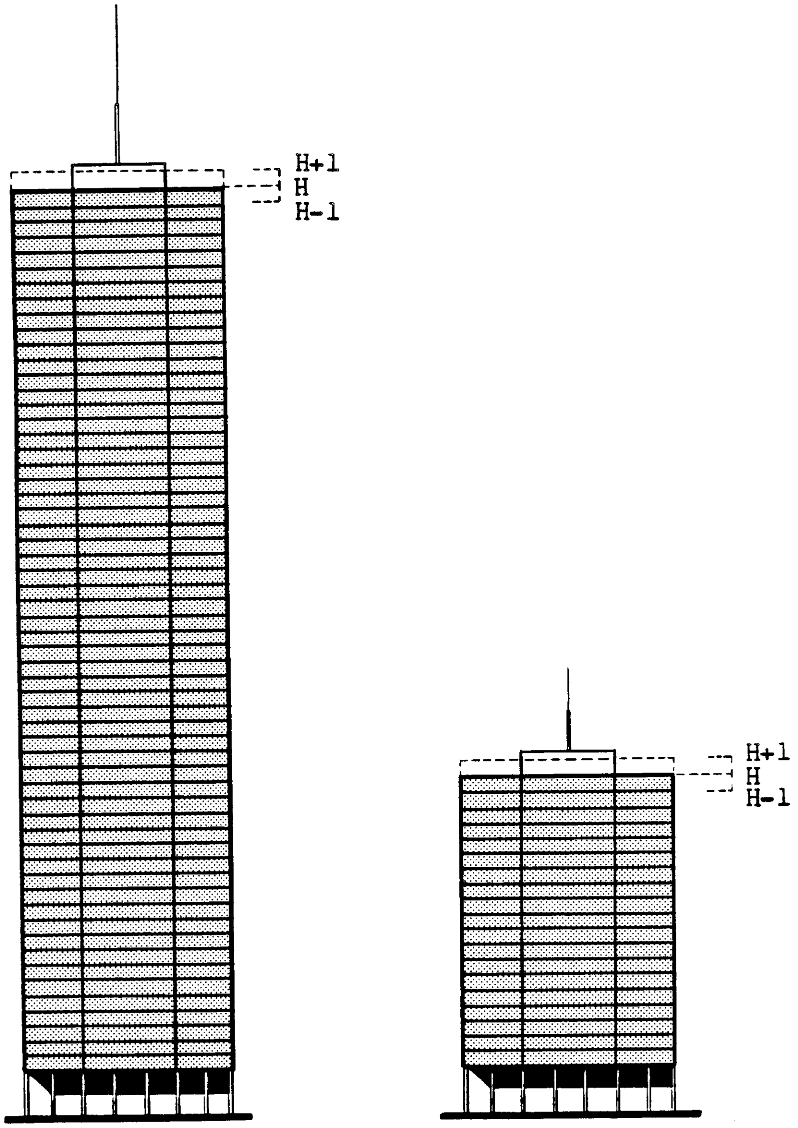


Fig. 4.6 Designated Range Analysis For Existing High Rise Development of 20 and 60 Stories High if Developer is only Interested in Determining if the Existing Height is Optimal at Time of Sale.

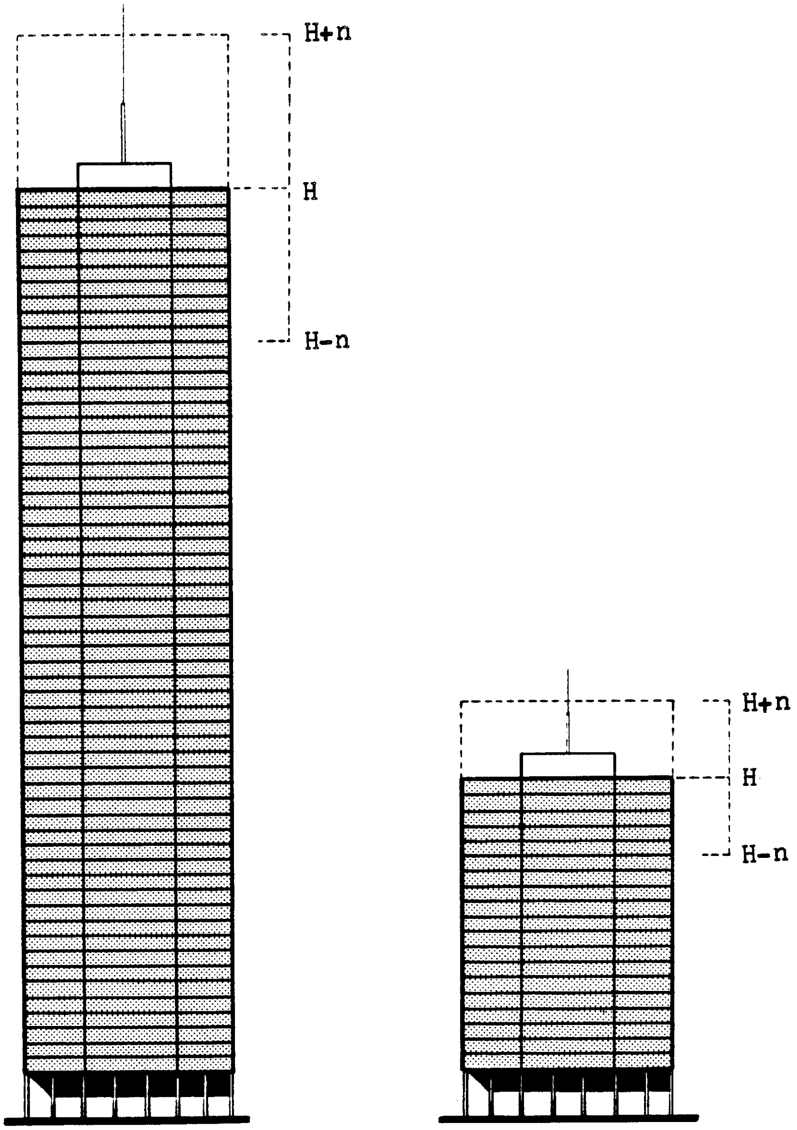


Fig. 4.7 Designated Range Analysis For Existing High Rise Development of 20 and 60 Stories High if Developer is Interested in Determining Optimal Height Building at Time of Sale.

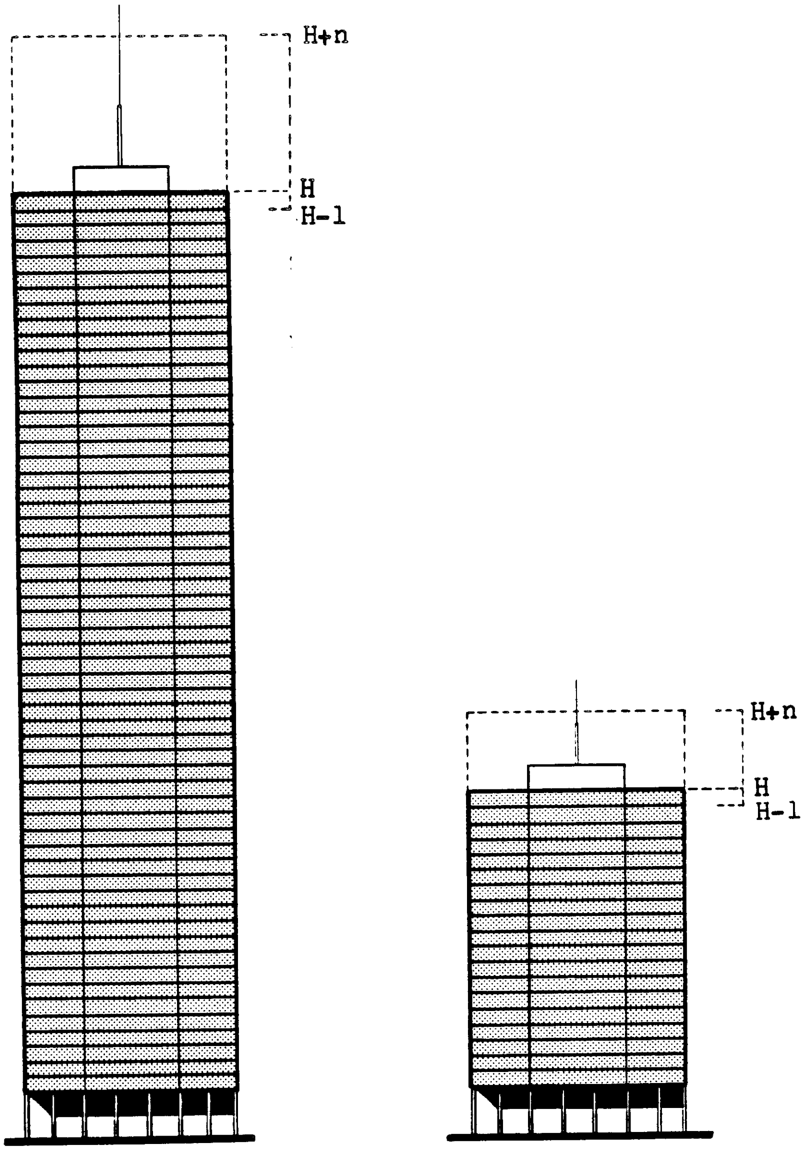


Fig. 4.9 Designated Range Analysis For Existing High Rise Development of 20 and 60 Stories High if Developer is Interested in Determining Optimal Height Building at Time of Purchase When the Return on Investment Measures for H-1 are Less than H.

