The Influence of Design on Building Cost

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Based on notes obtained during his MBL studies

INTRODUCTION

OBJECTIVE:

To introduce members of the public who are involved with building projects to certain of the cost implications of design variables so as to enable them to evaluate and implement a rudimentary cost benefit approach to future projects.

BACKGROUND TO THE PROBLEM:

Let us look at a practical problem which has cropped up many times in the past and, I am sure, you have come across as well.

Buildings A and B are designed to meet the same needs i.e. both are office blocks or hotels, shops, houses, etc., yet when comparing the costs per m² of floor area, we find that Building A costs say R10,000/m² while Building B only costs R7,500/m². Further analysis shows that they have the same external and internal finishes with similar roof and floor constructions. In fact there seems no apparent reason why the rates should not be exactly the same.

This exercise is meant as a guide to enable you to explain such discrepancies in a more meaningful way.

THE SQUARE METRE RATE:

This method of expressing the cost of buildings is quite convenient and therefore widely used in cost comparisons and rudimentary cost planning. It is calculated by dividing the net cost of the building (excluding site works, cost of land, etc.) by the gross square metres of the building or Gross Floor Area (GFA). Typically GFA can be defined as the total floor area inside the building envelope, including the external walls, and excluding the roof.

Considerable care has however, to be taken in using costs expressed in this way to make allowance for widely differing conditions on different projects.

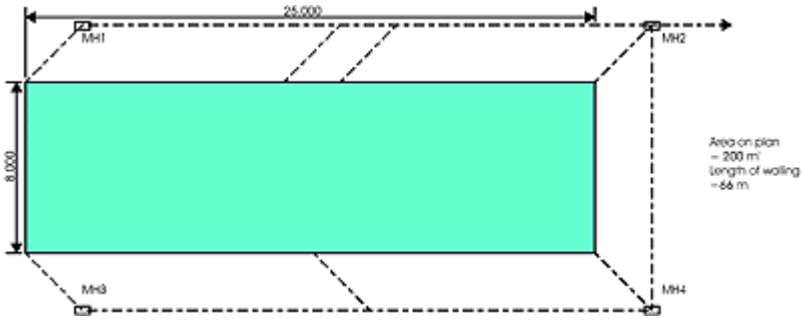
Let us examine some design variables which can influence our square metre rate adversely.

Note: Rates are reflected to illustrate significance of influence and are NOT to be taken as accurate, nor indicative of current prevailing rates! Rates were accurate at the time of research, meaning that the variances and significance were valid at that time, and should still be accurate for comparison purposes.

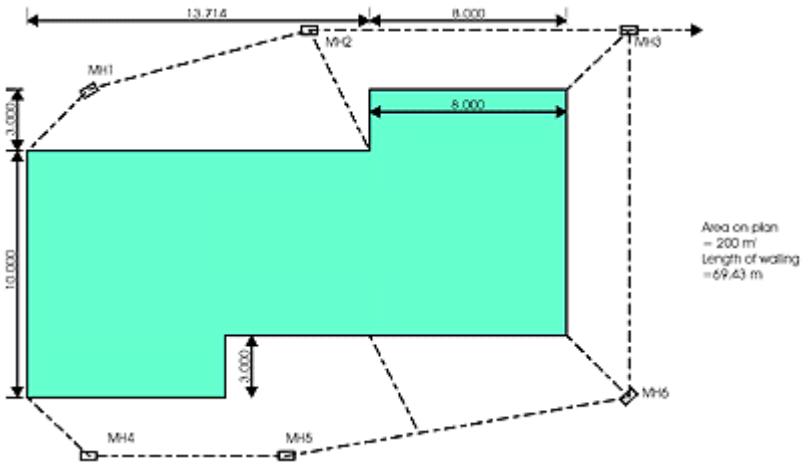
SHAPE ON PLAN

The shape of a building has an important effect on cost. As a general rule the simpler the shape of a building, the lower will be its unit cost. Let us illustrate this as follows:

