Cost-Efficient Programming of Road Projects Using a Statistical Appraisal Method

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A statistical appraisal method (SAM) is presented that can undertake cost-efficient programming of road projects in which a large number of projects are to be examined and data are scarce or difficult to acquire. This is often the case in developing countries, and SAM is illustrated by an example concerning appraisal of low-volume rural roads in the Philippines. Most project appraisal methodologies are based on cost-benefit analysis techniques in which costs and benefits for the design life of the projects are estimated and net present values or internal rates of return are calculated. One of the main obstacles to the use of such methods is the tremendous data requirement for the applied benefit and cost estimation models. The use of a statistical regression technique on readily available data or those with a low collection cost is suggested as a method for limiting the requirements for data with a high collection cost. In addition to SAM, a simplified method, budget level test (BLT), is introduced. BLT measures the efficiency of a simplified appraisal method—in this case, SAM—compared with that of cost-benefit analysis. Application of the programming methodology presented indicates that the data requirements in the appraisal type dealt with can be lowered by 50 percent without seriously jeopardizing the quality of the appraisal.

The need for simplified appraisal methods has been pointed out by many writers (*1–3*). By simplified these authors mean methods that do not require the same amount of data as a cost benefit analysis (CBA). This need is especially true for low-volume rural roads, in which the total benefit of a project could be more or less offset by the cost of a comprehensive CBA.

Fricker (*4*) has suggested the use of statistical analysis on available data as a method for limiting the need for an extensive data collection. Fricker's work was based on pavement management systems, but the idea has been found to be useful also in connection with appraisal of low-volume rural roads.

Many projects recommended for implementation in nonvirgin areas have been submitted to several screening processes during several road development studies before the final recommendation for implementation is given (*1*). Therefore, some base data will often exist for many of the individual links in an appraisal study. These data can and should be used to minimize the need for additional data collection, which is often one of the main obstacles and an important cost component in the appraisal process.

The statistical appraisal method (SAM) is an attempt to structure a rational utilization of such existing data.

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The method is based on some basic assumptions regarding the pool of projects to be analyzed and the rationality of the project selection procedure:

- The projects should be independent, meaning that the benefit of one project should not depend on the implementation of another project. This condition is met by most feeder road studies in developing countries.
- The individual projects have to form a rather homogeneous population of projects. This means that the projects have to be of the same order of magnitude and also that they must serve roughly the same aim.
- Some of the same base data have to be present for all projects in question. These data include such factors as length of project, access constraint, approximate cost of construction, approximate existing traffic, and approximate population in the road influence area.
- Only the highest-ranking projects should be implemented, indicating a rational approach. Of course, network consistency should also be taken into account, but mainly to discard projects that require other nonviable projects to be implemented as a prerequisite for their own viability.

Although the presentation of SAM is exemplified by a calculation example concerning low-volume rural roads in a developing country, other applications concerning programming of large numbers of homogeneous projects are also possible by this method.

OUTLINE OF METHOD

The method can be described according to the following five steps, which represent the rationale of SAM.

Step 1: Study Identification

At the first stage the aim of the study must be identified, and on this basis the relevant benefit types are outlined. For each type of benefit a relevant estimation model must be formulated because a formal CBA will have to be carried out for some of the projects.

In addition to the identification of aim and benefits, all projects must be identified. It must be verified that they serve roughly the same aim (e.g., agricultural development) and that the expected impact is of the same type. A 50-km feeder road in a virgin area may induce a shift in agricultural production toward cash crops, whereas an upgrading of a 5-km feeder road will be unlikely to induce such shifts. Therefore it may be necessary to break up the project pool into several subgroups, which can be analyzed separately.

Step 2: Data and Benefit Proxy Variables

For each type of benefit that cannot be estimated on the basis of existing data, a number of proxy variables for these benefits must be identified. Often it will be possible to draw on previous studies. It must be shown that there is a significant relationship between the proxy variables and the actual benefit elements. A significance level better than 10 percent has been used.

All the data for the proxy variables must be collected. Only data that can be collected at low cost should be included here. Also an estimated cost of construction must be found.

