COST BENEFIT ANALYSIS FOR CONSTRUCTION PROJECTS

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ABSTRACT

Cost Benefit Analysis (CBA) is a common framework for evaluating the benefits and drawbacks associated with any particular project. The technique has the advantage that all costs and benefits are taken into account before finalizing the project. Using a case study, this paper presents the methodologies that can be applied while conducting Cost Benefit Analysis for construction projects.

INTRODUCTION

We are living in a civilized society which demands that much more thoughts should be given to all possible alternative schemes before arriving at the best solution obtainable. Our old price mechanism is purely set on profitability and perfectly copes with the situations where financial costs and returns are the only considerations. However, today's civilized society cannot accept that everything is governed purely by profit. Society wants better facilities for health, education and to preserve the environment in which it lives. Certain pressure groups are constantly pursuing the governments to control the noise, dust, atmospheric pollution, ecological conservation, provide better health facilities and open spaces within urban areas. All these can only be provided to the public if the governments properly evaluate the social benefits and losses of the schemes before launching them.

Another demand of today's society is that it wants to be benefited from the schemes whether directly or indirectly. It is often observed that a benefit to one part of society is not necessarily a benefit to the whole of the society. Of course, by benefiting some sectors of the community, often incurs costs to the other sectors. For example a factory may provide employment but at the same time also causes pollution and devaluing of local house prices, due to noise, increased road transport etc.

On the other hand, the government problems are the annual population growth rate and increase in average human age which is consuming a major part of available funds/resources. In Europe, Germany is facing the worst situation. Population Director of UNO has released a report in October, 1998 which states that the world population would be increased 50% by 2050. Average human age which was just 45 years in 1950 is now 63 years. Europe is badly suffering from the increase in human life where 20% of the population is over 60 years and the said percentage would be increased to 35% by 2050. This situation is threatening social setup (i.e. pension, politics, health etc.) in Europe (UNO Report). In this situation, it is more important for the governments to give special thoughts to the society's demands and try to adopt the schemes which equally benefit the whole society. The objective can be achieved by adopting the Cost Benefit Analysis (CBA), since it is concerned with evaluating schemes for the whole society and not just for isolated sectors. Furthermore, it evaluates the effects on all affected parties that allow the government to control the resentments among a society.

Generally, in any CBA analysis of a scheme researchers initially consider two to three alternatives to find the best net gain for the society. However, a particular scheme giving the highest net gain may not be the one chosen, as the sectors of society who gain and those who lose may not be distributed fairly. For example, if we consider Schemes A & B as shown in Table-1 below, it would be unlikely that society would allow Scheme A to be adopted. Though the Scheme B is not quite financially beneficial to society, but at least it is more evenly weighted to the affected sectors and as such is more likely to be carried out.

Table 1: Comparison of Benefits

Description	Scheme-A	Scheme-B
Cost to wealthy	-	-
Benefit to wealthy	$ 2.0 M	$ 0.8 M
Cost to poor	$ 0.2 M	-
Benefit to poor	-	$ 0.8 M
Total benefit	**$ 1.8 M**	**$ 1.6 M**

During carrying out of evaluations, it should be considered that everyone is made better off by a particular scheme and known as "*pareto improvement*". It is a difficult task; therefore in the majority of schemes, a potential pareto improvement is looked for, where certain sectors of the society benefit and others lose. There is an overall social benefit if the collective benefits are greater than losses; however, not everyone gains individually. Potential Pareto improvement can be converted into a pareto improvement if costless transfers of goods and/or money can take place among the various sectors of society. Transfer payments are those made other than in exchange for productive services. The most common form of transfer payments consists of those operated by a government. Here, the payments are taken from certain sectors of the community in the form of income taxes etc., and are given to the poorer sectors in the form of grants, subsidies, etc. (Shutt, 1997).

If we look back at both schemes as appearing in Table-1, Scheme A seems very unfair but upon considering the transfer payments the final outcome would be as follows (assuming the tax percentage 50%).

Original benefit to wealthy $ 2.0 M,
Transfer via taxes - $ 1.0 M

Original cost to poor $ 0.2 M,
Transfer via state aide +$ 1.0 M

Final benefit to wealthy $ 1.0 M, Pareto improvement
Final benefit to poor $ 0.8 M, Pareto improvement

From the above it can be said that through operation of transfer payments, a grossly unfair situation becomes workable.