IRREGULAR SHAPES



BUILDING A



BUILDING B

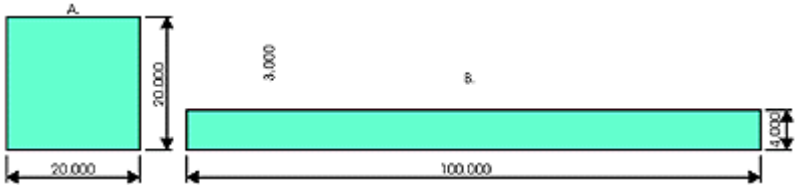
We note that both plans have exactly the same floor areas, yet building B is far more expensive due to the shape of its design. Reasons for the increase in costs are:

1. Building B has a higher perimeter/floor area ratio (to be discussed in more detail later) and requires 6% more external walling to enclose the same floor area than A.
2. Setting out costs will be increased by as much as 50%.
3. Excavations will cost between 6% and 20% more.
4. Drainage costs will increase by approximately 25% due to the extra manholes and extra length of piping needed.
5. Additional costs will also result from other elements of the building such as the walling and roofing due to the work being complicated by the shape.

It can therefore be concluded that the irregular shapes of buildings add to their overall cost.

REGULAR SHAPES

Regular shapes in contrast, become more expensive the longer and narrower they are planned. This can be illustrated by the following examples of a square and rectangular building with the same floor area.



BUILDING A **BUILDING B**

CASE A

Area on plan = 400m²
Length of walling = 80m
Assume 3m high walling @ R200.00/m²
Then cost/m² = 80 x 3 x 200 ÷ 400
= R 120.00/m²

CASE B

Area on plan = 400m²
Length of walling = 208m
Assume 3m high walling @ R200.00/m²
Then cost/m² = 208 x 3 x 200 ÷ 400
= R 312.00/m²

The length of building B thus resulted in an additional expense of R 76,800.00 over that of Building A.

CONCLUSION

It is important that both architect and client are fully aware of the additional costs (or savings) that probably will arise from even small changes in the shape of the building. They can then adopt a rudimentary cost benefit approach in considering the advantages of different shapes in seeking a suitable balance between cost, aesthetics and functional aspects.

Although the square building is the simplest plan in shape, one must remember that the shape of a building is dictated by:

FUNCTION

i.e. Factory shapes depend on the form of machines used and the production layout. Schools and hospitals rely on natural lighting and therefor tend to be rectangular in shape. Hotels are orientated towards the best view.

SITE

The slope and shape of a site might dictate the shape of the building especially where the plan to plot ratio approaches one.

ECONOMICS

Office buildings with depths up to 18m lease more readily to smaller businesses as areas can be

easily split to accommodate different concerns. Buildings often become a function of the owners financial success and tend to reflect this in the use of materials and design detail.

SIZE OF A BUILDING

Increases in the size of a building usually produces reductions in unit cost such as the square meter rate. The prime reason for this is that on costs do not rise proportionally with increases in the plan size of a building. Expressed in another way we can say that the Preliminary and General items expressed as a percentage of total cost tends to decline with an increase in size and cost. A practical illustration would be the construction of two shops for R500,000.00 and R1,500,000.00 respectively:

SHOP A

Cost : R500,000.00
Foreman's salary : R10,000.00/month
Construction time : 3 months
Percentage of on-costs = R10,000 x 3 ÷ (R500,000 – (R10,000 x 3))
=R 30,000.00 ÷ 470,000
=6.4%

SHOP B

Cost : R1,500,000.00
Foreman's salary : R 10,000.00/month
Construction time : 5 months
Percentage of on costs = R10,000 x 5 ÷ (R1,500,000 - (R10,000 x5))
=3.4%

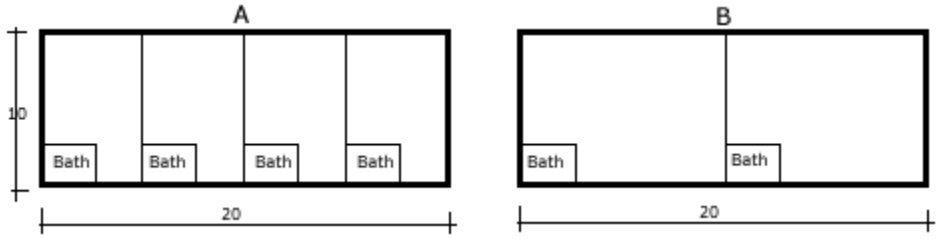
In larger buildings other reductions in unit costs may arise due to savings in:

a. Prices paid for materials by the builder
b. Vertical transportation costs in high rise buildings
c. Larger room sizes etc.