Step 3: Initial Subsample for CBA Calculation

A subsample of projects must be selected for comprehensive CBA to establish their actual benefits. The selection of this group of projects can be made in several ways. Because some projects may have been analyzed in an earlier study, it would make sense to start with these as a subsample. If this is not feasible (e.g., because of inconsistencies between studies), a sample might be selected at random, as is the case in the example described later.

The size of the sample should be large enough to remove biases caused by extreme projects but small enough to allow for CBA calculations and further refinement at a later stage. By empirical analysis it has been found that 10 to 15 percent of the total project pool is an adequate initial sample size.

Step 4: Regression Analysis

The fourth step concerns establishing a relationship between the proxy variables and the actual benefits of the selected initial subsample. This relationship is determined by the use of a multiple linear regression technique. All proxy variables found to have a significant relationship to the benefit in question are used as independent variables, and the actual benefit is used as a dependent variable. The regression relationships are then applied so as to calculate benefits for the remaining projects, for which only proxy variables are available.

Step 5: Project Ranking

Step 5 concerns ranking of all projects, both projects with actual benefits and projects with statistically derived benefits. This ranking is made on the basis of a benefit-cost ratio criterion. If the number of projects needed to exhaust the budget can be taken from the top of the ranking, without reaching or including any of the projects that have only regression-based benefits, the analysis can be stopped. Otherwise, an additional subsample must be selected. An additional subsample of projects is determined for CBA analysis, and Steps 4 and 5 are repeated until no further analysis is required. The projects making up this subsample are the highest-ranking projects with regression-based benefits.

It is presumed that it is acceptable to reject a project but not accept one on the basis of a statistical appraisal result. Only projects that have undergone formal CBA are accepted. This corresponds to a general safety principle, in which all actions suggested should be thoroughly analyzed, whereas this may not be completely the case with options that are rejected. In addition to ranking of the projects, CBA calculations also allow for a testing of the absolute profitability of the projects because net present value and internal rate of return can be derived directly from the CBA figures.

BUDGET-LEVEL TEST

In spite of much justified criticism, CBA has survived for many years; there seems to be a consensus that, in spite of flaws and simplifications, CBA is, from a theoretical point of view, the best methodology around. The general CBA framework is an open-ended concept that does not limit the analyst to a limited number of aspects. Anything can in principle be built into CBA. This is not to say that CBA is the perfect tool; quite the contrary. CBA involves a number of problems, of which data requirement is one of the major ones. Cross-sectional or time-series data often do not exist, and even when they do they represent the past, not the future, which is what is really required. Nevertheless, in this context it is justifiable to use CBA as the reference method. Thus CBA will be seen as the correct ranking of projects, and any other method will be judged on its ability to reproduce this ranking. The following concepts are used:

- The prediction ability is the percentage of projects placed correctly by the method in question. Thus a prediction ability of 70 percent indicates that 70 percent of the projects in question have been placed correctly in the ranking. The meaning of correctly will be discussed below.
- The budget level is the percentage of the projects in question that can be financed under the current budgetary conditions. Thus a budget level of 40 percent indicates that funds are available for implementing 40 percent of the projects being examined.
- A good project is a project that under the given budgetary conditions would be accepted. It would be placed in the acceptance stratum by CBA.
- A bad project is a project that under the given budgetary conditions would be rejected. It would be placed in the rejection stratum by CBA.

The rationale of the budget-level test (BLT) is that if funds are available for 40 percent of the projects in question (the budget level is 40 percent), the main point of interest is whether a project belongs to the upper 40 percent of the ranking or the lower 60 percent of the ranking; that is, whether it belongs to the acceptance stratum or the rejection stratum. The essential point is how large a percentage of the projects recommended for implementation by SAM would also have been recommended by CBA. Therefore, the quality of a simplified method such as SAM is defined as the percentage of good projects placed in the acceptance stratum with reference to a formal CBA. This percentage is the prediction ability. Often the budget level is not known in advance; thus all relevant budget levels can be examined, leading to a two-dimensional result shown as a curve on a graph. Such a graph is shown in Figure 1, in which the four curves represent the prediction ability of four simplified appraisal methods when tested against CBA for any budget level between 0 and 100 percent.