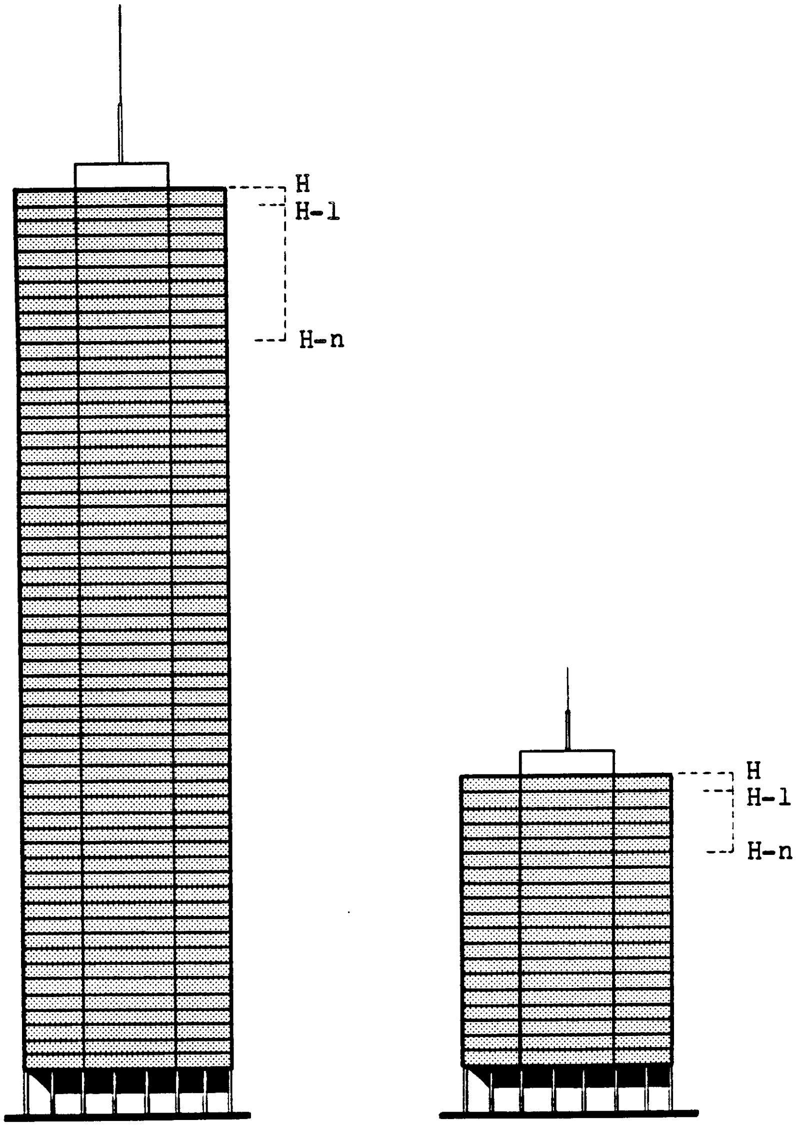
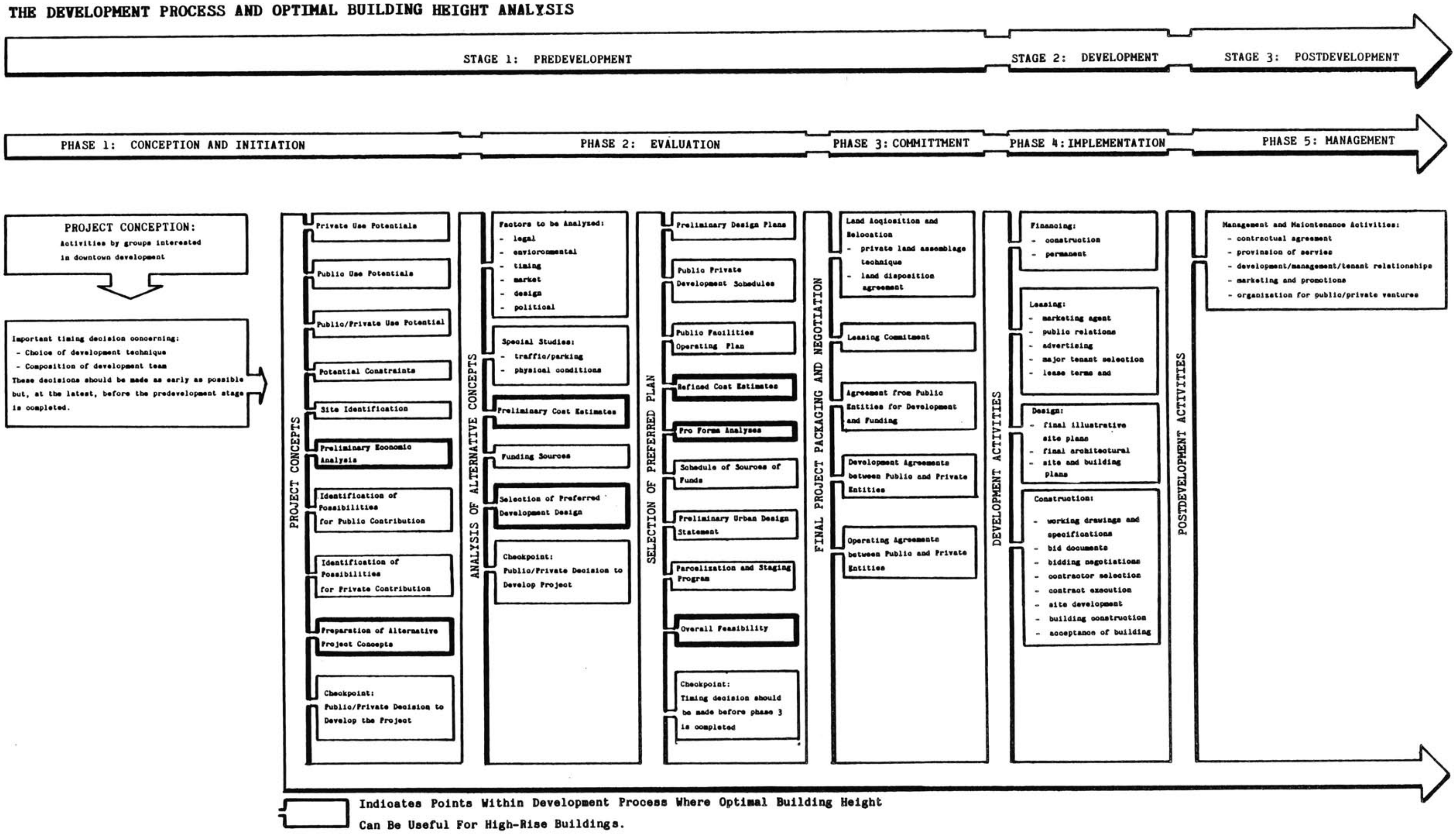


Fig. 4.8 Designated Range Analysis For Existing High Rise Development of 20 and 60 Stories High if Developer is Interested in Determining Optimal Height Building at Time of Purchase When the Return on Investment Measures for H-1 are Greater than H.

5.0 USE OF PROPOSED MODEL IN DEVELOPMENT PROCESS

THE DEVELOPMENT PROCESS AND OPTIMAL BUILDING HEIGHT ANALYSIS



Indicates Points Within Development Process Where Optimal Building Height Can Be Useful For High-Rise Buildings.

5.1 STAGES OF THE DEVELOPMENT PROCESS

Development projects proceed in three states that include five well defined steps:

- **Predevelopment**
  - Project initiation and conception (those actions that lead to an idea for a project and the subsequent steps toward implementation)
  - project analysis (analysis, testing, and preliminary design)
  - final project packaging (formalizing the agreements required to proceed with site acquisition and construction of the project)
- **Development**
  - project implementation (financing, leasing, design, and construction)
- **Postdevelopment**
  - project management (management and maintenance of the project).

5.0.1 **THE PREDEVELOPMENT STAGE** PROJECT INITIATION AND CONCEPTION (PHASE 1)

Development, like any other type of development, is usually initiated by one or a combination of the following parties:

- long-term land owners (downtown property interests)
- space users (hotel chains, retailers, corporations)
- public agencies (redevelopment authorities or planning departments)
- public or private ad hoc committees (private business and government interests)
- for-profit business entities (professional developers and equity investors)
- local nonprofit development corporations (private or public).

These project catalysts' motives, goals, and expected returns vary greatly. The common thread, however, is the desire to seek revitalization through the formulation of one or more specific development projects. Early in the process, the public and private parties involved should decide what type of development technique will be used and the composition of the development team. These decisions can have an important bearing on the course of development activity in the central business district.

The type of development entity depends primarily upon the strength of the market. If a strong market exists for development, it is less likely that public participation will be necessary to start the project. However, if a poor market has led to a deteriorated downtown, significant public commitment to private development may be necessary.

Public involvement can range from the usual permitting and regulatory responsibilities in a strong market to direct leadership of the development stage. Between these two extremes it can comprise the private sector's programming public uses in combination with private uses under a contractual arrangement or an arrangement in which public and private groups are development partners.

One of the recent major issues with regard to development is when and how the private developer should be brought into the process. Local public development agencies have frequently attempted to formulate projects without involving the potential developer of the project or consulting with experienced developers. Without this expertise, the public project too often fails to generate any response from the private sector.
Increasingly, public agencies are recognizing that private developers must participate in the project initiation phase.

While the need for involving private developers is recognized, no standard models have yet been developed for such participation. A number of different approaches have been used with apparent success, however. Recently, many communities have formed quasi-public development corporations empowered with the flexibility to engage in a variety of developmental activities. By working closely with private developers, these corporations have fostered the necessary environment for development to occur.

The section of a developer to lead project initiation has its potential problems. Developers tend to specialize in certain types of projects; they also tend to have limited capabilities in systems planning, which local governments must address in designing public standards for development. Developers are acquiring broader experience, however; increasingly, they can show a community a potential economic opportunity that the community itself had not realized.

The increasing number of projects in which local governments initiate development has led to the emergence of private consulting firms whose expertise lies in formulating and packaging projects. The firms capable of offering this assistance have strong real estate and development experience in the private sector and a working knowledge of public programs. While these firms normally work under contract to the local government agency, they may also work for a private developer who is negotiating with a local government on a project. They may direct development programming from project initiation to negotiation of terms for the business arrangement. When the consultant is working for both the public and the developer, they should jointly select the consultant and share expenses to avoid the consultant's favoring one side or the other.

In an overview such as this one, it is difficult to discuss developer selection unless the initiator of the development is first established. While the character of the initiator will affect the choice at some point in the process, the person or organization initiating development will seek out a professional developer to:

- enter into a joint-venture partnership with
- assume control of the project
- assist in formulating the project, possibly with an understanding that the developer will ultimately take control of the project or develop the project for a fee.

