SCHOOL DESIGN AND ECONOMY

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1. ABSTRACT:

Economy in school building design and construction is a subject of great practical importance, particularly in the developing country like Bangladesh, as most of the school committees face the problem of construction of their school projects, due to the shortage of fund. The school designers, all over the world are searching for economic design and construction system of school buildings. The economy in school design can be achieved in many ways. The author did some survey and studied in 1989 in the department of architecture, B.U.E.T. on construction materials and their relative cost. Impact of the system of construction and management techniques on the overall cost of the building was also observed. It was found that choice of a particular system of construction and better management in both layout ad details of construction might significantly influence the cost.

This paper represents an attempt to elaborate on the subjective term 'economy' and the objective term 'cost' on school building design and construction. The author also attempts to focus on the need, ways and means of achieving eonomy in school.

2. INTRODUCTION:

Any satisfactory school design must have three primary attributes. It must (1) be simple, flexible an functional, (2) be cost effective and economical, and (3) have an adequate service life. The spaces, both indoors and outdoors should create an environment conginical for the propagation of knowledge and proper development of human minds keeping in view the affordability of the community for which the educational facility is being designed.

The communities in Bangladesh have strict financial limtations; it is more true in rural communities. It is extremely difficult for rural communities to provide the surplus resources necessary to finance the

essential facilities like education, recreation etc. Out of 9, 132 secondary schools only 172 are totally financed by the government [(i)], the rest are only partially helped by the government. Bulk of the resources have to be generated by the community it self. Moreover education is not considered a direcly productive sector. Though the running cost of the educational facilities can somehow be maintained by the help of the government and active participation of the members of the community, the capital cost or the initial cost of construction is difficult to come by. A minimum capital cost is almost a precondition for educational facilities to take off. It is vitally important that architects, make use of all the tools in their hands to keep the capital cost at bare minimum. A through knowledge of the available methods of construction their relative cost can serve as a good starting point for the designers.

The choice of certain economic design principles help to formulate the eriteria for economic school design. Economic school design principles depend very much upon the type of educational planning, occupational time, flexibility and space standards of the schools.

3 DESIGN PRINCIPLES FOR ECONOMY:

An economic educational system can considerably be achieved by followong proper principles of planning and space standards developed by different national and international organisations associated with educational fcilities design. Here the tern 'economy' is not only used as 'low unit cost' but is considered as a planning factor that refers to the management of the means and resources of a particular community spent for educational, religious and recreational purposes.

3:1 COMPREHENSIVE EDUCATIONAL PLANNING:

In most of the rural communities, besides the regular schooling various other educational, recreational and religious institutions like local libraries, madrashas, clubs, women sewing centres, mosques and play fields etc. are homogeneously distributed within the catchment area of a secondary school. Within a perimeter of three miles from a secondary school, two local libries, and four play fields are found [(2)]. The local people bear the expenses of these institutions seperately. A compehensive education planing and unification of these institution in a place preferabley within the secondary school could save considerable expenses for the society. Space sharing can be very effectively done within the school campus.

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* *(1) SFYP, Draft copy, Government of Bangladesh*

* (2) *p-369, Dr Mazharul Haque, Opcit*

3:2 OCCUPATIONAL TIME:

The occupancy rate of the secondary school campuses are very low. With one shift of classes only, in most cases the secodary school buildings are underused and the occupancy rate is only twentyfive percent or six hours in a day. By using multiple shifts and adding more community programmes,there is a scope for increasing the occupancy rate by about seventy five percent or eighteen hours in a day, thus minimise the wastage incurred by duplication of structures.

3:3 FLEXIBILITY:

The change in curriculum and technique of education, demands the change of the internald and external spaces of the school buidings. This chanse of space or expansion of school structure may be difficult and expensive if it is not considered at the time of designing. A flexible type of structure is suitable for growth, change and improvement and is economic in course of time.

3:4 SPACE STANDARD:

Many dimensions of the indices can be identified for saving the cost of the school project. Space standerd is one of the indices to minimise the school project cost. The amount of space required for(a) a pupil or an user (b) a group of pupils or for a school community, (c) number of pupils per class, (d) quality of materials and finishing provided in school. are some form of units of meaurement of space standerds. A more rational allocation of available money and building resources is possible by following the minimum space standards [(3)]. Minimum space standards should be followed in our under developed communities where resource is scared. This minimum space standard could be followed as the means of control over the irrationally used school land and materials, as well as this is the only means for achieving community's minimum eductional needs and aspirations.