The hatched area in the graph represents an area in which the prediction ability is calculated on the basis of very few projects. Therefore, individual projects will have a very large influence on the result. From a statistical point of view, the prediction ability at low-budget levels is uncertain, and the results should be interpreted with great care.

If for a given pool of projects no information is available, one can in principle resort to simple guessing when appraising the projects. With a budget level equal to 100 percent it is a trivial task. All projects can be accepted. Thus the prediction ability is also 100 percent.

The normal situation arises when the budget level is not 100 percent and often is much below. In that case there are four possibilities:

- A good project is placed in the acceptance stratum.
- A bad project is placed in the acceptance stratum.
- A good project is placed in the rejection stratum.
- A bad project is placed in the rejection stratum.

Only the first two possibilities are relevant to the calculation of the prediction ability. If no information whatsoever exists, the probability of these two possibilities can be calculated. They are denoted P_{ga} and P_{ba}.

Because 40 percent of the projects by definition are good projects when the budget level is 40 percent, the probability of selecting a good project (P_g) at any budget level is

$$P_g = BL/100$$

where BL represents the budget level in percentages. Likewise, the probability of randomly selecting a bad project (P_b) at any budget level is

$$P_b = 1 - (BL/100)$$

Knowing the budget level for each run of the test, the probability of placing a project in the acceptance stratum (P_a) is given by

$$P_a = BL/100$$

On the assumption that independence exists between the selection of a project and the assignment of it to a stratum, the compound probabilities can be calculated as follows:

$$P_{ga} = P_g \cdot P_a = BL^2/100^2$$

$$P_{ba} = P_b \cdot P_a = (BL/100) - (BL^2/100^2)$$

The prediction ability (PA) is the percentage of good projects in the acceptance stratum:

$$PA = [P_{ga}/(P_{ga} + P_{ba})] \cdot 100 \Rightarrow PA = BL$$

Thus, a random method will provide a prediction ability equal to the budget level. If the budget level is 40 percent, only 40 percent of the projects recommended for implementation by

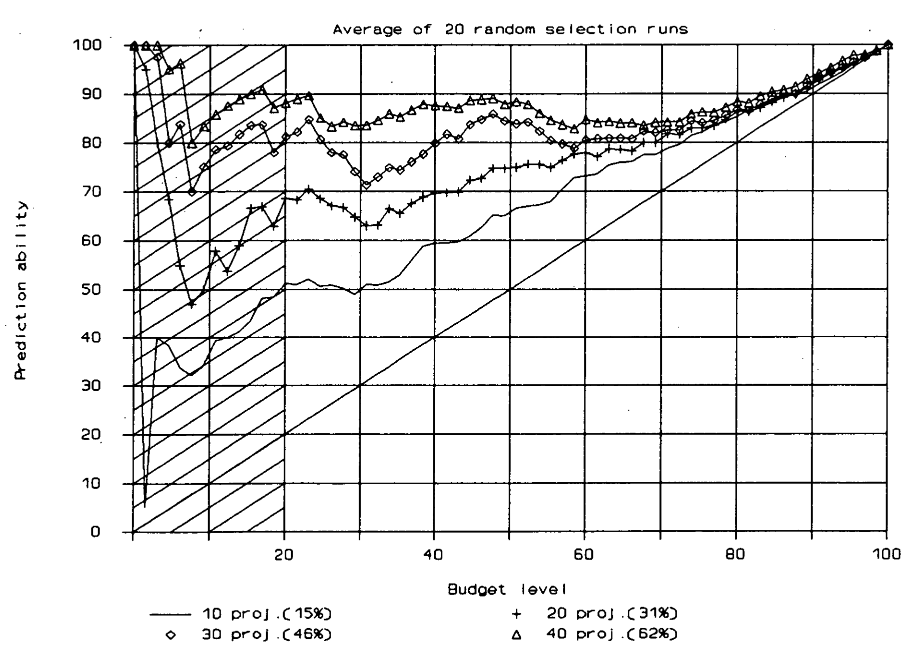

FIGURE 1 Budget-level test on four analytical levels of the statistical appraisal method. Each percentage refers to the percentage of projects used as basis for regression analysis.

a random method will be correct. This can be thought of as a minimum on which any appraisal method should be able to improve. The noncounterintuitive result is shown as a diagonal line in Figure 1.