Several major criteria in selecting a developer should be used in almost any instance that might be described:

- the developer's past experience with the type of project contemplated, projects with similar demands, and projects in the local area
- the developer's financial strength, particularly his ability to raise the required equity funds
- the developer's current availability and capacity to handle the project
- the developer's reputation in the industry
- the developer's ability to assemble a competent team and produce a high level of design.

Project conception is also difficult to discuss without having a defined initiator. In most cases, however, the predevelopment process for project conception would be the progression from a general concept or alternative concepts for development to a specific project proposal. The exact nature and order of the activities leading to a specific project proposal depend on the known quantities in a particular case. For example, an initiator may identify a specific space need and general locational requirements but not a particular site. In that case, possible sites must be identified and evaluated. In other cases, the site may have been determined, but the uses, scale, and design of the development on that site must be determined.

Project conception would normally proceed through a logical series of considerations as outlined here. Potential sites for development are the most common starting point. With a site or sites identified, economic opportunities identifying potential uses of the site are analyzed. Because much downtown development cannot be achieved without the cooperation and/or participation of both the public and private sectors, the analysis would also identify potential public and private contributions to the project. It is often difficult to determine what level of public contribution might be appropriate because this issue is frequently a political one.

If this initial analysis is favorably received, existing data and studies are reviewed during the next phase. Appropriate individuals are interviewed to ascertain tenant availability for office, retail, service, and public spaces. The following major areas are examined:

- the potential for use by private firms: identifying the need for office space, retail facilities, commercial space, recreation facilities, and transient or other housing facilities
- the potential for use by the public: identifying the need for administrative space, public facilities, convention facilities, and special-use space
- the potential for joint use: ascertaining opportunities to combine uses of space in a development (courtyards, stairways, service areas, mechanical facilities)
- potential constraints: ascertaining the existence of an uncooperative public atmosphere, availability of development funds, lack of political consensus, opposition from special interest groups
- identification of potential sites: evaluating site

alternatives in light of market demand, costs of acquisition, and other factors

- Preliminary Economic Analysis: identifying potential tenants by interviews and data collection and development crude pro forma and OPTIMAL BUILDING HEIGHT ANALYSIS.
- identification of possibilities for public contribution: ascertaining the availability of public funds for front-end costs; exploring leveraging possibilities based on availability of public funds; determining other forms of public contribution such as land use control incentives, land leases, and tax assistance
- identification of possibilities for private contribution of local equity monies (if necessary): ascertaining local investors' attitudes toward providing equity monies and exploring possible leveraging ratios with these private commitments in terms of federal grant applications
- preparation of alternative project concepts: synthesizing data into a number of possible project alternatives and discussing possibilities with potential major participants (public and private entities, potential tenants, and investors.) Developing pro forma and OPTIMAL BUILDING HEIGHT ANALYSIS for project alternatives.

The initiator then presents the findings to the public body. The public entity must then decide on the merits of the package. If a clear development strategy is apparenet, the public entity authorizes the initiator to prepare details of the project concept, thus moving into phase 2. If, however, a clear development strategy does not emerge at the end of phase 1, it may be necessary to proceed to selective detailed analysis, normally done during phase 2, to determine the best development strategy. Phase 2 activities include preparing a detailed market feasibility report on the top-priority project(s), the financial plan, a detailed program and design layout, an operation and management schedule, and proposed agreements between the public and private parties to insure execution of the adopted project. At the completion of phase 2, a refined development strategy has been established.

PROJECT ANALYSIS (PHASE 2)

After the final step in phase 1--the formulation of a development strategy--is completed, evaluation begins. It involves analyzing the alternatives and selecting the preferred option and includes the following considerations for each of the proposed alternatives:

- GENERAL FACTORS
    - regulatory and legal considerations
    - environmental considerations
    - timing and sequence of development
    - political support
- MAJOR STUDIES
    - market analysis
    - planning and design
    - financial, including preliminary cost estimates, refined pro forma analysis, premininary identificaiton of sources of funding and refined OPTIMAL BUILDING HEIGHT ANLAYSIS.

From these analyses, a preferred design and development program is identified. Further analysis of it results in:

- a final preliminary design
- development schedules
- an operating plan for public facilities to be incorporated in the project
- cost estimates
- a financial pro forma analysis
- OPTIMAL BUILDING HEIGHT ANALYSIS
- a cost benefit analysis
- the basis for public/private negotiation toward a final project.

The objective at the end of this phase is to propose a project that meets basic physical, economic, financial, and legal requirements of the public and private participants in the project.

Before phase 3 begins, the final decisions about development technique and the composition of the development team must be made. At this point, the public and private parties should be prepared to negotiate and execute all documents necessary for the projects development.

FINAL PROJECT PACKAGING (PHASE 3)

The final phase of predevelopment includes formalizing the agreements required to proceed with site acquisition and construction should be secured in five areas:

- land acquisition and relocation: acquiring land through gradual purchase or through equity participation agreements with property owners, executing a land disposition agreement
- leasing: securing preliminary lease agreements with prospective major tenants through letters of interest, letters of intent, or agreements to buy or lease space
- public deevelopment and funding: securing contractual commitments from public entities to develop and finance the project
- development agreements between public and private entities: executing a master agreement between the public and private parties to proceed with development
- operating agreements between public and private entities: executing a master agreement between the public and private parties that defines the responsibilities for operation and maintenance of public, private, and common spaces and/or facilities.

5.0.2 **THE DEVELOPMENT STAGE** (PROJECT IMPLEMENTATION)

The events leading to development have resulted in a single project of definable location and scale. Four tasks--financing, leasing, design, and construction--comprise the second stage of development, which sees the design become a reality.

FINANCING

Four types of financing must be obtained to initiate a project: predevelopment financing, long-term mortgages, equity funds for activities not covered by basic mortgages, and short-term construction loans. Financing can be either public or private.

The degree of public invovlement in and public contribution to financing depends upon the strength of the local market, which is determined during predevelopment. Therefore, the amount and type of public financing has been determined before the development stage. During this stage, public activities are involved in preparing and marketing the financial instruments--usually bonds of some type (general obligation, special assessment, tax increment, revenue, etc.). Private financing arrangements and instruments are also finalized during this stage. They include life insurance companies, commercial banks, savings banks, savings and loan associations, pension and trust funds, real estate investment trusts, foreign funds, and individual or corporate investors.

LEASING

The objective of leasing is to secure final commitments from tenants. Leasing affects long-term financing arrangements of the project: Lenders are more likely to finance projects that have solid commitments from tenants. A well organized marketing program can attract numerous potential tenants. Lease negotiation is a challenging art. On one hand, the potential tenant, particularly a major one, can make difficult demands for rates and terms. On the other hand, the developer has designed a project that is attractive to potential tenants and that he hopes cannot be duplicated elsewhere except at rates and terms unacceptable to the tenant. Thus, lease negotiation, even after basic commitments have been made, can be protracted, difficult, and demanding of the developer's best skills.

DESIGN

The design of the project is influenced by market studies, requirements of precommitted tenants, cost and site constraints, the developer's preferences, and applicable government regulations. While the concept was defined during the predevelopment stage, during development the design team creates specific plans for the project. The design team often includes many professional skills and their interaction toward a final design that achieves the development program's objectives. Ideally, the design team works directly with the principal officers of the development company.

The criteria for selecting a design team often evolves around previous experience with the developer or the possession of specilized skills, such as knowledge of local codes or ordinaces. Frequently, when public and private uses are linked in the same project, two design teams can be involved--one for public components and one for private components.

This situation should be avoided if at all possible, but if it must occur, then one design team should have a senior position and a way to coordinate design efforts must be established.

CONSTRUCTION

The final activity during the development stage is construction of the project. Construction management is a sophisticated endeavor, which inlcudes initiating and administering contracts, overseeing bidding and negotiations, supervisiong contractors and subcontractors, scheduling activities, and monitoring work progress. Its objective is to complete the project according to the cost and schedule established during contract negotiations. Because large downtown projects may have many elements and phases, design and construction often overlap by the use of such techniques as design-build and accelerated or fast-tract construction.

5.0.3 **THE POSTDEVELOAPMENT STAGE** (PROJECT MANAGEMENT)

After the project has been constructed, contracts must be negotiated to ensure proper management and maintenance of the project. These agreements are based on the preliminary arrangements made during predelvopment. They stipulate relationships between the developer, the manage, and the tenants.

Three management activities are necessary to operate and maintain a downtown project. First, the project manager must provide basic services to tenants--maintaining the heating and cooling plants, providing lighting, cleaning, for example--that maintain the structure's physical viability. Second, the manager must administer financial accounts and be responsible for tenant relations. These tasks include collecting rents, managing insurance security coverage, and negotiating leases and renewals. Third, the manager is responsible for marketing and promoting the project, and public relations.

The management of a totally private project is carried out under the direct control of the owner/developer or a professional management company. The manager can provide services through its own staff or contract for services outside the organization. The objective of postdevelopment management is to ensure the long-term success of the project.

While good postdevelopment management is easy to define in concept, its application to downtown projects where there are public/private cooperative development endeavors is a relatively new and murky situation. Because such developments are all recent, little field experience of any duration can be used to define best practices. However, the development of expertise in this area may be the ultimate key to the encouragement of the joint public/private development endeavors needed to revitalize downtowns.

6.0 APPLICATION OF PROPOSED MODEL-CASE STUDIES

6.1 Introduction

The following chapter looks at two existing case studies, one located in Cambridge and the other in Boston and analyzes each one separately to determine if the new proposed optimal building height model is applicable in real practice.

Factors determining the decision to use the chosen case studies were based on the following criteria.

1. Information availability to incorporate into the proposed model.
    --project name, location, date of construction, and completion
    --project owner, developer, architect, and financial institution
    --architectural plans
    --elevations
    --sections
    --use breakdown
    --capital cost data
    --operating pro forma statement
2. Access to developers, owners, architects, and financial institutions funding the projects.
3. Building height, (approximately 20 stories)

The Massachusetts Housing Finance Agency (M.H.F.A.) provided the necessary information in this dissertation. The Agency is a self supporting state agency charged with financing and promoting the construction, purchase, and rehabilitation of housing, in the Commonwealth.

The Agency does this through loan programs designed to stimulate the construction of mixed-income rental housing, assist in the preservation of the Commonwealth's existing housing stock, and provide homeownership opportunities for low and moderate income households.

