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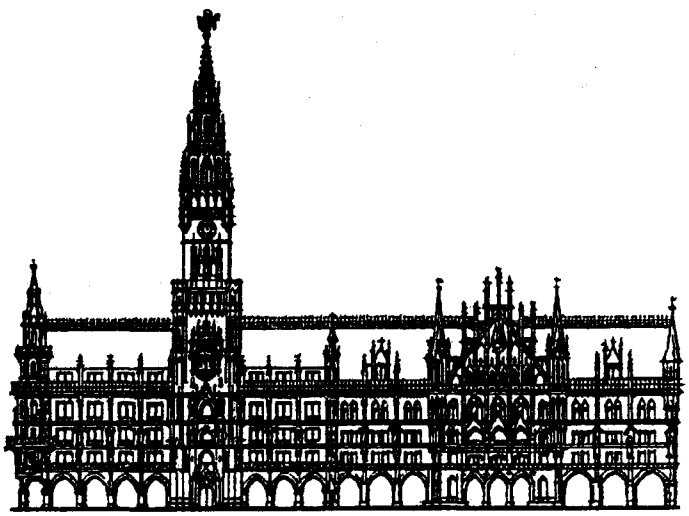

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COST BENEFIT ANALYSIS

implemented in a government organisation

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Cost Benefit Analysis implemented in a large government organisation

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Abstract:

A large government organization spends large amounts of money on automation. The projects carried out vary from simple administrative systems to complex real-time hardware/software systems. In general requirements analysis is done in-house while the further development is tendered to outside contractors.

Within the organisation the need was felt for a method for evaluating and prioritizing project proposals that took into account the specific characteristics of this environment. Further requirements where:

- the method should be as simple as possible,
- the method should be usable both on project and on multi-project level,
- the method should be aimed at providing instruments rather than procedures.

On this basis a three stage model for cost-benefit analysis was developed. The first stage consists of a single summary form, containing information on costs, quantitative and qualitative benefits and risks.

To facilitate gathering this information a second stage was added. Each item from the first stage was broken down in more detailed items. This facilitates the discussion needed to obtain the relevant information.

A proper analysis can be performed only when relevant information from previous projects is available. First and second stage information from previous projects partly fits this bill. In order to be able to gather further relevant information a third stage was added, describing relevant project information to be gathered in a structured and unambiguous way.

Finally some guidelines for the use of the method were formulated.

COST BENEFIT ANALYSIS IMPLEMENTED IN A GOVERNMENT ORGANISATION

INTRODUCTION

This study was carried out in a large Dutch governmental organization. This organisation is aimed at the development and maintenance of infrastructural facilities. The organisation consists of a number of large functional staff departments and of an number of regional departments with a relative large autonomy. A large variety of information systems is used, ranging from simple administrative systems to complex real-time systems.

Requests for the development of new systems are decided on by top-management. However, these requests are formulated by different department with different purposes in mind for totally different types of systems. Also the formulation and presentation of these proposals varies widely. What these requests do have in common is that they all require funding which has to be found within a single budget.

Top management is therefore faced with the task of comparing and ranking these project proposals. It can be imagined that they encounter some problems when trying to perform this task. With this problem as a starting point a study was commissioned into a method for cost-benefit analysis.

This study will be described in this paper. First the goals of the study and the approach chosen will be discussed. Next the resulting method will be looked at and some remarks on the use of the method will be made. The paper ends with some conclusions and final remarks.

GOALS AND APPROACH OF THE STUDY

Starting point of the study was the need for a basis for comparison of several project proposals. The need was felt for a simple format for presenting the costs and benefits of a proposal in a consistent way in order to enable top management to perform their task of evaluation and ranking. Along the road several other goals surfaced.

Not only were there problems at top management level, but also at project level it was found to be a problem to come up with a sound cost-benefit analysis which would take into account the various interests of the different parties involved. This caused an additional goal to be formulated, namely the support at project level for making a cost-benefit analysis.

Most people will have a more or less accurate picture of the meaning of terms as 'cost' and 'benefit'. However, if one wants to be able to discuss these notions for a specific project more detailed expressions will have to be used. A 'language' for the description of costs and benefits will have to be designed which can be understood by all the parties involved, whether they be potential users, developers or managers. This means that one of the major goals of

such a study is to provide a framework for communication. Given such a framework it is possible to involve interested parties in an efficient way.