EXAMPLE

This example concerns low-volume rural roads in the Philippines—so-called barangay roads—where data have been collected by a Danish consulting firm, Hoff & Overgaard A/S, for the Ministry of Local Government in connection with a study (ADB-Assisted Third Road Improvement Project, unpublished data, 1985).

Step 1

On the basis of the study reports, 65 projects were identified as a fairly homogeneous group of road rehabilitation projects. The appraisal of projects described in the reports was based on the four following benefit types:

- Time savings related to nonagricultural traffic.
- Vehicle operation cost savings (VOC) related to nonagricultural traffic.
- Maintenance cost savings.
- Increase in producer surplus in the agricultural sector, which also accounts for benefits related to agricultural traffic.

Step 2

To demonstrate the potential of SAM as compared with the CBA undertaken by the consultant, several possible proxy variables available from the study reports were examined: length of project road, population in road influence area (RIA), population growth in RIA, percentage of unutilized land in RIA, and access constraint. Only three of these showed a significant relationship with the actual benefit types. Significance levels are shown in Table 1. The significance test is used only to select proxy variables, which are as follows:

- *Length of proposed road.* VOC savings depend on length in connection with the amount of traffic on the road. Therefore length could serve as a partial proxy variable for this benefit type. Maintenance cost savings depend largely on the length of the proposed road and can therefore also utilize the information contained in this proxy. Also producer surplus showed a significant relationship, although it is not as strong as the others.

  One might argue that the cost of a project is more or less proportional to its length and that length should therefore be eliminated to prevent both benefits (through regression equations) and cost from being dependent on length. The significance levels, however, indicate that the benefits dependence on length is not total. Instead of cost and benefits per kilometer, in this study length was included as a proxy.
- *Population in RIA.* Population in RIA is an important proxy in the estimation of traffic amounts and can therefore serve as partial proxy for both maintenance savings and VOC savings. Also this proxy showed a significant relationship with producer surplus.
- *Access constraint.* The access constraint factor is a measure of the percent closure of the existing road over the year. If no road exists, the closure is 100 percent. If half of the distance is closed half of the year, the access constraint factor is 25 percent. Time savings are strongly correlated with this factor because after upgrading, high-access constraint often will entail a transport mode shift, for example, from headloading to small vans. Also maintenance savings showed a significant relationship with this proxy.

The significance of the relationships was tested successively in the regression model by use of a *t*-test on each coefficient in the regression equations (*5*).

Step 3

From the project pool a subsample of 10 projects was selected. The selection criterion adopted was random selection of projects. The size of the initial sample was determined on the basis of empirical testing of SAM.

Step 4

A multiple linear regression analysis was carried out to establish the relationships between proxy variables for the ten projects in the initial sample and the actual benefits found by CBA.

TABLE 1 Significance Levels

	Proxy variables		
Benefits	Length	Population	Access constr
Time savings	-	-	0.022
VOC savings	<0.001	0.012	-
Maintenance savings	<0.001	<0.001	0.002
Producer surplus	0.074	<0.001	-

Step 5

The relationships found were then applied to the proxy variables for the rest of the project pool. With cost and benefits known for all projects (10 with actual benefits and 55 with statistical benefits) a benefit-cost ratio could be calculated and all projects could be ranked. These items are illustrated in Figure 2, in which the project pool is ranked. Column 1 contains the name of each project; Column 2, the ranking achieved by the consultant; Column 3, the ranking on the basis of statistical benefits; and Column 4, an indication of the level at which each project was included in the sample used for regression analysis. An example is the Josefina-Don Mariano Marcos project, which in the CBA study ranked as Number