The M.H.F.A. raises money for its loan programs through the sales of tax-exempt securities to private investors. Sale proceeds are loaned to qualified borrowers, either directly by the Agency or through local lenders, at reduced interest rates. This approach enables the Agency to finance housing at cost savings, while encouraging private sector participation in the provision of safe and affordable housing for Massachusetts residents.

CASE STUDIES CHOSEN

Development Name Location City or Town	Developer's Name Address	Contractor's Name Address	Architect's Name Address	Started Ended	No. of floors (Basement Incl)	Apartments	Bedrooms Per Apartment 0 1 2
929 House 929 Mass Ave. Cambridge	Mac Davis Realty 929 Mass Ave. Cambridge, MA 02139	Mc-Bell Con. Corp. 351 Harvard St. Cambridge, MA 02138	Brattle Street Assoc. 236 Huron Ave. Cambridge, MA 02139	6/71 2/75	22	Total: 94	16 71 7 Original Loan: $3,366,774 Elderly: 0
	Conway Corp. c/o Alex McNeil & Assoc. 420 Providence Hwy Westwood, MA 02090	Sturoy Oak Con. Co. 420 Providence Hwy. P.O. Box 407 Westwood, MA 02090					
Symphony Plz West 333 Mass Ave. Boston-Fenway	State Street Develop. 84 State St. Boston, MA 02109	Taylor, Woodrow, Blitman Con. Co. 10 Tremont St. Boston, MA 02108	Arch Plan, Inc. 84 State St. Boston, MA 02109	9/76 1/79	18	Total: 216	62 139 15 Original Loan: $8,541,200 Elderly: 215

929 HOUSE CAMBRIDGE, MASSACHUSETTS

Floor Breakdown:
1 elevator machine room
1 roof & elevator penthouse
13 residential
    4 upper @ 4,200 = 16,800 6 units
    1 transitional@ 3,900 = 3,900 6 units
    8 lower level @ 4,800 = 38,400 8 units
2 offices
1 mezzanine
4 parking (below grade) = 108 spaces
22 floors

SYMPHONY PLAZA WEST

Floor Breakdown
1 elevator machine room =
15 residential @ 10,300 = 154,4500 216 units
1 commercial =
1 parking util, laund., stor. = 22 parking spaces
18 floors

6.2 929 HOUSE, CAMBRIDGE, MASS.

Extreme-Range Interpolation

6.2 929 House, Cambridge, Mass.

For purpose of illustration, consider an existing high-rise residential building project with rentable units built in 1971. Later an analysis is conducted to determine if in fact the height chosen was optimal building height level. If not, then what were the factors that determined the height. All necessary data such as capital cost breakdown, loan equity terms, revenue, operating expenses, type of depreciation and tax bracket of owner etc...is available.

The following are assumptions leading to the analysis of the return on investment measures at various floors for 929 House through the extreme range-interpolation method.

-- Original architectural drawings do not indicate the low-rise structure that exists today on the site. The assumption is therefore that the 1971 application for financing to the M.H.F.A. does not take into account the additional structure.

-- Original architectural plans indicate laundry and storage space at top level. Existing conditions indicate two apartment units at top level with laundry at plaza level. For simplicity and because we have the figures to the original architectural floor plans, we will use the 94 units to calculate revenue for residential use.

-- Because top floors, elevator machine room and elevator penthouse, are not typical, we will decided to increase and decrease floors by typical upper level apartment floors with a gross square foot of 4,200.

-- Floor height of 929 House is 18 stories with an additional 4 levels of parking below grade. (See case studies chosen.)

-- The designated range for investigation is three floors above and below existing height H. This range is due to the fact that the last three levels of apartments are typical floors, while the fourth level, (from the top to bottom), is not. This will simplify the analysis.

-- The range has been identified as H-n, H and H+n.

-- The return on investment measures for H-n, H, and H+n are based on M.H.F.A. capital costs and the operating pro forma statement.

ASSUMPTIONS FOR CAPITAL COST BUDGET

Total Square Foot of Building

Increases and decreases of total square foot of building is based on a typical upper level apartment floor with a gross square foot of 4,200.

Average Construction Cost Per Square Foot

The average construction cost per square foot increased and decreased by 1% per every floor. This is based on Kingston and Clark's research on the effect of square foot costs to building height. See Appendix, Section 8.2.1. (More accurate figures would be available from experts in the field of construction cost estimates for desired floor height.)

Total Construction Fees

Total construction fee increase and decrease based on the total square foot of building multiplied by the average square foot of construction cost, minus the demolition and site work. The variable is the average square foot of construction cost.

Carrying Charges and Financing

These costs are dependent on the construction period. As the length of construction period increases or decreases, so does the carrying charges and financing. See Appendix Section 8.2.2. (Professional advise is recommended.)

Legal And Orgnaization

Legal and organization increases and decreases are based on the construction period.

Land Cost

Original land cost will remain constant while land residual will vary depending on replacement cost.

Total Replacement Cost

Total replacement costs equal the addition of all the above.

Total Equity

Total equity is based on 10% of the total replacement cost (provided by M.H.F.A. in 1971).

Total Loan Amount (Permanent)

The total loan amount is equal to the total replacement cost minus total equity.

Construction Period

The construction period will increase and decrease in direct proportion to an increase and decrease of building height, approximately 10 days with each additional story. This also depends on type of construction. See Appendix Section 8.2.2.

Permanent Loan

The Permanent loan, rate, @7% term, 40 years) the permanent loan is determined by total replacement cost minus total equity. Loan provided by M.H.F.A.

*Technically the demolition and site work costs should not increase or decrease with an increase or decrease in floor heights. Unfortunately, the format in which the construction cost breakdown figures have beeb presented require us to also increase these figures.

ASSUMPTIONS FOR TOTAL ANNUAL INCOME AND EXPENSES

INCOME

Residential Rents

Residential rents increase and decrease based on the number, type and location of units. (See appendix, section 8.2.4).

Commercial Rents

Commercial rents stay constant, They are not affected by the increase or decrease of residential floors above. This is true only for this case.

Parking Rents

Parking stalls will increase and decrease based on each additional increase or decrease of units. (One stall is allocated for each residential unit.)

Vacancy Collection Ratio

The vacancy collection raito is based on M.H.F.A. standards.

EXPENSES

Management Fees

Commercial Fees stay constant while residential fees increase and decrease with relation to number of floors. At 13 residential floors management fees = 11,672 Interpolation to get figures within designated H-n and H+n range.

Heating

Commercial fees stay constant while residential fees increase and decrease with relation to number of floors. At 13 residential floors heating fees = 41,718 Interpolate to get figures within designated H-n and H+n range.

Maintenance

Commercial fees stay constant while residential fees increase and decrease with relation to number of floors. At 13 residential floors maintenance fees = 9,924 Interpolate to get figures within designated H-n and H+n range.

Replacement Reserve

Commercial fees stay constant while residential fees increase and decrease with relation to number of floors. At 13 residential floor repalcement reserve fees = 10,218. Interpolate to get figures within designated H-n and H+n range.

Annual Taxes

Commercial real estate taxes along with employee payroll taxes stay constant. The real estate taxes are based on the assessed value of the project and the annual tax rate of tax levy. Because this information is not available to us we will increase and decrease the taxes with relation to the increase and decrease on the number of floors of the project. Interpolate to get figures within designated H-n and H+n range.

Miscellaneous

No miscellaneous items are taken into account.

Return on Equity Investment

Return on equity investment is based on 6% interest on the equity given to the owner by M.H.F.A. The amount of equity is based on 10% of the total replacement cost.

Total Annual Expense

The total annual expenses is the addition of the following items:

Total Annual Oper. Expense
Total Annual Taxes
Miscellaneous
Return on Equity Investment to M.H.F.A.
= Total Annual Expense

Debt Service

The permanent loan is assumed to be a fixed rate mortgage for H-n and H+n. (term 40 years, rate = 7%)

	Loan	Principle	Debt Service/Yr
H+n=25	3,755,699	18,813	281,712
H =22	**3,366,774**	**16,865**	**251,161**
H-n=19	2,995,761	15,006	224,709

Depreciation

	Tot. Replct. Cost	Land	*Depreciation
H+n=25	4,172,998	350,000	3,822,998 x 0.5 = 191,150
H =22	**3,740,860**	**350,000**	**3,390,860 x .05 = 169,543**
H-n=19	3,328,623	350,000	2,978,623 x .05 = 148,931

*The depreciation method used is:

200% declining balance where 100%/40 yrs = 2.5% x2 = 5%/yr.

*CAPITAL COST BUDGET

	H-n=19	M.H.F.A. HGiven=22	H+n=25
Total Sq. Ft. of Bldg.	112,093	124,693	137,293
Ave. Const. Cost/S.F.	24.09	24.83	25.58
Construction Items			
*demo. & site work		65,000	
residential		2,586,729	
accessory buildings			
bond premium		17,400	
sub-total const. items		2,669,129	
Construction Fees			
builders gen. O.H.@2%		53,382	
builders profit @10%		266,912	
archit. fee-design @3%		80,073	
archit. fee-inspec.@1%		26,691	
sub-total const. fees		427,058	
TOTAL CONST. FEES	**2,700,320**	**$3,096,187**	**3,511,955**
Carrying Chgs. & Finan.			
Const. loan 18mo.@6% on $1,750,000		157,500	
real estate taxes		41,006	
insurance		15,000	
MHFA applic. fee		500	
MHFA finan. fee (1%)		33,667	
MHFA site inspec. fee		--	
recording expenses		12,000	
rent-up & mktg. exp.		20,000	
total carrying chgs. & financing	**264,136**	**$ 279,673**	**295,210**
Legal & Organizational			
legal		10,000	
organizational		5,000	
total legal & organ. exp.	**14,167**	**$ 15,000**	**15,833**
Land Costs			
Land: 14,000sq.ft. x $25/sq.ft.		350,000	
carrying chgs. & exp.		--	
total land cost	**350,000**	**$ 350,000**	**350,000**
TOTAL REPLACEMENT COST	**3,328,623**	**$3,740,860**	**4,172,998**
TOTAL EQUITY(10%of T.R.C.)	**332,862**	**$ 374,086**	**417,299**
TOTAL LOAN AMOUNT	**2,995,761**	**$3,366,774**	**3,755,699**
term 40 years, rate 7%			
Construction period	**17M**	**18M**	**19M**