4 ELEMENTS OF ECONOMY:

The shortage of money required for the construetion of the school buildings in our communities requeres the search for inexpensive construction of school buildings. In order to make the school structure inexpensive for both long term economy as well as immediate capital

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* *(3) P-121 ARISBR, School building Design. and*

P-21, EB reprt-5, Xantharid virochsiri, Design Guide for secondary school in Asia, 1977.

outlay, the school designers should know the elements of school economy. In the context of school design, the cost for running the facilities may be devided into two types fo elements 'initial cost' and 'maintenance cost.'

4:1 INITIAL COST :

The initial cost may become an important element of total school cost in a number of ways. The land cost, building cost, service cost and furniture cist etc. comprises the initial cost of the school project.

The initial cost of a school project varies from cimmunity to community and also with a given time. In most of the communities the school site is donated by the effluent donars of the community. If the location of donar's land is not suitable for the school site this may be exchanged by mutual agreement with any other suitable site.

The choice of suitable material, simple structural system and the efficient construction managemnt play a considerable part in balancing the construction budget. The installation of manually operated services involving less technology, can save the initial cost.

4:2 MAINTENANCE COST:

While considering the initial cost of a school building the additional cost on account of its maintenace must be considered. Some times due to improper choice of materials the total maintenance cost during the life time of the building might prove uneconomic in he long run. Specially choice of less durable material in moving parts of the building might necessiate recurrent changes. The careful and logical selection of the building materials, finish materials, furniture materials and educational materials etc. can save the initial cost as well as the frequency of maintenance. Cost of educational materials, repair, cleaning, painting etc. are considered as the maintenance cost of the school.

4:3 ELEMENT INTERRELATIONS:

A schoof site found free from a donar may not be suitable from the locational point of view, might requir the change of site for the ideal location with respect of its commuity. In the same way, the use of cheaper and unstable materials might reduce the initial construction cost, would require the replacement much sooner than the permanent materials. Therfore, both the elements (cheapness and permanency or

cheapness and ideal use etc.) should be considered simltenously for an economic school.

5 CRITERIA FOR ECONOMIC SCHOOL DESIGN:

There are some architectural elements which do not influence the educational process. Architects have relative freedom to work with those elements in reducing the cost of construction. The local community people always try to save money and want to go for less expensive construction. Design criteria and space standards could be formulated to achieve the reasonable econmy of the planning, designing and construction of the school in the context of prevailing ecnomic and cultural conditions of the community. The degee of such economy depands on the scale of achievement of design criteria. regarding conprehensive educational planning, occupational time, flexibility, space standard, initial and maintenance costs etc.

5:1 SCHOOL LAYOUT AND PLANNING:

Educational architecture, in our country, is primarily shaped by economy. Considering that, the simple elongated rectangular layout having verandah at one side facing the court or play ground is the most common plan for school buildings in Bangladesh and rightly so the class rooms arranged against a straight corridor seem to be a rational arrangement. The layout of the school should be compact, leading it self to optimum economy. In the conventional teacher- centric teaching system, the square or rectangular shape class rooms have been proving more economical than any other shape of class rooms.

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*(4) p-172, Faruque A.U. Khan, Opcit.