Projectname	CBA rank	SAM rank	Incl. level
Guinpana-an- Alingasao	30	1	
Tagumpay- Sitio Baran	53	2	
Kiangan- Julongan	2	3	
Bantug- SanGuillermo	1	4	
Lipay - Tubo-Tubo	11	5	
Lagawe- Burnay- Hingyon	6	6	
Josefina- Don MarianoMarcos	3	7	10
Sto.Tomas- Sta.Maria	7	8	
Dao - Jct.Maindang- Cuartero	25	9	
Mayoyao- Banao- Alimit	13	10	
Burgos- Iba - Sula	37	11	
Darubba- Runruno	50	12	
Bonifacio- Kanao-Kanao	15	13	
Gamu- Lullutan - SanAntonio	10	14	
BenitoSoliven- SanAntonio	9	15	10
SitioNabilog - Banban	31	16	
Dibuluan- Sta.Isabel	41	17	
Nagdayao- Pis-anan- Bad-as	4	18	
Dibuluan- Bannawag	49	19	
PHILSECO - Cawag	20	20	
Dibuluan- Palasian	24	21	
Jct.East Villaflores - Putian- Astorga	64	22	
Debibi - Tucod	16	23	10
Quirino - Lullutan	22	24	
Nat. Hwy- Gabriela- SitioTapaya	63	25	
NRJ - Katipunan- Sitio Tionggo	17	26	10
Salug- Benoni- Godod	8	27	
Tuburan- Duluan- Parallan	33	28	
Tuburan- Bongbongan	23	29	
Buluangan - Bungsod- Lublub	19	30	
SitioNabilog - Bago	28	31	
NRJ Manjuyod- Cabcaban	52	32	
SanRoque- Sta.Teresa	36	33	
Zamboanguita Calango	40	34	
Debibi - Eden	51	35	
Abaca- Camandagan CasayViejo	39	36	
SitioNabilog - Guincalaban	35	37	
Banga- Taywan	46	38	
Hilaitan - Trinidad	29	39	
Jamindan Tapaz	18	40	
Aritao - Sta.Clara - Canabuan	21	41	
Poblacion- Capaoayan Mangabol	42	42	
Nato- SanRamon- IbangcalC	32	43	
NR - Sampaguita Tamban(incl. NanialanSpur)	14	44	
NRJ - Mapurao- KapanikianSur	48	45	
BatoJct.- Bungot- Itangel	65	46	
T. Fornier - Carmelo- Villar	55	47	
Jct.Bagumbayan Bugo- Bawang	26	48	10
Mabilang- SanCarlos - Mangabol	61	49	
SanGuillermo - Villa Concepcion	27	50	
Jct.S.Roque- S.Agustin- S.Martin	54	51	
Lagawe- Montabiong- Jucbong	5	52	
Salgan- Batabat- East Villaflores	38	53	10
Maindang- Cuartero	56	54	
Tudela- Sinuza- ColambutanSett.	12	55	
SapangDalaga- Concepcion	34	56	
Casiguran- Dilasag	44	57	10
Villa Aglipay - Pao	47	58	10
BenitoSoliven- Villa Concepcion	59	59	
NRJ SanIsidro - Jct.Bug-ang	57	60	
Poblacion- Calipayan- Mababanaba	43	61	
Abbag- Pongo	45	62	
Sto.Niro - Dungao	58	63	
Burgos- SanClemente	60	64	10
Ma-ayon- Maindang	62	65	10

FIGURE 2 Ranking of project pool based on analysis of 10 projects.

3. It was randomly picked as one of the ten projects in the initial sample and was ranked as Number 7. Another example is the Lagawe-Montabiong-Jucbong project, which in the original CBA study ranked as Number 5. This project is strongly misrepresented by the statistical benefits because it was ranked as Number 52.

Steps 4 and 5 Repeated

The next five additional projects were selected for CBA calculation as the five highest-ranking projects with only statistical benefits. These were the projects with the original ranks 30, 53, 2, 1, and 11. Data were collected, benefits were cal-