METHODOLOGY

Construction management at this time is dominated by three principal approaches that are considered acceptable for research. These are (a) quantitative methods (b) qualitative methods and (c) a combination of both quantitative and qualitative methods, known as a mixed approach. Quantitative methods use deductive thought processes to unveil relationships; the method is underpinned by data collection and analysis. The qualitative approach is drawn from the interpretive philosophical view and uses inductive thought process to determine relationships. Seymour et al. (1995, 1997) strongly argued for the use of "interpretive" (qualitative) approaches over the "rationalistic" (quantitative) approaches often used for construction research. Qualitative approaches yield an investigation that is primarily concerned with meaning as opposed to causality. This unscientific approach was bitterly criticized by the leading researchers such as Runeson (1997) and Harris (1998). On the other hand, despite criticizing, Raftery et al. (1997) were advocates of the combined approach. However, the debate succeeded to advance the mix mode, combining the both quantitative and qualitative approaches. A study of abstracts of papers published in the CEM journal from 1983-1996 revealed that 57% of the researchers utilized quantitative methodological approaches. Only 8% were based upon qualitative research methods, and 13% used a mixed methodology (Loosemore et al., 1996). The remaining papers were classified as "non-

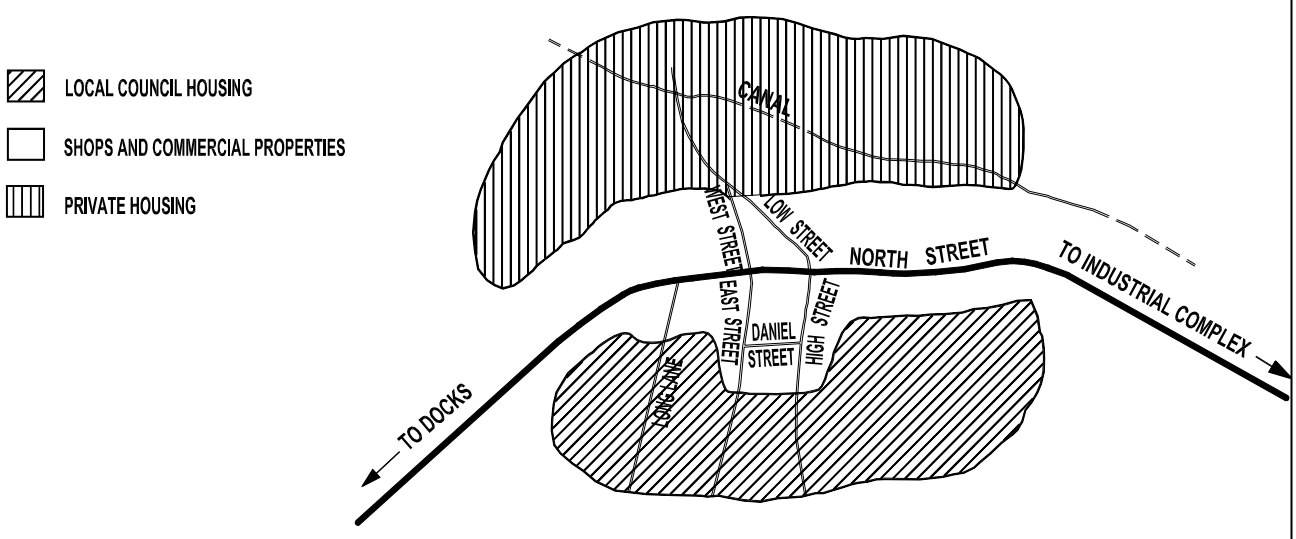

Figure 1: Town as Existing

research" papers. A review of the ARCOM proceeding for the period 1999-2001 shows that the trend of qualitative and mixed mode approaches have increased slightly. However, it remains the case that the quantitative approach dominates construction management research, although it is perhaps noteworthy to mention that many quantitative approaches employ qualitative or subjective methods for the purposes of measuring variables and predictors in models.

In the case of the present study, researcher adopted the combined approach since it is the best for a case study. Approach involved the following steps.

- Identification of the problem.
- Proposal and alternative solutions.
- Identification of the affected sectors.
- Identification of the costs and benefits.
- Quantification of the costs and benefits.
- Summary and conclusions.