FULLNESS ON PLAN

A concept closely relates to that of size as discussed under the previous section but distinguishing for the usage factor. It is obvious that the rate per square metre for a block of bachelor flats will differ a great deal from the rate for a block of three bedroom flats.

Let us look at the following buildings:



BLOCK A **BLOCK B**

Assuming that an internal division wall will cost us R4,500.00 and a bathroom will cost R25,000.00 complete. We can then calculate the influence of these elements as follows:

BLOCK A

Cost of division walls	=3	@	4,500 =	R 13,500
Cost of bathrooms	=4	@	25,000 =	R 100,000
				R 113,500
				113,500 ÷ 200 =
				R 567.50

BLOCK B

Cost of division walls	= 1	@	4,500 =	R 4,500
Cost of bathrooms	= 2	@	25,000 =	R 50,000
				R 54,500
				54,500 ÷ 200 =
				R 272.50

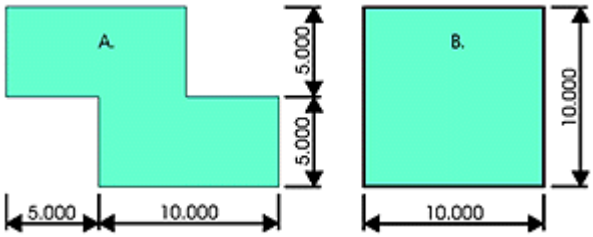
Although other more complex relationships come to operate with such a comparison we can generally state that an increase in the “fullness” of a design will also increase the cost per metre square.

PERIMETER/FLOOR AREA

We have already seen that the plan shape directly conditions the enclosing walls. The Perimeter/Floor area Ratio allows us to compare different plans to establish the more economical proposal.

The lower the ratio, the more economical will be the proposal. Circular buildings have the best ratio but savings are more than offset by the higher cost of circular work.

Let us once again look at a practical example:



Assuming that both buildings have an identical floor to ceiling height of 3.00m then the:
PERIMETER/FLOOR AREA RATIO FOR:

BUILDING A

= AREA OF ENCLOSING WALLS ÷ TOTAL FLOOR AREA
= 50m x 3m ÷ 100m²
= 1.50

BUILDING B

= AREA OF ENCLOSING WALLS ÷ TOTAL FLOOR AREA
= 40m x 3m ÷ 100m²
= 1.20

It should be borne in mind that the perimeter cost can be in the order of 20% to 30% of total cost and an external wall is normally almost twice as expensive as an internal partition.

Once again we should keep other design criteria in mind but the Perimeter/floor area ratio does allow the more experienced client to state the optimum ratio (from analysis of similar buildings erected in the past) as part of the design criteria during his brief to the Architect.

CIRCULATION SPACE AND OTHER VARIABLES

The minimisation of circulation space by the economic layout of the building provides a definite cost benefit. Entrance halls passages corridors, stairways and lift wells can be regarded as dead space which cannot be used profitably, but involve considerable cost in air-conditioning, lighting cleaning and decorating.

In doing a trade-off analysis between cost and circulation space, one has to consider the functional and aesthetic inputs as previously discussed, but substantial savings can be made by sound subjective judgement.

A fair ratio for circulation to total space can be obtained from previous projects and included in the criteria given during the design brief.

It is interesting to note that in a recent comparison of two alternative plans, the circulation space in blocks of flats varied between 22% and 32%

Unfortunately very few cost analysis done in the past give details of circulation space and information for different uses are sadly lacking.

OTHER VARIABLES:

Several other variables play a role in determining the cost of the design and should be borne in mind.

FLOOR TO CEILING HEIGHT

It is obvious that by increasing the height of walls, we must increase our rate per M^2.