***Extracted from the 6/30/71 M.H.F.A. Application for Mortgage Financing**

*TOTAL ANNUAL PROJECT INCOME-EXPENSES

INCOME	H-n=19	M.H.F.A H Given=22	H+n=25
Residential rents	240,128	297,000	353,872
Less Vacancy (3.9%)	9,365	11,600	13,801
Sub-total residential	**230,763**	**285,400**	**340,071**
Commercial	86,700	86,700	86,700
Less Vacancy (5.0%)	4,300	4,300	4,300
Sub-total commercial	**82,400**	**82,400**	**82,400**
Parking	28,350	34,020	39,690
Less Vacancy (5.0%)	1,418	1,701	1,985
Sub-total parking	**26,932**	**32,319**	**37,705**
TOTAL EFFECTIVE GROSS INCOME	**340,095**	**400,119**	**460,176**
EXPENSES			
Oper. Exp. (line 1)	68,172	85,141	102,110
Total Taxes (line 2)	37,169	41,372	45,575
Misc. (line 3)	--	--	--
TOTAL OPERATING EXPENSES	**105,341**	**126,513**	**147,685**
DEBT SERVICE: ANNUAL PAYMENT FOR INTEREST AND PRINCIPLE TO M.H.F.A.(3,336,774)	**224,709**	**251,161**	**281,712**
EQUITY at 6% INTEREST	**19,972**	**22,445**	**25,038**

***Extracted from the 6/30/71 M.H.F.A. Application for Mortgage Financing**

TOTAL ANNUAL PROJECT EXPENSES

	H-n=19		M.H.F.A. H Given=22		H+n=25	
	COMM.	RESID.	COMM.	RESID.	COMM.	RESID.
Management						
fee			4,207	11,672		
other						
subtotal mgt.	4,207	8,978	4,207	11,672	4,207	14,366
Total Management	**13,185**		**15,879**		**18,573**	
Heating						
fuel (htg/hot water)			1,440	16,526		
elec. power			1,007	6,541		
elevator power			83	365		
elevator maint.			500	2,186		
water			347	2,281		
gas			--	--		
garbage & trash remov.			125	819		
payroll (att. schd)			1,500	9,000		
insurance			500	3,500		
janitorial mater.			50	500		
other						
subtotal operating	5,552	32,091	5,552	41,718	5,552	51,345
Total Operating	**37,643**		**47,270**		**56,897**	
Maintenance						
decorating						
($ /unit per year)			800	4,700		
repairs			500	4,324		
extgerminanting			50	400		
ground materials				500		
other						
subtotal maint.	1,350	7,634	1,350	9,924	1,350	12,214
Total Maintenance	**8,984**		**11,274**		**13,564**	
Replacement Reserve	500	7,860	500	10,218	500	12,576
Total Replct. Reserve	**8,360**		**10,718**		**13,076**	
subtotal annual	**11,609**	**56,563**	**11,609**	**73,532**	**11,609**	**90,501**
TOTAL ANNUAL OPER. EXPENSES	**$68,172 (1)**		**$85,141 (1)**		**102,110(1)**	
Annual Taxes						
real estate			10,500	30,390		
employee payroll			50	432		
other						
subtotal taxes	10,550	26,619	10550	30,822	10,550	35,025
TOTAL ANNUAL TAXES	**$37,169(2)**		**$41,372 (2)**		**$ 45,575(2)**	
Miscellaneous	**$ -- (3)**		**$ -- (3)**		**$ -- (3)**	
Returned on Equity Invst. @ 6% rate	**$19,972(4)**		**$22,445 (4)**		**$ 25,038(4)**	
TOTAL ANNUAL PROJECT EXPENSES	**$125,313**		**$148,958**		**$172,723**	

OPERATING PRO FORMA
(STATIC)

	H-n=19	MHFA HGiven=22	H+n=25
Gross Income	355,178	417,720	480,262
Less Vacancy	15,083	17,601	20,086
Eff. Gross Income	340,095	400,119	460,176
Oper.Exp.	105,341	126,513	147,685
Net. Oper. Income	234,754	273,606	312,491
Less Debt Service	224,709	251,161	281,712
Less Equity Int.	19,972	22,445	25,038
Before Tax Cash Flow	(9,927)	-0-	5,741
Less Depreciation	148,931	169,543	191,151
Add Principle	15,006	16,865	18,813
Taxable Income	143,852)	(152,678)	(166,596)
Less Tax Payment	(71,926)	(76,339)	(83,298)
After Tax Cash Flow	61,999	76,339	89,039

RETURN MEASURES
(STATIC)

	H-n=19	Interpolation		MHFA HGiven=22	Interpolation		H+n=25
R.O.T.A.	7.05%	7.14%	7.22%	7.31%	7.37%	7.43%	7.49%
R.O.E.(B.T.C.F.)	(2.98%)	(1.99%)	(1.00%)	-0-	.46%	.92%	1.38%
R.O.E.(A.T.C.F.)	18.63%	19.22%	19.82%	20.41%	20.72%	21.03%	21.34%

Conclusions

Based on the 929 House case study analysis, optimal height level does not fall within the designated range of 19 to 25 floors. Optimal height falls outside this range, somewhere above 25 floors. Therefore the best choice within that range would have been a height of 25 floors. This conclusion is based on the assumptions of:

capital cost budget
increases and decreases
total annual income and expenses increases and decreases
type of permanent loan financing
operating pro forma statement increases and decrease
results of selected return measures

We can see that the return measures increase with an increase of each floor. This is one indication that external factors influenced the height chosen.

At this point there is a necessity to expose and analyzed the external factors, (the factors not accounted for in the proposed optimal building height model), that influenced the height of 929 House. These external factors might include:

--marketability
--available funds
--public support
--political support
--environmental impact of neighborhood and city
--zoning regulations
--traffic, parking
--infrastructure
--pedestrian
--other

After discussing with the owners of 929 House the final height decision was primarily based on two major factors. One was public support regarding the existence of high-rise buildings in Cambridge, Massachusetts. The other factor was traffic and parking. If public support was favorable and building height increased, then the traffic and parking requirements would increase, thus requiring more space. This would have resulted in additional costs for the additional floors of parking.

It is also apparent that a zoning varience was required to proceed with the construction of this development in fill. This is based on the current low-rise heights of existing buildings around the site.

6.3 SYMPHONY PLAZA WEST, BOSTON, MASS.

Range-Marginal Analysis

6.3 Symphony Plaza West, Boston, Mass.

For purpose of illustration, consider an existing high-rise residential building project with rentable units built in 1976. Later an analysis is conducted to determine if in fact the height chosen was optimal building height level. If not, then what were the factors that determined the height. Necessary data for construction cost breakdown figures at H+n and H-n are not available because they would be too costly to acquire or would consume too much time to calculate. Here, a different technique for finding the optimum is requried. That technique is marginal analysis.

The following are assumptions leading to the analysis of the return on investment measures at various floors for Symphony Plaza West through the range-marginal analysis method.

GENERAL ASSUMPTIONS

- -- floor height of Symphony Plaza West is 18 stories (see case studies chosen).
- -- The designated range for investigation is five floors above or below existing height H. This decision is based on existing height.
- -- The range has been identified first as H and H+1, and second as H and H+n or H and H-n, depending on return measure results.
- -- The return on investment measures for H are based on M.H.F.A. capital costs and the operating pro forma statement.

ASSUMPTIONS FOR CAPITAL COST BUDGET

Total square foot of building

Increases and decreases of total square foot of building is based on a typical floor apartment with a gross square foot of 10,300.

Average construction cost per square foot

The average construction cost per square foot increased and decreased by 1% per every floor. This is based on Kingston and Clark's research on the effect of square foot costs to building height. See Appendix, Section 8.2.1. (More accurate figures would be available from experts in the field of construction cost estimates per desired floor height.)

Sub-total direct costs

Data on itemized direct costs not available. The figure will be added to the construction fees.

Total Construction Costs

Total construction fees increase and decrease based on the total square foot of building multiplied by the average square foot of construction cost, minus anything not being affected by increases and decreases of height.

Carrying charges and finance

These costs are dependent on the construction period. As the length of construction period increases or decreases, so does the carrying charges and financing. See Appendix Section 8.2.2. (Professional advise is recommended.)

Total development cost

Total development cost is the addition of all the above minus land cost.

Total land cost

Original land cost will remain constant, while land residual will vary depending. This is based on the capitalized value of the building (net income divided by a capitalization rate) minus development costs. In this way, the developer can determine what value has been added to the land by the project.

Total Replacement Cost

Total replacement costs equal the addition of all the above. Land cost is included.

Total Equity

Total equity is based on 10% of the total replacement cost.

Total loan amount (permanent)

The total loan amount is equal to the total replacement cost minus total equity.

Construction period

The construction period will increase and decrease in direct proportion to an increase and decrease of building height, approximately 10 days with each additional story. This also depends on type of construction. See Appendix Section 8.2.2.

ASSUMPTIONS FOR TOTAL ANNUAL INCOME AND EXPENSES INCOME

Residential Rents

Residential rents increase and decrease based on the number, type, and location of units. (See Appendix, Seciton 8.2.4)

Commercial rents

Commercial rents stay constant. They are not affected by the increase or decrease of residential floors above. This is true only for this case.

Parking rents

Parking rents stay constant. They are not affected by the increase or decrease of residential floors above. This is true only for this case.

Vacancy collection ratio

Vacancy and collection ratio is based on M.H.F.A. standards.

EXPENSES

Management fees

Commercial fees stay constant while residential fees increase and decrease with relation to number of floors. At 16 residential floors management fees = 57,927. Calculate to get figure for H+1.

Operating expenses

Commercial fees stay constant while residential fees increase and decreaes with relation to number of flolors. At 16 residential floors heating fees = 174,619. Calculate to get figure for H+1.

Maintenance

Commercial fees stay constant while residential fees increase and decrease with relation to number of floors. At 16 residential floors maintenance fees = 23,760. Calculate to get figure for H+1.

Replacement reserve

Commercial fees stay constant while residential fees increase and decrease with relation to number of floors. At 16 residential floors replacement reserve fees = 35,807. Calculate to get figure for H+1.