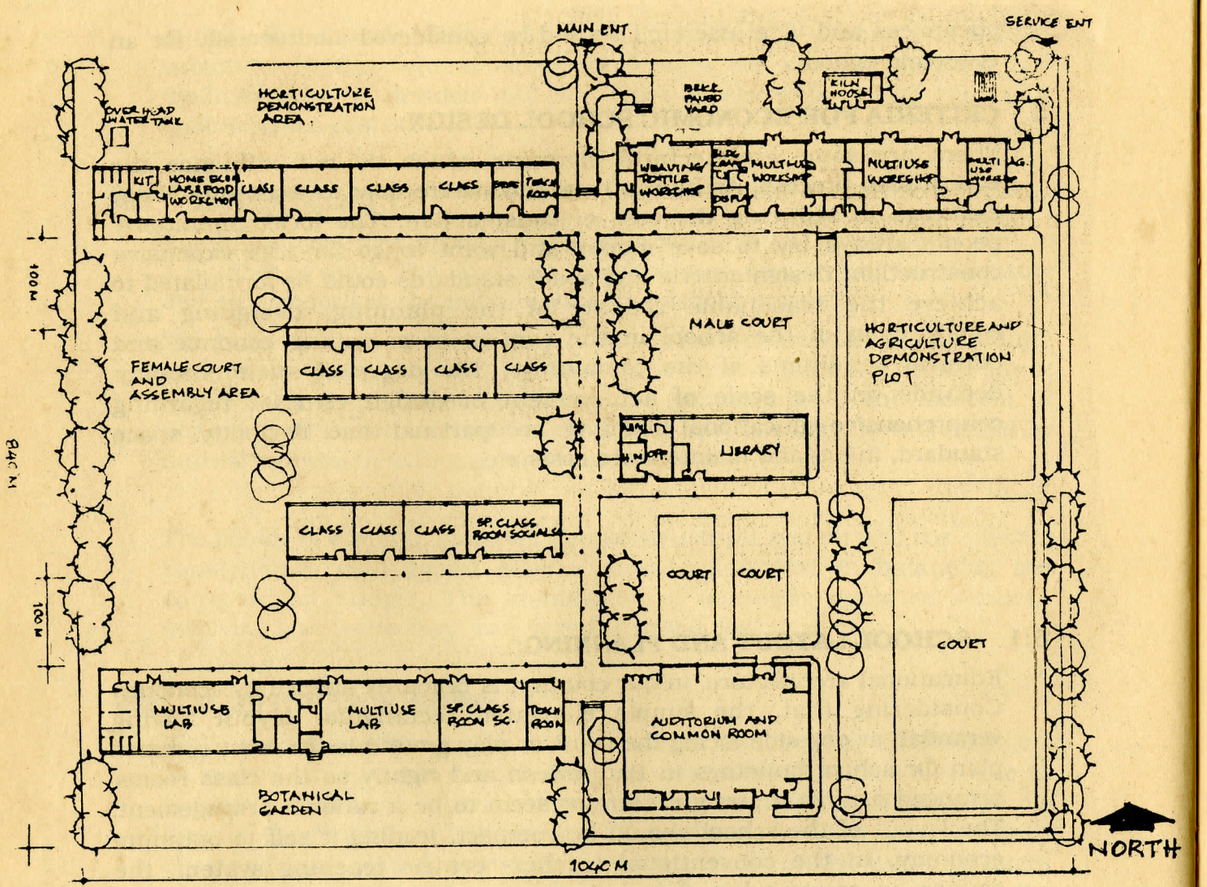

FIG-1 ECONOMIC LAYOUT AND PLANNING OF SCHOOL CAMPUS.

A class room like 26'-8" x 30'-0(8'00m x 9'00m) is sufficient for 48 number of places in the secndary level. And 346'-0" x 280'-0" measuring 10,764 sq. yard is sufficient for a scondary school camous. [4]

5:2 SCHOOL GEOMETRY AND FORM:

There is a definite relationship between geometry and construction cost. As for example, let us consider two secondary schools, one BUET school and other is the Udayan school in Dhaka, having different types of layout. Although both the schools have exactly the same area (for example,as per fig-2), the BUET school has only approximately 60 percent as much outside wall area as the Udayan school, yet it has exactly the same area. If each of these schools has similar type of construcion, there is a possibility that Udayan school might be more expensive.