Projectname	CBA rank	SAM rank	Incl. level
Bantug- SanGuillermo	1	1	15
Kiangan- Julongan	2	2	15
Josefina Don MarianoMarcos	3	3	10
Lagawe- Burnay- Hingyon	6	4	
Sto.Tomas- Sta.Maria	7	5	
Dao - Jct.Maindang- Cuartero	25	6	
Mayoyao- Banao- Alimit	13	7	
Gamu- Lullutan - SanAntonio	10	8	
BenitoSoliven- SanAntonio	9	9	10
Bonifacio- Kanao-Kanao	15	10	
Darubba- Runruno	50	11	
Lipay - Tubo-Tubo	11	12	15
Burgos- Iba - Sula	37	13	
Dibuluan- Sta.Isabel	41	14	
Nagdayao- Pis-anan- Bad-as	4	15	
Debibi - Tucod	16	16	10
SitioNabilog - Banban	31	17	
NRJ - Katipunan- Sitio Tionggo	17	18	10
PHILSECO - Cawag	20	19	
Dibuluan- Palasian	24	20	
Jct.East Villaflores - Putian- Astorga	64	21	
Quirino - Lullutan	22	22	
Dibuluan- Bannawag	49	23	
Salug- Benoni- Godod	8	24	
Nat. Hwy- Gabriela- SitioTapaya	63	25	
Buluangan - Bungsod- Lublub	19	26	
Banga- Taywan	46	27	
NRJ Manjuyod- Cabcaban	52	28	
SitioNabilog - Bago	28	29	
NR - Sampaguita Tamban(incl. NanialanSpur)	14	30	
Hilaitan - Trinidad	29	31	
Abaca- Camandagan CasayViejo	39	32	
Jamindan Tapaz	18	33	
Aritao - Sta.Clara - Canabuan	21	34	
Tuburan- Duluan - Parallan	33	35	
Jct.Bagumbayan Bugo- Bawang	26	36	10
SanGuillermo - Villa Concepcion	27	37	
SitioNabilog - Guincalaban	35	38	
Zamboanguita Calango	40	39	
Guinpana-an Alingasao	30	40	15
NRJ - Mapurao- KapanikianSur	48	41	
Nato - SanRamon- IbangcalC	32	42	
Debibi - Eden	51	43	
Maindang- Cuartero	56	44	
BatoJct.- Bungot- Itangel	65	45	
Mabilang- SanCarlos - Mangabol	61	46	
Salgan- Batabat- East Villaflores	38	47	10
Tuburan- Bongbongan	23	48	
Jct.S.Roque- S.Agustin- S.Martin	54	49	
Tudela- Sinuza- ColambutanSett.	12	50	
T. Fornier - Carmelo- Villar	55	51	
SapangDalaga- Concepcion	34	52	
Poblacion- Capaoayan Mangabol	42	53	
SanRoque- Sta.Teresa	36	54	
Lagawe- Montabiong- Jucbong	5	55	
BenitoSoliven- Villa Concepcion	59	56	
Casiguran- Dilasag	44	57	10
Villa Aglipay - Pao	47	58	10
Abbag- Pongo	45	59	
Poblacion- Calipayan- Mababanaba	43	60	
Tagumpay- SitioBaran	53	61	15
Sto.Niro - Dungao	58	62	
NRJ SanIsidro - Jct.Bug-ang	57	63	
Burgos- SanClemente	60	64	10
Ma-ayon- Maindang	62	65	10

FIGURE 3 Ranking of project pool based on 15 projects.

culated, and new regression coefficients were estimated (Step 4 repeated). With these new relationships benefits were recalculated, and a new ranking was found (Step 5 repeated). This ranking is shown in Figure 3. The Josefina project is now correctly ranked as Number 3. The Lagawe project, on the other hand, is still in the lower end of the ranking scale.

The process was repeated another five times, adding five projects each time. The process was stopped when 40 projects out of 65 were examined by using CBA. The process is illustrated for 20 and 40 projects in Figures 4 and 5. In Figure 4 and especially in Figure 5 it can be seen that more and more projects in the upper part of the ranking have actual benefits,