IDENTIFICATION OF THE PROBLEM

A town for some years had a problem of increasingly heavy traffic, departing from a growing industrial complex, north of the town, towards the docks, on the south side. The main traffic flow travels along the North Street and has been causing various problems of noise, fumes, congestion and accidents. As a result of a fatal accident, the Local Council became under greater pressure to construct a bypass around the town. Majority of the residents and shopkeepers wanted a bypass, but at the same time, did not want to loose their current property. Town, as existing, is shown in Figure-1.

PROPOSAL AND ALTERNATIVE SOLUTIONS

Scheme-A, B and C as shown in Figure-2, were proposed to Local Council as a possible solution to the problem. Scheme-A involved demolition of 135 Local Council dwellings and 35 shops on the East side of the Daniel Street, in addition to construction of a new fly over on the Long Lane. The total length of this bypass was 6.5 KM. Scheme-B involved demolition of 110 private dwellings and 60 shops in addition to construction of 7.5 KM bypass. Scheme-C involved no demolition. The length of this bypass was 11.5 km.

IDENTIFICATION OF THE SECTORS AFFECTED

Direct involvement of following sectors was identified.

a. The Local Council
b. Existing owners of private housing.
c. Existing tenants of Local Council housing.
d. Existing owners and tenants of shops and commercial properties.
e. Telecommunication Department.
f. Power Department
g. Gas Department.
h. Water and Drainage Department.

IDENTIFICATION OF THE COSTS AND BENEFITS

Following costs and benefits were determined for all the three Schemes.

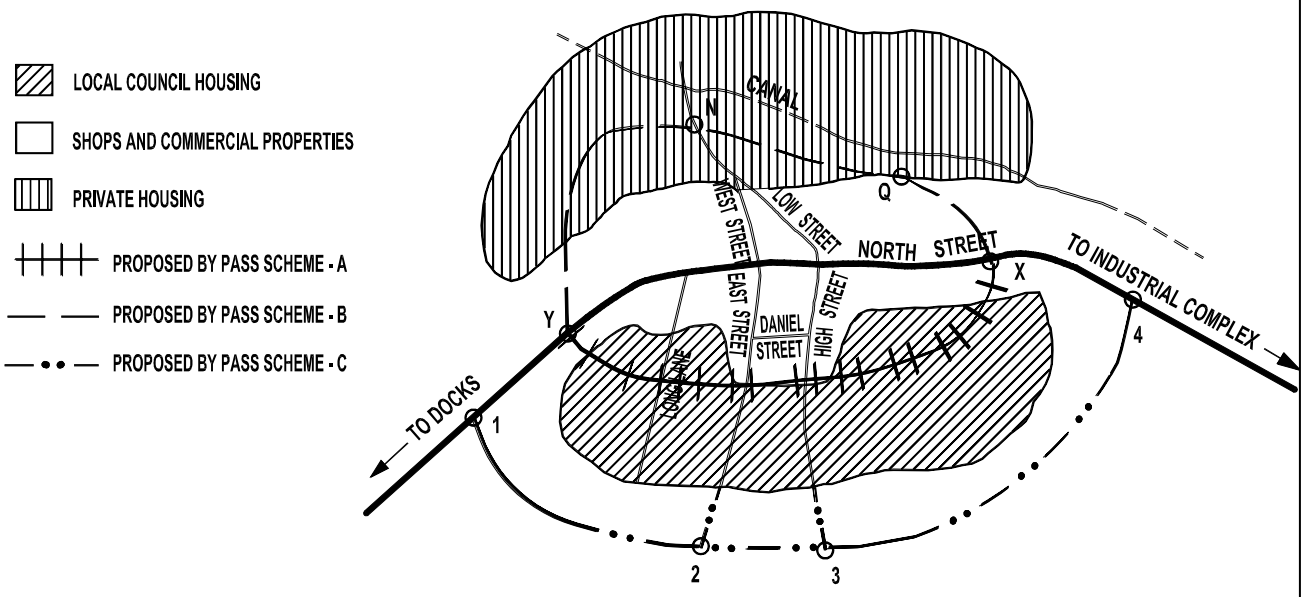

Figure 2: Proposed Bypass Scheme A, B and C for Town

Scheme-A

Benefits:

- Safer, less congested travel for road users.
- Less noise and smoke for commercial area.
- Employment opportunities for the local residents during construction of bypass.
- Safety, health and welfare of shoppers increased.