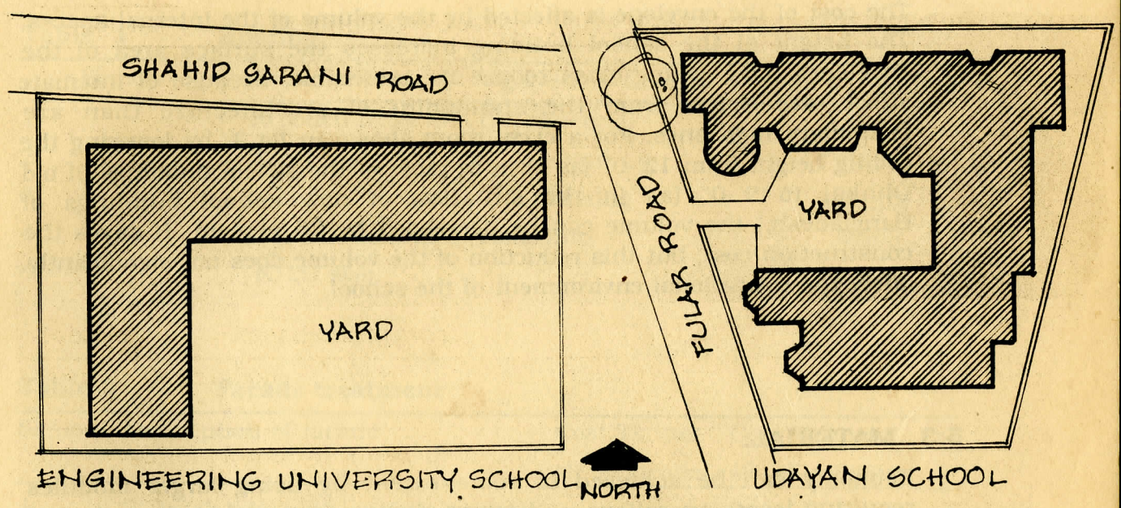

FIG-2 DIFFERENT TYPE OF SCHOOL GEOMETRY.

Again, greater the outside wall, greater is the possibility of water penetration, hence greater is the maintenance cost. The economical school building will be rougly rectanglar and straight with a minimum number of breaks and corners in plan. the simple geomery is one of the way to the cut cost.

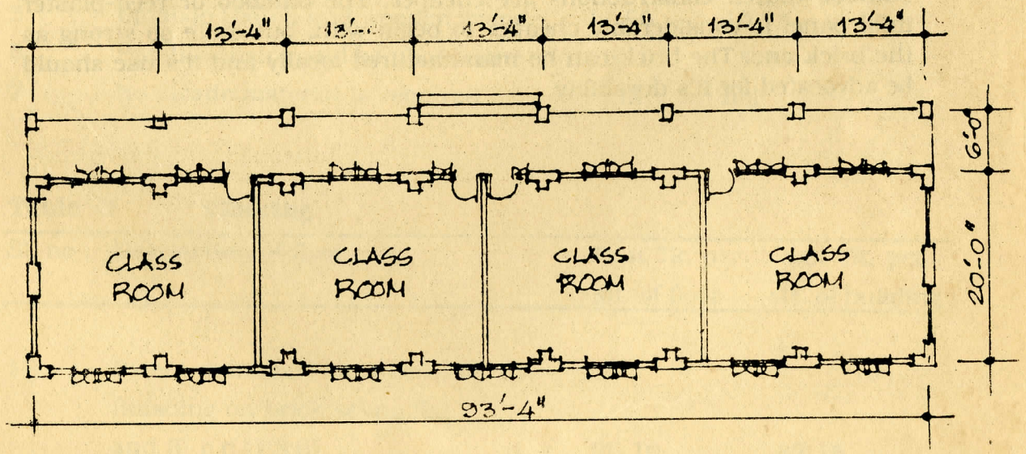

FIG-3. PLAN OF A SCHOOL BLOCK

The breaks in the silhauettee of the roofs of school building add some construction cost. Any break in the roof mass or in parapet wall make the school building expensive. The school buildings with simplified roof lines prove more economical at the time of construction as well as throughout the life of the buildings.

The cost of the envelope is affected by the volume of the internal spaces. The height of the school building increàses the surface area of the envelopes. Low ceiling class rooms are preferable, because of intemate effect, are better from the standpoint of arechitecture than are customary high ones. For a class room shown in fig 3, by lowering the ceiling height from 12'-0" (as seen in most of the school buildings of old Dhaka) to 9'-0" (as in the situation of new school buildings of Bangladesh,) the volume can be decreased by 25 percent. It saves the construction cost, but this reduction of the volume does not significantly. affect the educational environment of the school.