Even given the possibility to communicate properly on the subjects of costs and benefits it still is possible to do so in a haphazardous and ineffective way. Discussions might focus on some aspect while others which are possibly just as interesting are either ignored or lightly touched. If the framework mentioned above is presented in the form of a checklist two advantages appear. First at a project level people at least know which subject have to be looked at. If one or more subjects are not relevant for the proposal in question it is possible to indicate this. Forgetting important subjects is less likely. A second advantage is that at top management level information on the costs and benefits associated are presented in a uniform and comprehensive way. This makes it possible to evaluate and rank these proposals while being confident that the proposals represent a complete picture of what is planned.

A remaining problem here is the reliability of the information gathered. If top management wants to be able to base their decisions on the information described in the project proposal the would need some assurance that this information is correct. The fact that a manager requires a form to be completed and that in due course such a form appears does not imply that the information gathered in this way is reliable. Quite often this type of form is completed with little or no attention of effort being spent. A typical example are time account sheets which are interesting material for sociological research but give no real information on the actual way the time is spent. A method to heighten the quality of information in the proposal is the so called 'closed loop' principle. If care is taken that the people who gather the information can put this information into practical use themselves, high quality information gathering is more likely to happen. This principle was taken into account when designing the method.

The goals we tried to achieve when designing this method can be illustrated by looking at the problems that can occur if a less methodical approach to estimating a project is chosen. Consider for instance what might happen when estimating a project means that the 'super expert' looks out the window for several minutes and then gives his verdict. Possible problems which might occur are:

- Nobody, not even the expert himself, knows what the basic assumptions underlying this estimate are. Mistakes in these assumptions or later occurring changes that affect them will therefore not be noticed.
- If the basis for the estimate is not known, then it will be a problem convincing the development team of the validity of the estimate. If they are not convinced their motivation can suffer, with possibly large effects on effort and leadtime.
- An expert may state his vision of the benefits of the proposed project. However if the actual people who are involved in realising these profits don't concur. This means that either the expert is wrong in which case the proposal is founded on an overoptimistic cost-benefit analysis. It also might mean that the expert is right, but that the potential users don't know what the system will mean for them. This in its turn might cause problems with the acceptance of the system, again resulting in an over optimistic analysis.

- There is no way of knowing that the expert has taken into account all possible cost and benefit factors. This makes it difficult if not impossible for top management to make a proper evaluation of the proposal.
- Costs and benefits can not always be directly expressed into monetary terms. The final evaluation of the relative value of possible tangible and intangible benefits versus costs is one which will have to be done by top management. The evaluation will be the direct consequence of the interpretation of management policy. Only top management is qualified to make this interpretation. This evaluation is not possible if the information needed is hidden under common denominators such as cost or benefit.

Given these considerations the approach chosen was to provide the possibility of discussing costs and benefits in a more concrete way, while at the same time providing a checklist aimed at completeness in the analysis.

In designing the method care was taken to adapt the method as much as possible to the specific circumstances of the target organization. Therefore the actual design phase was sandwiched between two organisation oriented phases. The first one was used to get acquainted with the way projects were proposed in practice. This phase took the form of a series of interviews with participants of two recently completed projects. The second phase was intended to obtain feedback from the organisation. This took the form of a discussion with a group of people in the organisation responsible for the introduction of software project management practices. This was followed by a discussion with the participants of a current project to find out if the method fitted in with their experience and if the language used and the questions asked were intelligible and reasonable. Finally a presentation followed by discussion for a representative panel drawn from the organisation. This feedback material was incorporated in the method which was then delivered to the organisation.

THE METHOD

The method consists of three parts. Basis of the method is a single form containing a summary of the cost-benefit analysis of a single project. This form is presented in table 1 and will be referred to as the CBA-form.