Projectname	CBA rank	SAM rank	Incl. level
Bantug- SanGuillermo	1	1	15
Kiangan- Julongan	2	2	15
Josefina Don MarianoMarcos	3	3	10
Lagawe- Burnay- Hingyon	6	4	20
Sto.Tomas- Sta.Maria	7	5	20
BenitoSoliven- SanAntonio	9	6	10
Gamu- Lullutan- SanAntonio	10	7	20
Lipay - Tubo-Tubo	11	8	15
Bonifacio- Kanao-Kanao	15	9	
Mayoyao- Banao- Alimit	13	10	20
Burgos- Iba - Sula	37	11	
Debibi - Tucod	16	12	10
Nagdayao- Pis-anan- Bad-as	4	13	
NRJ - Katipunan- Sitio Tionggo	17	14	10
Darubba- Runruno	50	15	
Dibuluan- Sta.Isabel	41	16	
Dibuluan- Palasian	24	17	
Quirino - Lullutan	22	18	
Sitio Nabilog - Banban	31	19	
Salug- Benoni- Godod	8	20	
Nat. Hwy- Gabriela- Sitio Tapaya	63	21	
Banga- Taywan	46	22	
NR - Sampaguita Tamban(incl. NanialanSpur)	14	23	
PHILSECO - Cawag	20	24	
Jct.East Villaflores - Putian- Astorga	64	25	
Hilaitan - Trinidad	29	26	
Aritao - Sta.Clara - Canabuan	21	27	
Jamindan Tapaz	18	28	
Buluangan - Bungsod- Lublub	19	29	
Dao - Jct.Maindang- Cuartero	25	30	20
SanGuillermo - Villa Concepcion	27	31	
Sitio Nabilog - Bago	28	32	
NRJ Manjuyod- Cabcaban	52	33	
Jct.Bagumbayan Bugo- Bawang	26	34	10
Abaca- Camandagan CasayViejo	39	35	
NRJ - Mapurao- KapanikianSur	48	36	
Tuburan- Duluan- Parallan	33	37	
Guinpana-an- Alingasao	30	38	15
Dibuluan- Bannawag	49	39	
Maindang- Cuartero	56	40	
Tudela- Sinuza- ColambutanSett.	12	41	
Sitio Nabilog - Guincalaban	35	42	
SapangDalaga- Concepcion	34	43	
Mabilang- SanCarlos- Mangabol	61	44	
Debibi - Eden	51	45	
Jct.S.Roque- S.Agustin- S.Martin	54	46	
BenitoSoliven- Villa Concepcion	59	47	
Salgan- Batabat- East Villaflores	38	48	10
T. Fornier - Carmelo- Villar	55	49	
Nato- SanRamon- IbangcalC	32	50	
Lagawe- Montabiong- Jucbong	5	51	
Poblacion- Capaoayan Mangabol	42	52	
Zamboanguita Calango	40	53	
BatoJct.- Bungot- Itangel	65	54	
Casiguran- Dilasag	44	55	10
Abbag- Pongo	45	56	
Tuburan- Bongbongan	23	57	
Poblacion- Calipayan- Mababanaba	43	58	
Villa Aglipay - Pao	47	59	10
Sto.Niro - Dungao	58	60	
SanRoque- Sta.Teresa	36	61	
NRJ SanIsidro - Jct.Bug-ang	57	62	
Tagumpay- Sitio Baran	53	63	15
Burgos- SanClemente	60	64	10
Ma-ayon- Maindang	62	65	10

FIGURE 4 Ranking of project pool based on 20 projects.

whereas most of the projects in the lower part of the ranking have statistical benefits.

Even though the acceptance stratum contains only projects that have undergone formal CBA, it may still contain a number of bad projects. This is because a number of good projects have proxy variables that misrepresent them. The socioeconomic loss caused by this flaw is small, however, because the projects that replace the misplaced good projects are those that should have been placed just below the budget line, as the best of the bad projects.

Figure 1 shows the BLT for 10, 20, 30, and 40 projects being CBA analyzed and representing successive analytical