5:3 MATERIAL:

Economy can be achieved to some extent by using larger modules requiring lesser operations and joints. Certain materials are costly and others are relatively cheaper. Usually the heavy and permanent materials are costly and temporary materials are cheap. The use of cheaper and unstable materials might trduce the initial construction costs. This would require the replacement much sooner than would the permanent and stable materials. concrete, stone, and ceramic bricks are costlier, ordinary brick construction takes medium cost, where as C. I. sheet and bamboo thatcn constructions are cheaper. The bamboo or reed-plaster infill panel is considerably cheaper to begin with, but quite so strong as the brick one. The brick can be manufactured locally and it's use should be advocated for it's durability.

Table -1 Roofing

Sl. no.	Description of roofing system	Cost Tk. per sft. of building
1	Wooden truss and C.I. sheeting	33.47
2	Steel truss and C.I. sheeting	5823
3	Woodon truss and C.A. sheeting	51.32
4	Steel truss and C.A sheeting	7608
5	R.C.C. slab	38.86

Table-2 Facade treatment

Sl. no.	Description of facade	Cost Tk. per sft. of facade	Cost Tk. per sft. of building
1	5" brick wall with outside pointing and inside plaster	31.80	28.83
2	5" brick wall with inside and outside plaster	33.34	30.23
3	C.I. sheet and wooden frame	27.35	24.80
4	C.A. sheet and wooden frame	34.44	31.22
5	Bamboo thatch and wooden frame	11.86	10.75
6	Bamboo thatch and bamboo frame	5.79	5.25
7	No facade material is required	nill	nill

Table -3 Flooring

Sl. no	Description of floor	Cost Tk. per sft. of floor	cost Tk. per stt. of building
1	Patent stone and neat cement finishing on brick soling flat and 3" c.c (1:3:6)	36.10	32.15
2	Brick flooringflat on 5" bricks on edges	23.95	21.33
3	Terrazzo flooring on brick soling and 3" c.c(1:3:6)	66.18	58.94

Table -4 **Door and window**

Sl.no.	Description of door and window	Cost Tk. per sft. of door and window	Cost Tk. per sft. of building
1	Wooden (frame: Silkarai, shutter: Gammar) door and uindow, 3mm. clear glass	131.52	20.55
2	Steel frame, wooden (gammar) door shutter, steel window shutter and 3mm. clear glass	78.22	12.22
3	Anodized aluminium frame, aluminium door and 5mm. clear glass	520.09	84.43

5:4 LOCAL TECHNOLOGY AND CONSTRUCTION SYSTEM:

The use of simple structural system and local technology, help in balancing the constructon bugdet of the rural schools. The underdeveloped rural building technology and the shortage of construction bugdet have a strong influence upon both the planning and facade treatment of school buildings. In fact the construction bugdet has been almost a controlling element in secondary school building form snd it's architecture.

Table-5 **Foundation**

Sl. no.	Description of foundation	Cost Tk.per rft. of foundation	Cost Tk. per sft. of building
1a	Brick spread stepped foumdation on brick soling and 3" c.c(1:3:6)	175.00	22.99
1b	Brick spread stepped foundarion on p.v.c. sheet	143.31	18.82
2	R.C.C. footing and brickwork upto plinth	203.50	26.73
3	R.C.C column footing, grade beam, and brick wall upto plinth	234.53	30.81
4	wooden post and brick work upto plinth	104.22	13.69

Table-6: **structural system**

SL. no.	Description of structural system	cost Tk. per sft. of builoing
1.	2'-6"x 1'-8" T-shape 10" thick brick columns in building and 1'-8"x 10" brick columns at varenda, continuous lintel, D.P.C. pointing outside and plaster inside etc.	18.68
2	10" load bearing internal and external walls and 1'-8" x 10" brick columns at varenda, Lintal over door and windoows, pointing outside and plaster inside, D.P. C. etc.	44.42
3a	12" x 12" R.C.C. columns for building, 10" x10" R.C.C. columns at varenda and R.C.C. beams	43.92
3b	12" x 12" R.C.C. columns for building, 10" x10" R.C.C. columns at varenda and wooden tie beams	19.31
4	wooden posts and wooden tie beams	5.26

The R.C.C.structure is permanent but more expensive for many reasons. More over the method of R.C.C. contruction is not familiar to the local masons. Wooden post, wooden truss , C.I. sheet and bamboo mat facades,C.I.sheet roofing etc. are more popular to the local craftsman and even the community people can contribute their free or cheap labour in the construction.