Total Annual Expenses

The total annual expenses is the addition of the following items:

Total Annual Oper. Expenses
Total Annual Taxes
Miscellaneous
Return on Equity Investment to M.H.F.A.
= Total Annual Expense

Annual taxes

Commercial real estate taxes along with employee payroll taxes stay constant. The real estate taxes are based on the assessed value of the project and the annual tax rate of tax levy. Because this information is not available to us we will increase and decrease the taxes with relation to the increase and decrease on the number of floors of the project.

Miscellaneous

No miscellaneous items are tekaen into account.

Return on equity investment

Return on equity investment is based on 6% interest on the equity given to the owner by M.H.F.A. The amount of equity is based on 10% of the total replacement cost.

Debt service @ H+1

The permanent loan is assumed to be fixed rate mortgage for H+1. (Term 30 years, rate 7.41%)

	Loan	Principle	Debt Service
H+1=19	9,017,920	88,651	756,879
H =18	8,549,600	84,047	717,879

Depreciation

	Tot. Replct. Cost	Land	* Depreciation
H+1=19	10,019,911	70,350	9,949,561x.05=497,478
H =18	9,499,597	70,350	9,949,247x.05=471,462

Debt service @ H+n=23

Loan @ 30 years term, 7.41% rate

	Loan	Principle	Debt Service
H+n=23	10,977,215	107,912	921,324

Depreciation

	Tot. Replct. Cost	**Land**	*** Depreciation**
H+1=23	12,196,905	70,350	12,126,555x.05=606,328

*The depreciation method used is: 200% declining balance where 100%/40yrs. = 2.5% x 2 = 5%/yr.

*CAPITAL COST BUDGET

	M.H.F.A. HGiven=22	H+1=19	H+n=23
Total Sq. Ft. of Bldg.	193,401	203,701	244,901
Ave. Const. Cost/S.F.	40.71	41.12	42.79
Subtotal Direct Costs	6,666,532		
Construction Fees			
Construction Fees			
Surveys, permits, etc. premium	35,950		
Archit. fee-design	224,205		
Archit. fee-inspec.	64,261		
Clerk of works	25,000		
Developer's fee	855,250		
sub-total/ const. items	1,207,666		
TOTAL CONST. FEES	**$7,876,185**	**8,376,185**	**10,479,314**
Development Costs			
Carrying Chgs. & Finan.			
Const. loan interest	987,680		
Real estate taxes	22,000		
Insurance	360,000		
MHFA applic. fee	350		
MHFA finan. fee (1%)	85,496		
fee	34,213		
MHFA site inspec. fee	150		
Organizational & acctg.	10,000		
up and mktg. exp.	21,500		
other fin. fees	409,881		
rental income			
Total Development Costs	**$1,555,049**	**1,573,376**	**1,647,241**
Total Land Cost	**70,350**	**70,350**	**70,350**
TOTAL REPLACEMENT COST	**1$9,449,59**	**10,019,911**	**12,196,905**
TOTAL EQUITY	**$ 949,997**	**1,001,991**	**1,219,690**
TOTAL LOAN AMOUNT	**$8,549,600**	**9,017,920**	**10,977,215**
term 40 years, rate			
Construction period	**28M**	**28.33M**	**29.66M**

***Extracted from the 9/21/76 Application for Mortgage Financing**

*TOTAL ANNUAL PROJECT INCOME-EXPENSES

INCOME	**M.H.F.A H Given=18**	**H+1=19**	**H+n=23**
Residential	088,748	1,1,159,315	1,428,982
Less Vacancy (5%)	54,437	57,966	71,449
Sub-total residential rents	**1,034,311**	**1,1,101,349**	**1,357,533**
Commercial	120,696	120,696	120,696
Less Vacancy (5%)	6,035	6,035	6,035
Sub-total commercial	**114,661**	**114,661**	**114,661**
Parking	10,080	10,080	10,080
Less Vacancy (5%)	504	504	504
Sub-total parking	**9,576**	**9,576**	**9,576**
TOTAL EFFECTIVE GROSS INCOME	**158,548**	**1,1,225,586**	**1,481,770**
EXPENSES			
Tot. Oper. Exp.(line 1)	292,113	310,370	383,398
Real Estate Taxes(line 2)	91,538	97,259	120,144
TOTAL OPERATING EXPENSES	**383,651**	**407,629**	**503,542**
DEBT SERVICE: ANNUAL PAYMENT FOR INTEREST AND PRINCIPLE TO M.H.F.A.	**717,879**	**756,879**	**921,324**
EQUITY at 6% INTEREST (line 3)	**57,000**	**60,119**	**73,181**

***Extracted from the 9/21/76 Application for Mortgage Financing**

OPERATING PRO FORMA
(STATIC)

	M.H.F.A. HGiven=18	H+1=19
Gross Income	1,219,524	1,290,091
Less Vacancy	60,976	64,505
Eff. Gross Income	1,158,548	1,225,586
Oper.Exp.	383,651	407,629
Net. Oper. Income	774,897	817,957
Less Debt Service	717,897	756,879
Less Equity Int.	57,000	60,119
Before Tax Cash Flow	-0-	959
Less Depreciation	471,462	497,478
Add Principle	84,047	88,651
Taxable Income	(387,415)	(407,868)
Less Tax Payment	(193,708)	(203,934)
After Tax Cash Flow	193,708	204,893

RETURN MEASURES

	M.H.F.A. HGiven=18	H+1=19
R.O.T.A.	8.16%	8.16%
R.O.E.(B.T.C.F.)	-0-	.10%
R.O.E.(A.T.C.F.)	20.39%	20.45%

In all cases the return on investment measures chosen for H+1 are greater than HGiven, therefore:

--optimal building height is above the existing height H
--the floors should be increased

The designated range H+n will be 5 floors above H.

OPERATING PRO FORMA
(STATIC)

	M.H.F.A. HGiven=18	19	20	21	22	H+n=23
Gross Income	1,219,524	1,290,091				1,559,758
Less Vacancy	60,976	64,505				77,988
Eff. Gross Income	1,158,548	1,225,586				1,481,770
Oper.Exp.	383,651	407,629				503,542
Net. Oper. Income	774,897	817,957				978,228
Less Debt Service	717,897	756,879				921,324
Less Equity Int.	57,000	60,119				73,181
Before Tax Cash Flow	-0-	959				16,277
Less Depreciation	471,462	497,478				606,328
Add Principle	84,047	88,651				107,912
Taxable Income	(387,415)	(407,868)				(514,693)
Less Tax Payment	(193,708)	(203,934)				(257,347)
After Tax Cash Flow	193,708	204,893				241,070

RETURN MEASURES
(STATIC)

	M.H.F.A. HGiven=22	H-n=19	Interpolation			H+n=23
R.O.T.A.	8.16%	**8.16%**	8.13%	8.09%	8.05%	8.02%
R.O.E.(B.T.C.F.)	-0-	**.10%**	(.03%)	(.06%)	(.097%)	(1.33)%
R.O.E.(A.T.C.F.)	20.39%	**20.45%**	20.28%	20.11%	19.93%	19.76%

CONCLUSIONS

Based on the Symphony Plaza West case study analysis we see that optimal building height falls above the existing height. Analyzing a five floor range above existing height H we see that opitimal building height level falls within the designated range of 18 to 23 floors. Optimal building height is at the 19th level. This conclusion is based on the assumptions of:

Capital cost budget increases and decreases
Total annual income and expenses increases and decreases
Type of permanent loan financing
Operating pro forma statement increases and decreases
Results of selected return measures

We can see that the return measures increase from the 18th to 19th floor while decreasing from 20th thru 23rd floors. This could be one indication that external factors influenced the height chosen.

*At this point there is a necessity to expose and analyze the external factors, (the factors not acounted for in the proposed optimal building height model), that influenced the height of Symphony Plaza West. These external factors might include:

--marketability
--available funds
--public support
--political support
--environmental impact on neighborhood and city
--zoning regulations
--traffic, parking
--infrastructure
--pedestrian
--other

Although this exercise is to confirm the model's applicability in real practice, Symphony Plaza West is only 1/2 of the total development package presented to the M.H.F.A. Across the street stands it's twin, Symphony Plaza East. Dependent to one another, they form one entity conceived by the market demand for elderly housing.

*Repeated attempts to contact the developers of Symphony Plaza West for height determination, throughout this dissertation has been without success.

7.0 EVALUATION AND CONCLUSIONS

7.1 LIMITATIONS

--It's possible that for proposed projects, one can design based on optimal heighty determination at a given time, but a few years later, based on economic conditions and market demand, optimal height may not be at the chosen height. This situation deals with future uncertainties which can be difficult to predict.

This issue brings up the question: do we base our height determination on current conditions, future conditions or both. If it is for future conditions: then for how far into the future? These issues would probably better be handled by marketing analysts who could advise the private investor with which decision to take, based on expected market demands.

--Limitations and choices on return measure analysis, explained in Chapter 4.5, clearly identifies the complexity on height determination results. Appropriate return measure ratios must be chosen to justify economic height determinaiton, return on equity, which utlilizes cash flow, is emphasized the most.

7.2 FUTURE RESEARCH

The following are future research recommendations derived from the economic model's applicability in real practice.

--At present the developer depends on other professions to provide him with additional increases and decreases of capital cost figures. In time, collected capital cost figures for high-rise developments can provide the developer with his own necessary data, thus minimizing the dependence on other professions.

Capital cost ranges and percentages can be collected and organized based on:

Building type
Building height -**cost/unit**
Building material

The economic model can then be computed into a spread sheet program with appropriate formulas to increase and decrease variable capital cost figures for increased and decreased floor heights. These formulas, based on previous collected capital cost figures for high-rise developments, would require the accuracy that would otherwise have been provided by other professions in the field.