HEIGHT OF BUILDING

A comparison of the unit rates for a single storey and multi-storey buildings will show substantial differences. Savings can be achieved by decreasing the plan size and increasing the height of buildings but a point is eventually reached where the cost of vertical transportation, services, substructure etc., outweigh the cost of an additional storey. Land values, plot size and the buildings function tend to have direct influence on its height.

CONSTRUCTIONAL DIFFERENCES

Reinforced concrete walling in lieu of brick walling of industrialised building methods in lieu of conventional methods will have a huge influence on the cost. The Quantity Surveyor should be brought in as early as possible in the design stage to advise on the influence of the proposed construction method on cost.

DIFFERENCE IN FINISH AND ARCHITECTURAL DETAIL

Careful attention should be paid to the standard of finishes required, especially of those on the vertical components of a building as they are more difficult to incorporate in our yardstick of unit rate.

START AND FINISH DATES

An earlier completion date saves money but can only be achieved by careful planning during the design and construction phases of the project.

The use of C.P.A or network analysis programming tools should be encouraged.

A case can be made for the view that construction time should not be specified in the tender documents, but that the builder should be given the opportunity to tender on time as well as price. The exception should be when a building has to be completed in a shorter period than would be reasonably contemplated.

It could well be that the higher price from a tender is the most economical, once construction time, earlier trading and savings on escalations are considered.

Although most tenders make provision for a penalty for late completion, almost none provide the builder with an incentive bonus for early completion.

A detailed and more specific brief to the Architect may require more effort on the part of the client, but is the cornerstone to efficient time management.

CONTRACTUAL TERMS AND CONDITIONS

The Bill of Quantities remains the Rolls Royce of tendering arrangements, but another contract form might be equally suited to your needs. Types of contractual arrangements available are:

1. COST PLUS CONTRACTS
    - Cost plus percentage
    - Cost plus fixed fee
    - Cost plus fluctuating fee
2. TARGET COST CONTRACTS.
3. MEASURE AND VALUE CONTRACTS OR SCHEDULE OF RATES CONTRACTS
4. CONTRACTS BASED ON DRAWINGS AND SPECIFICATIONS
5. PACKAGE DEAL CONTRACTS
6. QUANTITY SURVEYOR AND PACKAGE CONTRACTS
7. PROVISIONAL QUANTITIES CONTRACTS
8. NEGOTIATED CONTRACTS
9. BILLS OF QUANTITIES CONTRACTS
    - Open tenders
    - Tender by invitation
    - Operational bills
    - Elemental bills

Although tender arrangements should be decided at the sketch design stage, other tender conditions such as the competitiveness of the market and the quality of the tender documents also play important roles in fixing the final price of a project.

LOCALITY OF AREA

Building costs within South Africa vary considerably and allowance should be made for locality in the cost plan or feasability for this.

Tendered rates within the same town or city may also vary due to conditions imposed on the Contractor by the Client. An example of this is where work has to be done within a high security area

and the Contractor is subjected to security requirements that result in lost time or a restricted labour force.

MARKET CONDITIONS

Market conditions during recessions increase competetiveness and many builders then venture away from their traditional base in search of work.

CONCLUSION

The Architect is there to advise on design, the Quantity Surveyor to keep tabs on the cost but it is up to the initiator of the building process to lay the ground rules. This you can only achieve through an intimate knowledge of what your needs really are, and what you're prepared to pay to have them satisfied. By stating definite parameters to the design and cost teams from the start, you will improve the probability of getting what you envisage.

The square metre rate can become an efficient tool in controlling the influence of design on building cost if used with care in a Cost plan.

The Cost plan is a statement of the proposed expenditure on each section or element of a new building related to a definite standard of quality. Each item of cost is generally regarded as a "Cost Target" and is usually expressed in terms of cost per square metre of floor area of the building as well as total cost of the element.

The input into your cost planning will depend largely on the quality of the cost research done in investigating building costs and their interrelationships, including maintenance and running costs, in order to build up a positive body of information which will form basic guidelines in planning and controlling the cost of future projects.

We hope that, by studying some of the influences of design on cost we have been able to assist you in understanding some of the elements that play a role in determining the building cost.