This form in itself provides sufficient information to evaluate and rank a number of proposals. However, for all but the most simple proposals the questions asked in this form are too difficult to answer at once. The second part of the method provides help for answering these questions. Most questions are broken down in more detailed questions which are concrete, easier to answer and to agree on. This breakdown is provided in the form of a series of tables, each aimed at a specific subject. The information needed to fill out these assistant forms will be referred to as the cost-benefit data (CBA-data).

CBA-form and CBA-data together form the main part of the method. Determining the CBA-data for a specific proposal can be made easier if the draftees have data on past projects

available, for instance in the form of an experience database. The third part of the method proposes the contents of such a database.

Figure 1 provides an overview of the relation between the three parts of the method. In addition to the forms comprising each of the three steps a report provides information on the suppositions underlying the method and definitions of the expressions used. This terminology makes it possible to achieve a consistent usage of language and furthers the communication between the parties involved. Each of these parts will be looked at closer in the following sections.

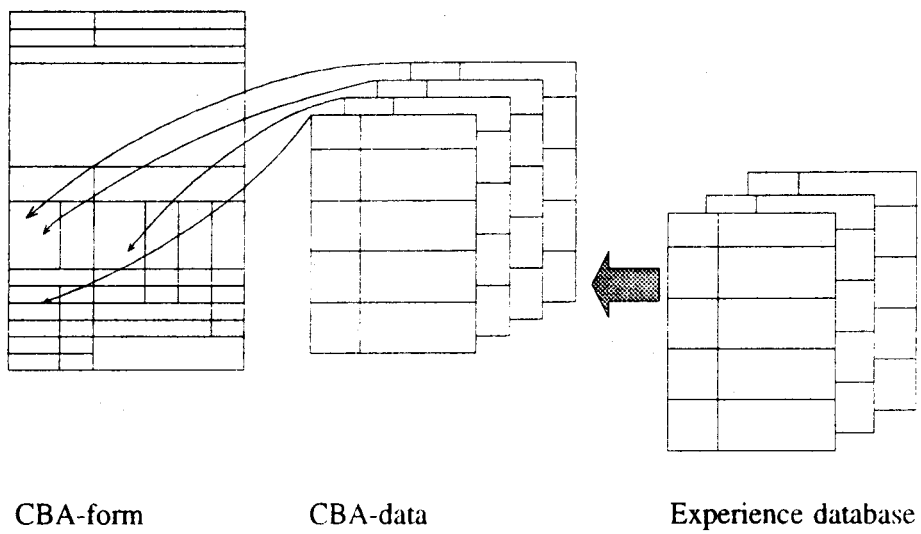

Figure 1: The relation between the parts of the CBA-method

CBA-form
The form starts with some general information, the identification of the project, the principle who will be responsible for the project, and the dates of completion and evaluation. Next the names (and the commitment) of representatives of all parties involved is asked. All parties involved refers at least to the principal, the future users, the developers, and the organisational units which will be affected by the proposed system. Estimated leadtime of the project gives an inkling of the scale of the project. It also gives an indication of the time period over which the costs and benefits are accrued.

For costs a distinction is made between the development costs which are incurred only once and the annual recurring costs of maintenance and management of information systems and

facilities. A further distinction is made between the external, mainly out of pocket expenses and the internally incurred costs which are partly financial and partly organisational.

Table 1: Summary table of the method: the CBA-form

Project name:			Principal:			
Date of completion:			Date of evaluation:			
Draftees:			1>	2>		
3>	4>		5>	6>		
estimated leadtime of the project (in months)		__ M	innovative system O yes O no			
Short description of the project:						
COSTS			BENEFITS			
	internal	external	Non-quantifiable benefits			
cost of development				value	weight	total
Annual costs			strategic match			
cost of maintenance (per annum)			management information			
cost of control (per annum)			political information			
Risk judgement			political pressure			
Risk factor	value	weight	infrastructure match			
organisation						
specification			Quantifiable benefits over 5 years			
technical			Final conclusion			
infrastructure						

The question regarding innovation is based on the assumption that in principle two kind of proposals exist. Systems aimed at substitution of existing (manual) tasks will be looked at from a more financial cost-benefit point of view. On the other hand if a system is aimed at doing something new, for instance a totally different practice of operations, a pure financial cost-benefit analysis will not provide sufficient insight. For these proposals a closer look at non-quantifiable aspects is needed. After a short verbal description of the proposed project the remainder of the form is devoted to three main aspects: costs, benefits and risk.