Costs:

- Financial cost of the scheme.
- Loss of 135 Local Council dwellings
- Loss of 35 shops owned by private sector.
- Noise and pollution transferred from commercial area to residential area.
- Reduction in Local Council house values close to new road.
- Botheration to local residents during construction of bypass.
- Botheration to local residents whose shops or houses are included in demolitions.

Scheme-B

Benefits:

- Safer, less congested travel for road users.
- Less noise and smoke for commercial area.
- Employment opportunities for the local residents during construction of bypass.
- Safety, health and welfare of shoppers increased.

Costs:

- Financial cost of the scheme.
- Loss of 110 private dwellings.
- Loss of 60 shops owned by private sector.
- Noise and pollution transferred from commercial area to residential area.
- Reduction in private house valves close to new road.
- Botheration to local residents during construction of bypass.
- Botheration to local residents whose shops or houses are included in demolitions.

Scheme-C

Benefits:

- Totally safe, less congested and fast travel for road users.
- Reduction in noise and smoke for commercial area.
- Further reduction of noise and smoke for residential areas.
- Employment opportunities for local residents during construction of bypass.

Costs:

- Financial cost of the scheme only.

In summary, it can be said that the costs and benefits of the Schemes- A & B are similar to each other, whereas the Scheme-C is totally different, and contains more benefits as compared to the relevant costs. It should be noted that the cost is a secondary issue in any CBA study.

QUANTIFICATION OF THE COSTS AND BENEFITS

CBA analysis attempts to put an explicit monetary value on items which are not traded in the market, and are therefore not priced, e.g. pollution, noise, dust, etc. In CBA analysis, where a definite cost or benefit can be recognized but impossible to allocate a value in the form of actual figures. The following abbreviations along with a sign of plus (+) or minus (-) are used, following the indicating letter. Normally minus (-) indicates costs and plus (+) denotes benefits. The quantity of symbols of plus (+) or minus (-) signs would indicate the intensity (Shutt, 1997).

a) Abbreviation used when there is a one time only cost or benefit.

M indicates money.
P indicates physical.
T indicates time.
I indicates intangible.
N indicates number.

b) Abbreviation used where there is an annual flow of cost or benefit.

m indicates money.
p indicates physical.
t indicates time.
i indicates intangibles
n indicates number.

This technique is generally known as "quantifying the unquantifiable". Using above techniques the following was quantified for the case study.

A) Cost of Schemes to Local Council

Estimated cost of schemes to Local Council is shown in Table-2.

Table 2: Estimated Cost of Scheme to Local Council

No.	Description	Scheme-A	Scheme-B	Scheme-C
1.	Road construction	$ 3.25 m	$ 3.75 m	$ 6.95
2.	Bridge construction over long lane	$ 2.00 m	-	-
3.	Purchase & demolition cost of shops	$ 6.00 m	$ 12.00 m	-
4.	Purchase & demolition cost of houses	$ 27.00 m	$ 33.00 m	-
5.	Cost of land for road	-	-	$ 3.00 m
6.	Cost of services such as telephone/power	$ 1.00 m	$ 1.00 m	$ 0.50 m
	Total capital cost	**$ 39.25 m**	**$ 49.75 m**	**$ 10.45 m**

B) Existing Owners of Private Housing

Scheme-A & C will not affect the private housing. However, 110 private dwelling would be demolished if scheme-B is adopted. The owners will receive the compensations, but it seldom covers all costs involved, particularly with soft furnishing. There would, therefore, be a monetary cost or M --. There would also be the intangible cost i -- of moving house. Since 110 families would be affected, therefore, we considered the monetary cost M-110 and intangible cost i-110. It will also cost an amount of 33 m $ to Local Council.

C) Existing Tenants of Local Council Housing

Scheme-B & C will not affect this sector. However, 135 dwellings would be demolished if the scheme-A is adopted. Local Council will loose a rent of 0.80 m $ per annum as well as a property of 27 m$. On the other hand 135 families would be affected with intangible cost of moving houses that can be shown as i-135.