6 DISCUSSION AND CONCLUSION:

The professtional school designers are always compelled to take descision concerning the choice of economic method of consruction.

The development of an appropriate method and finally its refinement and standardisation is considered assential for economic school design. This will be supplimented by designers personal experience and preferences. In order to select the appropriate method for construction, the ultimate aim should be the development of criteria for economic school design.

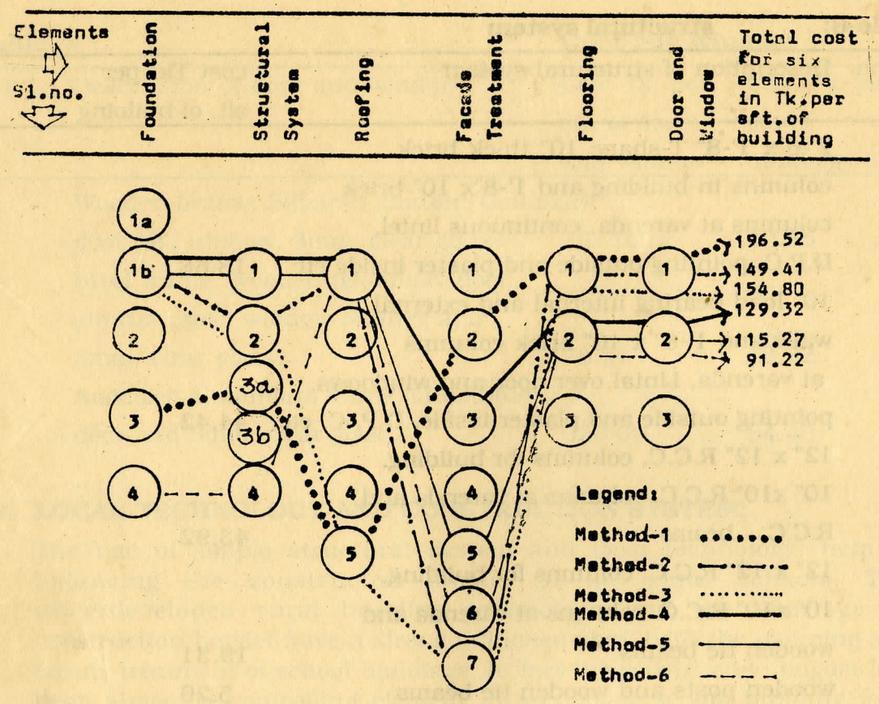

FIG-4. COST OF ELEMENTS.

R.C.C. as a building meterial is found to be expensive both in foundation and in structural system. The use of brick or timber in structural system is cheaper than R.C.C. Inroofing, wooden truss and C,I, sheeting is cheaper than R.C.C. slab.

The local materials are always cheeper than imported materials. The only exception found in the costing of doors and windows construction. The doors and window with sheet rame frame, wooden door shulters and steel window shutters are found to bc cheaper than doors and windows of wooden frame and wooden shutters (table- 4). Doors and windows with atuminium framing are over whelmingly costly than other type of doors and windows.

Certain elements and materials are not always necessary in foundation, if the soil condition is good. As for example, brick soling and cement concrete layer in foundation are not always essential and could be replaced by simple P.V.C sheet. Brick masonry works in foundation could be constructed directly on the P.V.C. sheet. This reduces much the foundation cost.

From the market survey, the unit cost for six elements of a small school block (fig.3) of a secondary school building are tabulated. Multiple number of construction methods could be developed from the cost information tables. These cost information tables are the means of obtaining the appropriate method of economic school design.Six different construction msthods were identified considering the permanancy of construction. The method no.4 is found to be quite satisfactory and reasonable for our rural school construction.

There may be certain restriction on the use of very temporary building materials, like mud in wall or straw/ reeds on roofing system. However, as all the school authorities are not equal in their solvency for construction budget, it is possible to construct relatively inexpensive school building at the beginning which can be progressively improved in stages, when more funds are available.

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