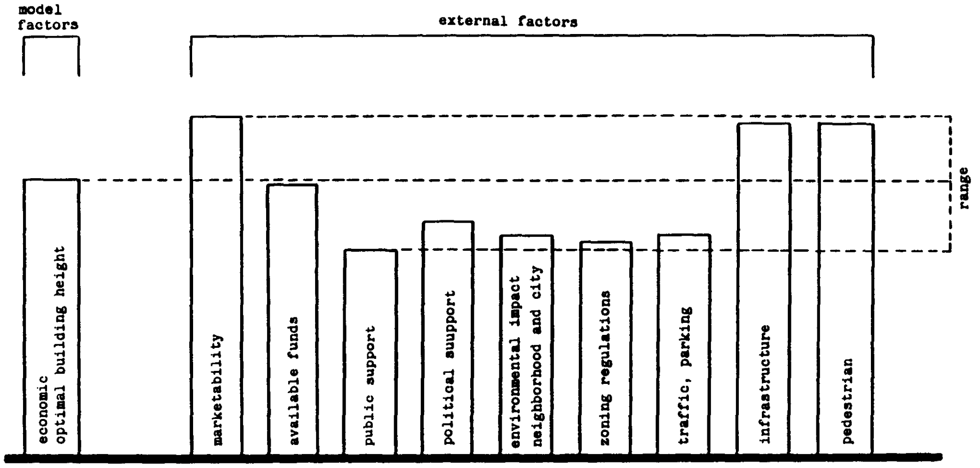
--Cost and revenue figure flexibility within the econimic model can greatly influence the return on investment measures. Accurate data on figures is critical as is the clear understanding of the framework for each cost-revenue item.

Future research on the economic model would perhaps be an analysis on the cost-revenue items indicating their clear range and limitations. Minimizing ambiguities, between each item and what is contained under that item in terms of services and costs, would be the primary objective. Ultimately this would refine height determination decisions.

--The proposed economic model examined factors of cost versus revenue for optimal height determination. The model excludes external factors vital to a building's height determination. These vital external factors not included in the model, after economic height is chosen might be:

Marketability
Available funds
Public support
Political support
Environmental impact of neighborhood and city
Zoning regulations
Traffic, parking
Infrastructure
Pedestrian
Other

Future research indicates the need for the development of an additional model which exposes, organizes, analyzes and manages the external factor that eventually influence the economic height determination. This model would link with the economic model for final height determination. (See diagram below.)



Developer's Economic and External Factor
Height Determination Diagram

The external factors can be listed based on developer's priority, then analyzed separtely to determine the relationship and effect on the economic height.

--After completion of the economic/external factors model, a dynamic operating pro forma analysis, from years two to ten can provide data on future return on investment measures. The projected operating pro forma variables can be computed into a spread sheet program and inflated or deflated to finally determine what effect they will have on the private investor's return on investment measures through designated years. This information would better prepare the owner for future decision-making situation regarding unexpected increases in expenses for the project.

--Real estate investors conducting feasibility analysis on existing high-rise developements would normally buy based on a reasonable return on their investment. In some cases, where the possibility that optimal height might fall above the existing heights and structural considerations are favorable to adding additional floor levels, the economic model for optimal height determination is an advantage for maximizing return.

--Determining optimal building height can take additional time and cost within the developments process. However, this is not a major factor. The increase experienced in the return measures from optimal height design overrules this.

Case study analysis of time/cost versus optimal height return measures would further reveal model's viability in real practice.

8.0 APPENDIX

8.1 ADDITIONAL FACTORS ENCOURAGING HIGH-RISE BUILDINGS

There are many varied psychological, economic, and in some cases, peripheral reasons for the construction of high rise buildings.

--There is the natural urge to build up, and this has been true from earliest of times.

--A tall building provides a sense of place.

--There is a natural urge to be at the centre of things.

--Ambition, power, and prestige has figured from earliest times.

--Land cost is frequently cited as a factor--and is a real one.

--There is the efficiency of vertical transportation (It is only 9 to 12 ft.) to a new environment.

--The tall building is an important instrument for shaping space.

--It can make possible the preservation of parks and other green space, providing opportunity for needed mental and spiritual renewal.

--It can provide for better urban living since the higher concentration can justify more amenities.

--In early days they were sources of safety (castles on peaks, tree houses, buildings on stilts) and even today their engineered construction is such that tall buildings are most likely safer than low-rise structures.

--There is a sense of social power of position and wealth living in tall buildings.

8.2 ANALYSIS OF VITAL FACTORS THAT CHANGE WHEN DETERMINING OPTIMAL BUILDING HEIGHT

Developers familiar with the production of high rise buildings acknowledge the impact of height on such factors as:

construction costs
carrying charges and financing
building efficiency
rental rates

All vital factors in determining project profitability, but rarely incorporate such considerations in their determinations of building densities.

The following section merely focuses on these vital factors and explains the relationships with building height.

The data on vital factors has been partially extracted from Jay S. Berger's 1967 doctoral dissertation on the Determination of the Economic Height of High-rise Buildings.

8.2.1 BUILDING HEIGHT AND CONSTRUCTION COSTS

The cost of construction, along with land costs, largely define the investor's total investment in a high-rise project, upon which he attempts to maximize returns. It has long been widely recognized that the square foot cost of construction increases with increasing building height.

This phenomenon is recognized by two major property valuation services in the United States, which provide cost estimates for building of varying uses, quality and characteristics, on a square foot and cubic foot basis for appraisal purposes. According to the E.H. Boeckh Manual of Appraisals:

> The height of a building will have a very marked effect on its cost. Besides variations in cost due to normal differences in specifications, workmanship, and materials, the number of stories in a building must be given full consideration. In other words, a 15-story building and a 25-or-50-story structure of the same general construction will not have the same base price per cubic foot of volume. This is due to the fact that as the height of a building increases, the increases in the various construction components do not vary in any direct ratio. Mechanical equipment and structural steel costs go up in an increasing ratio, foundation and roofing in a decreasing ratio, and others, such as interior and exterior finish, remain practically constant.

In the Marshall and Stevens Valuation Service, it is noted that:

> Base costs are given for buildings of three stories or less. For buildings having more floors (not counting basements), a recommended percentage adjustment is usually shown the cost pages. Where this is not shown, 1% should be added to the cost or each floor over three. This increase cost in the net of increased frame weight, construction difficulty, wage scales, etc., less savings from shorter heating and plumbing runs, a single roof, quantity savings, etc.

Kingston and Clark also noted the tendency for square foot construction costs to increase as building height increased...

Kingston and Clark also noted in some detail the behavior of the major cost components over height, indicating those construction cost factors which increased, decreased, or remained constant over height. Of those factors which tended to increase with increases in building height, the authors found that the costs of the structural frame and the mechanical equipment were most significant. Kingston and Clark also noted the increase in construction costs occasioned by increasing vertical transportation costs associated with increasing building height...

It can be noted from Table I that the cost per square foot of the 15-story building designed by Kingston and Clark is somewhat lower than that of the eighty-story building. This may be explained by the existence of certain cost components which decrease with increasing height, on a square-foot basis.

TABLE I

BUILDING COSTS PER SQUARE FOOT OF NET RENTABLE AREA

Building Height	Square Foot Costs		%incr./fl.
8 stories	9.29		
15 stories	9.10		
		.36 = 4.0% increase/7	= .57%
22 stories	9.46		
		.64 = 6.7% increase/8	= .84%
30 stories	10.10		
		.41 = 3.9% increase/7	= .56%
37 stories	10.51		
50 stories	11.09		
63 stories	11.73		
75 stories	12.59		

Source: J.L. Kingston and W.C. Clark, The Skyscraper, A Study of the Economic Height of Modern Office Buildings (New York: American Institute of Steel Construciton, 1930), p. 46.

The most significant of these cost components are the cost of excavation, foundations, and roofing. Below certain heights, the square-foot cost-increasing impact of those cost components which increase with height apparently is not sufficient to outweigh the impact of the diminishing square-foot costs of excavation, foundations, and roofing. The point at which overall square foot construction costs begin to take an upward turn would appear to be largely determinined by the relative magnitude of increaseing cost components vis-a-vis the costs of excavation, foundations, and roofing...

The study by Charles Thomsen revealed substantially the same relationships. The author analyzed the square foot cost characteristics of a series of hypothetical buildings in Houston, Texas, of from 15 to 50 stories, containing from 18,814 square feet per floor (for the 15-story building) to 25,679 feet per floor (for the 50-story building). Thomsen's findings are reproduced in part in Table II.

TABLE II

SQUARE FOOR CONSTRUCTION COSTS BUILDINGS OF VARYING HEIGHT

				%incr./fl.
15 stories	25.07			
		.58=2.3%	decrease/5	= -.46/fl
20 stories	25.49			
		.21=.84%	decrease/5	= -.17%
25 stories	25.28			
		.01=	____________	= equal
30 stories	25.27			
35 stories	25.51			
40 stories	25.79			
45 stories	26.23			
50 stories	26.93			

Source: Charles Thomsen, "How High to Rise: The Appraisal Journal, XXXIV (October, 1966), p.590.

The Thomsen study showed that from 15 to 30 stories, square foot costs tended to drecrease, but that above this height, tended to increase. The author identified foundation costs and window wall costs as ones which tended to decrease on a square foot basis as building height increases.

Unfavorable to the construction of taller buildings in terms of increasing costs per increasing heights are:

Mechanical costs: Such mechanical costs as heating, air conditioning, and electrical equipment tend to rise disproportionately as the building gets taller.

Elevator costs: The cost of good elevator service per square foot went up rapidly as the building got taller.

Indirect contractor costs: Construction of a taller building requires more complicated construction equipment (cranes, elevators, etc.), greater scheduling and storage problems, etc. These costs increase disproportionately.

In sum, a number of factors can be cited as being responsible for increasing square-foot construction costs which accompany increasing building height. Insofar as specific costs components are concerned, the increasing square foot costs of the structural frame and the mechanical systems, engendered by vertical expansion, apparently are the most significant of the factors leading to overall square foot cost increases.

8.2.2 BUILDING HEIGHT AND CONSTRUCTION PERIOD

One of the more significant determinants of the profitability of a high-rise building project is the amount of time which is required to complete it. As the construction period lengthens, construction cost components such as labor, storage, and equipment rentals increase in direct proportion to the increase in construction time, thereby raising overall construction costs.

In addition to the impact of the length of the construction period on construction costs, the cost of temporary financing, were relevant, and the amount of property taxes on both land and building during the construction period also increase in direct proportion to the increase in the length of the construction period, necessitating increased cash outlays prior to the project's productive life.