Projectname	CBA rank	SAM rank	Incl. level
Bantug- SanGuillermo	1	1	15
Kiangan- Julongan	2	2	15
Josefina Don MarianoMarcos	3	3	10
Nagdayao- Pis-anan- Bad-as	4	4	25
Lagawe- Burnay- Hingyon	6	5	20
Sto.Tomas- Sta.Maria	7	6	20
Salug- Benoni- Godod	8	7	30
BenitoSoliven- SanAntonio	9	8	10
Gamu- Lullutan- SanAntonio	10	9	20
Lipay - Tubo-Tubo	11	10	15
Mayoyao- Banao- Alimit	13	11	20
NR - Sampaguita Tamban(incl. NanialanSpur)	14	12	35
Bonifacio- Kanao-Kanao	15	13	25
Debibi - Tucod	16	14	10
NRJ - Katipunan- Sitio Tionggo	17	15	10
Jamindan Tapaz	18	16	35
Buluangan - Bungsod- Lublub	19	17	40
PHILSECO - Cawag	20	18	40
Aritao - Sta.Clara - Canabuan	21	19	35
Quirino - Lullutan	22	20	30
Dibuluan- Palasian	24	21	30
Dao - Jct.Maindang- Cuartero	25	22	20
Debibi - Eden	51	23	
Tudela- Sinuza- ColambutanSett.	12	24	
NRJ - Mapurao- KapanikianSur	48	25	
Jct.Bagumbayan Bugo- Bawang	26	26	10
SapangDalaga- Concepcion	34	27	
SitioNabilog - Bago	28	28	40
Hilaitan - Trinidad	29	29	35
SanGuillermo - Villa Concepcion	27	30	
Mabilang- SanCarlos- Mangabol	61	31	
NRJ Manjuyod- Cabcaban	52	32	
Guinpana-an Alingasao	30	33	15
SitioNabilog - Banban	31	34	30
Abaca- Camandagan CasayViejo	39	35	
SitioNabilog - Guincalaban	35	36	
Maindang- Cuartero	56	37	
T. Fornier - Carmelo- Villar	55	38	
Tuburan- Duluan- Parallan	33	39	40
Dibuluan- Bannawag	49	40	
Lagawe- Montabiong- Jucbong	5	41	
Tuburan- Bongbongan	23	42	
Jct.S.Roque- S.Agustin- S.Martin	54	43	
BenitoSoliven- Villa Concepcion	59	44	
Poblacion- Capaoayan Mangabol	42	45	
Burgos- Iba - Sula	37	46	25
Salgan- Batabat- East Villaflores	38	47	10
SanRoque- Sta.Teresa	36	48	
Poblacion- Calipayan- Mababanaba	43	49	
Dibuluan- Sta.Isabel	41	50	25
Nato- SanRamon- IbangcalC	32	51	
Abbag- Pongo	45	52	
Zamboanguita Calango	40	53	
BatoJct.- Bungot- Itangel	65	54	10
Casiguran- Dilasag	44	55	10
Sto.Niro - Dungao	58	56	
Banga- Taywan	46	57	35
Villa Aglipay - Pao	47	58	10
NRJ SanIsidro - Jct.Bug-ang	57	59	
Darubba- Runruno	50	60	25
Tagumpay- SitioBaran	53	61	15
Burgos- SanClemente	60	62	10
Ma-ayon- Maindang	62	63	10
Nat. Hwy - Gabriela- SitioTapaya	63	64	30
Jct.East Villaflores - Putian- Astorga	64	65	40

FIGURE 5 Ranking of project pool based on 40 projects.

levels of SAM. It is seen that for each increment in the number of projects used as the basis for the regression analysis the improvement in prediction ability gets smaller. Thus, for each extra dollar invested in additional data collection, the return goes down. This action corresponds with the principle of diminishing marginal return on increased evaluation efforts (*6*).

The initial sample is selected at random, and the result may depend on which projects are selected. To test if this effect is significant, the total process was repeated 20 times, and the test results shown in Figure 1 as BLTs actually represent an average of these 20 runs. An analysis of the variance derived from the 20 runs shows that when half of the projects are examined, this variation is without practical implications (*7*). On the other hand, the savings in data collection are diminished as more projects have to be examined. Therefore the aim is to find the lowest possible acceptance level of analysis.

The testing of SAM so far indicates that around half of the projects should be examined for practical purposes. This number of projects will result in a satisfactory study outcome defined as an almost correct ranking, achieved by a significant reduction in data collection costs compared with those in a traditional CBA study (*7*).

Last but not least, the procedure enables the analyst to reuse much of the information gathered in earlier studies, which previously went to waste.

CONCLUSION

Conventional appraisal methods of the CBA type are based on data collection and analysis of all projects in question. Because many projects are rejected, high-cost data are collected for projects that are not viable. This becomes particularly clear if only a limited number of the projects competing for implementation can be carried out because of the budget restriction.

The principal feature of SAM is the successive collection and iterative use of data, making data cost savings possible. A major finding is that by application of an SAM instead of a CBA approach, a savings of 50 percent could be obtained without seriously jeopardizing the quality of the appraisal.

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