D) Existing Owners and Tenants of Shops and Commercial Properties

In Scheme-A, 35 shops and in scheme-B, 60 shops would be demolished. Following the above stated method, we consider the monetary cost M-35/M-60 for shop owners and intangible cost i-35/i-60 for tenants respectively. However Scheme-C will not affect this sector. It will also cost an amount of 6.0 m $ and 12.0 m $ to Local Council respectively.

E) Industrial Complex Using Heavy Transport

For heavy transport to reach from Point "X" to "Y" on existing route takes 20 minutes while using Sscheme-A & B, it would take 6.5 minutes, which means 3 times better or can be indicated as t +++. If scheme-C is implemented then it would take 5 minutes (due to free road) which means 4 times better or can be indicated as t ++++.

F) Traveling by Car

The residents of 'town' will get the similar benefit of time as stated for heavy traffic (Item-E above) while traveling by car.

G) Safety

Safety for local residents will also increase. Using Traffic Police statistics for the Scheme-A & B, it will be enhanced as much as twice, which can be indicated as S++, and for Scheme-C, it will be 4 times (due to totally out of town), and can be indicated as S++++.

Some other benefits and costs such as decrease in house values can also be considered, however, were not included in the study.

Table-3, 4 and 5 represents the findings of CBA analysis for proposed schemes-A, B and C as compared to existing situation. Table-6 represents the summary and order of the preference for all three schemes.

Table 3: CBA Analysis for Scheme-A as Compared to Existing Situation

Sectors involved	Costs	Benefits	Balance
A. The Local Council	$ 39.25 m	-	- $ 39.25 m
B. Existing owners of private housing	-	-	-
C. Existing tenants of Local Council housing	i-135	-	i-135
D. Existing owners/tenants of shops/commercial properties	M-35, i-35	-	M-35, i-35
E. Industrial complex using heavy transport		t +++	t +++
F. Traveling by car		t +++	t +++
G. Safety		S ++	S ++

Table 4: CBA Analysis for Scheme-B as Compared to Existing Situation

Sectors involved	Costs	Benefits	Balance
A. The Local Council	$ 49.75 m	-	-$ 49.75 m
B. Existing owners of private housing	M-110, i-110	-	M-110, i-110
C. Existing tenants of Local Council housing	-	-	-
D. Existing owners/tenants of shops/ commercial properties	m-60, i-60	-	m-60, i-60
E. Industrial complex using heavy transport		t +++	t +++
F. Traveling by car		t +++	t +++
G. Safety		s ++	s ++

Table 5: CBA Analysis for Scheme-C as Compared to Existing Situation

Sectors involved	Costs	Benefits	Balance
A. The Local Council	$ 10.45 m	-	-$ 10.45 m
B. Existing owners of private housing	-	-	-
C. Existing tenants of Local Council housing	-	-	-
D. Existing owners/tenants of shops/commercial Properties	-	-	-
E. Industrial complex using heavy transport	-	t ++++	t ++++
F. Traveling by car	-	t ++++	t ++++
G. Safety	-	s ++++	s ++++

Table 6: Summary of Findings and Order of Preference

Sectors Involved	Scheme-A	Scheme-B	Scheme-C	Order of Preference		
				A	B	C
A. The Local Council	-$ 39.25 m	-$ 49.75 m	-$ 10.45 m	2	3	1
B. Existing owners of private housing	-	M-110, i-110		1	2	1
C. Existing tenants of local council housing	i-135	-	-	2	1	1
D. Existing owners/tenants of shops/commercial properties	M-35, i-35	-	-	2	3	1
E. Industrial complex using heavy transport	t +++	t ++++	t ++++	2	2	1
F. Traveling by car	t +++	t ++++	t ++++	2	2	1
G. Safety	s ++	s +++	S ++++	2	2	1
			Preference Totals	**13**	**15**	**7**
			Overall Order of Preference	**2**	**3**	**1**

CONCLUSIONS

CBA analysis demonstrates that the financial implications of Scheme-A and B are 4 to 5 times higher than the Scheme-C. In addition to huge financial implications, the both Schemes have definite costs in terms of "*Money*" and "'*intangibles*" that will affect the Local Council and public as well, especially when the local area residents are not willing to vacate the property. Benefits in terms of "*time*" and "*safety*" are also lesser as compared to Scheme-C. On the other hand, the Scheme-C has no definite costs for "*Money*" and "'*intangibles*" that may affect the Local Council or Public. Consequently, Scheme-C presents the best solution to the problem for people of the town.

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