Equally significant, the project's period of productivity is deferred until completion of the building, thus lowering the present value of the returns from the project over the economic life of the building.

It would seem to be obvious, then, that all things being equal, there would be a positive correlation between vertical expansion and the length of the construciton peirod. Persons interviewed in Los Angeles County during the course of this study were in complete accord that this was the case.

Empirical data on 14 post-World War II high rise office buildings in Los Angeles County were obtained for purposes of analyzing the relationship between building height and the lengh of the construciton period...

The conclusion was that the length of the construction period for high rise office buildings increases approximately one-third of a month, or 10 days with each additional story.

8.2.3 BUILDING HEIGHT AND BUILDING EFFICIENCY

Minimization of non-productive space in high rise buildings has important implications for the investor.

It is generally conceded that there is a negative correlation between building efficiency and increasing building height. As height increases, it is necessary to use an increasing amount of space for structural support, elevators, and mechanical equipment, for every square foot of rental space.

The declining in the ratio of net rentable area to gross building area associated with increasing height is largely due to the necessary explantion of the amount of building space devoted to non-income-producing service area. Each mechanical and electrical system in a given building has a series of "breaking points" i.e., additions to the amount of equipment, and therefore the amount of service space required for a given system occurred at specific heights, rather than in a smooth continuum. Increasing amount of floor space absorption by a given system, therefore, tends to take place in a step-wise fashion.

The breaking point for each of the various mechanical and electrical systems in a given building would not necessarily coincide. Given different breaking points for each systems, however, the decline in the ratio of net rentable area to gross building area accompanying increasing building height, due to the general expansion of these systems, can be expected to be more in the nature of a continuous decline than would be the case if only specific systems were involved.

It should be noted that certain service space uses, including stairways, corridors, storage areas and restrooms, do not increase as a proportion of gross building area with increasing height. The relationship between the space devoted to such uses and gross building area tends to be fixed and does not vary with increases in height: It is a function of scale rather than height.

Also, while the size of the building's structural columns increase with increasing building height, the amount of increase tends to be insignificant and therefore is of minor importance.

It is therefore the expansion of the electrical and mechanical systems, particularly the elevators, which results in decreasing ratios of net rentable area to gross building area as building height increases.

8.2.4 BUILDING HEIGHT & RENTAL RATES

A fourth determinant of building profitability which perhaps bears mention is the rental rate per square foot of rentable space which is paid by tenants of high rise office and apartment buildings. The general level of rental rates is essentially a function of building location and the demand and supply relationships at the location. Rental rates are additionally conditioned by the nature of the space and services provided, and the general condition of the buildings.

It has also been reasoned that building height is a factor explaining rental rate differentials between buildings. The effect of building height on average rental rates, then, may be an important factor determining the economic height of given high-rise office and apartment buildings.

With respect to the effect of building height on rental rates, two allied notions prevail. It is generally acknowledged that rental rates at specific story levels tend to increase with increasing height. It is further concluded that, as a result, average rental rates in high rise buildings also tend to be positively correlated with increasing height.

Data on Los Angeles County high rise office and apartment building rental patterns tended to indicate the differential pricing, based on location in vertical space, was widely practiced. Increases in per-floor rentals accompanying increasing height appeared to be more thoroughly characteristic of high-rise apartments than high-rise office buildings. All high-rise apartments upon which such information was available had rental schedules calling for rental increases with increasing height.

Of the post-World War II office buildings upon which rate-height information was obtained, 75% had rental schedules which specified increasese in per-square-foot rental rates with increasing height. Of the buildings which exhibited no such relationshp, half were wholly or almost wholly owner-occupied.

A number of persons interviewed in Los Angeles County indicated that the increase in rentals associated with increasing height was based, in part, on the prestige associated with location at greater and greater heights. Although infinitely less tangible than such factors as greater light and air, freedom from street noises and odors, and access to increasing between view, prestige appears to be a fundamental force differentials.

Through interviews in Los Angeles County, it was discovered that, in instances where rental schedules provided for increasing rental rates at alternatively higher locations in vertical space, such schedules were charactertiscally established by first arriving at an average square foot rental rate based on prevailing market rates, arbitarily setting this rate as the rental rate for space on the mid-floor, and thereafter scaling rates for individual floors upward and downward from this mid-floor rate. The effect on the average rental rate for the building, of course, would be to leave it unchanged.

Therefore, the positive correlation between rental rates at given floors and the relative location of these floors in vertical space does not inevitably lead to the conclusion that average rental rates will therefore be higher. If average rentals are higher in taller buildings due to the very factor of height, per floor rental rate differentials based on location in vertical space are not necessarily evidence thereof.

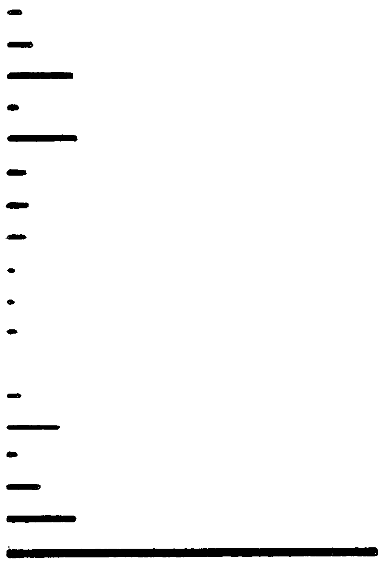
When floor levels increase in height you'll experience the following changes in the factors determining the return on investment measures. The reverse will be true when floor levels decrease in height.

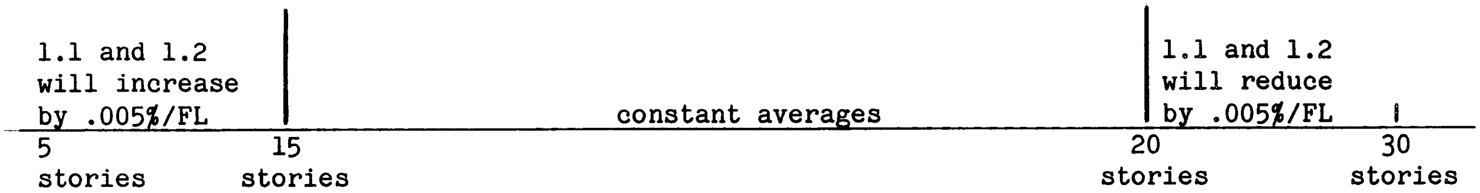
	CONSTANT	**INCREASES**	**EITHER/OR**	**DECREASES**
DIRECT COSTS	land acquisition, demolition & site work, site improvement, public improvements	construction costs, allowances (tenant fit out), sub-total, **contingency (6%)** **total direct costs**	other	building efficiency
INDIRECT COSTS		construction fees, tenant concessions, carrying changes & financing, rent-up deficit, sub-total, contingency (6%), **total indirect costs,** **total development cost,** **construction period**	predev. finan. short-term const. loan long-term mort. equity funds other	
OPERATING PRO FORMA		vacancy, gross income, effective gross income, operating expenses, net operating income, before tx cash flow tax effect, taxable income less tax payment **after tax cash flow**	debt service	

Although in general, factors determining optimal building height increase with increasing height and decrease with decreasing height, the amount in changes vary from one factor to another. Therefore, careful monitoring of each factor is vital in obtaining accurate return on investment measures. The exception to this are foundations and grade slabs.

8.3 ITEMIZED CONSTRUCTION COST PERCENTAGE AVERAGES FOR MIXED USE-HIGH RISE APARTMENTS (15-20 STORIES)

1.1	Foundations	3.00
1.2	Grade Slab	0.67
1.3	Supported Structure	17.00
1.4	Moisture Protection	2.25
2.0	Exterior Construction	18.00
3.0	Partition Systems	4.57
4.0	Finishes	4.77
5.0	Miscellaneous	3.25
6.1	Stair Construction	1.00
6.2	Elevators	1.59
7.0	Specialties	2.00
8.0	Equipment	N.A.
9.0	Plumbing	2.40
10.1	HVAC	12.50
10.2	Fire Protection	2.00
11.0	Electrical	8.00
Markups inc. G.C., OH, P & Cont'g		17.00
Total of Averages		100.00





The number (Percentages given are "averages" for mixed use/apartment type complexes of high rise configuration for 15 to 20 stories in height. For additional stories. the percentages will vary only in systems 1.1 and 1.2 in that they will reduce slightly (0.005%/floor) for each floor added for an additional 10 floors over the base. The exact opposite would ocur for reduction in height. This adjustment will have an effect on each system item from 1.1 through 11.0 with the items of overhead. profit, and contingency remaining the same. This compiled empirical data can provide the developer with ball park itemized construction cost breakdown figures when calculating for total development costs. (Courtesy of Falk Associates, March , 1984.)

8.4 UNIFORM DISCOUNT AND COMPOUND FORMULAS

(H-n HGiven H+n)

(1stYr 2 3 4 5 6 7 8 9 10)

FORMULAS

Single Compound Amount (SCA)
To find F when P is known

$$F=P\ (1+i)^N$$

Single Present Worth (SPW)
To find P when F is known

$$P=F\ \frac{1}{(1+i)^N}$$

Uniform Sinking Fune (USF)
To find A when F is known

$$A=F\ \frac{i}{(1+i)^N-1}$$

Uniform Capital Recovery (UCR)
To find A when P is known

$$A=P\ \frac{i(1+i)^N}{(1+i)^N-1}$$

Uniform Compound Amount (UCA)
To find F when A is known

$$F=A\ \frac{(1+i)^N-1}{i}$$

Uniform Present Worth (UPW)
To find P when A is known

$$P=A\ \frac{(1+i)^N-1}{i(1+i)^N}$$

Uniform Present Worth Modified
To find P when A is escalating
at rate e

$$P=A\ \frac{(1+e)}{(i-e)}\left[1-\left(\frac{1+e}{1+i}\right)^N\right]$$

Where:

P = a present sum of money
F = a future sum of money, equivalent to P at the end of N periods of time at an interest or discount rate of i.
i = an interest or discount rate
N = number of interest or discounting periods
A = an end-of-period paynmebnt (or receipt) in a uniform series of payments (or receipts) over N periods at i interest or discount rate.
e = rate of escalation of A in each of N periods

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