For benefits a distinction is made between (financially) quantifiable benefits on the one hand and several categories of unquantifiable benefits on the other. The non-financial benefits are an adaption of a selection proposed by Benson and Parker (1988). The adaptions were needed in order to obtain a better fit with the target organisation. For risk an indication of risk in four main categories is required. These categories are also derived from Parker and Benson (1988). Assessing both risk and non quantifiable benefits takes place on a four point scale. The original six-point scale which was suggested by Benson and Parker was considered to be too detailed by the organisation. The meaning of each value is explained in the extra tables that are provided in the second part of the method.

It is now up to top management to come to an agreement on the relative weight of each of these non quantifiable benefits. Given these weights it is now possible to make a proper evaluation of the proposal in which the main risk factors are included.

CBA-data
Support for filling out the CBA-form is provided in three ways. First there is the background material and the definitions which is provided in the accompanying report. Then there are the two types of tables forming the second stage of the method. All quantifiable costs and benefits are broken down in more detailed, checklist based questionnaires. An example of such a checklist is provided in table 2 in which the development costs other then personnel are detailed. Checklists are provided for:

- development costs, personnel,
- development costs, other,
- maintenance costs,
- costs of management and use,
- quantifiable benefits.

For each unquantifiable benefit and for each risk factor a separate table is provided to aid in assigning a value. An example of such a form is presented in table 3 which can be used to determine the appropriate value for political pressure.

Table 2: Development costs, other

Cost	external	internal
Hardware		
- committed to the project		
- committed to the users		
- allocated costs		
Software		
- committed to the project		
- committed to the users		
- allocated costs		
Other expenditure		
- travel & hotel allowance		
- printing-expenses		
- internal costs of training		
- external costs of training		
Total		

Table 3: Political pressure

0	The project has no political priority
1	The project provides information which is seen as politically useful
2	The project provides information which contributes towards the attainment of a politically important goal
3	The project is essential for the attainment of a politically important goal

Experience database

Given the CBA-form and the checklists for the CBA-data an experienced team should now be able to come up with a reasonable cost-benefit analysis for a proposal. It is however by no means certain that all parties involved possess the necessary experience. The third part of the method is aimed at correcting this lack by preserving on a regular basis relevant experience on projects. Given that the experience gathered when building previous projects

is available it is now possible to perform the cost-benefit analysis on a sounder basis, namely the results achieved with comparable (parts of) completed projects.

Such an experience database can be comprised of two types of data. The first type of data to be stored consists of the contents of the CBA-data. Not only the first estimates should be included, but also the results that were finally obtained. One might even consider to include all relevant changes that can be made in these data if during project executing alterations are made.

The second type of data regards other information regarding the system and the project. The exact information to be gathered will differ strongly between organisation. The amount of data to be gathered should be as small as possible in order to encourage systematic gathering and use. On the other hand the data should provide a sufficiently detailed picture of the old system, its development and use to be useful when making a new cost-benefit analysis. The items chosen will together form a new terminology which makes it possible for the communication to take place in a more structured and effective way. In this particular case we suggested that information be gathered on:

- number of staff involved,
- experience level of staff,
- size, complexity, required quality and expected period of operation of the system,
- number and type of users and user departments,
- regard for maintenance during development,
- maintenance experience,
- experiences obtained while managing the system.

An example of the type of data we decided on can be seen in table 4 which shows information which gives an impression of the amount of attention that is spent on maintenance during system development.

Table 4: Maintainability

	No		somewhat		Yes
will formal test procedures be used	1	2	3	4	5
will coding standards be used	1	2	3	4	5
will design standards be used	1	2	3	4	5
will documentation standards be used	1	2	3	4	5
will documentation tools be used	1	2	3	4	5
will the system be designed modular	1	2	3	4	5
what is the fraction of planned test versus total effort	percent				

USE OF THE METHOD

The method can be used for obtaining insight in a specific project proposal. It can also be used by top management to evaluate and rank a number of projects in a consistent way. Each possibility will now be looked at.

Evaluation of a single project
When evaluating a single project proposal use of the method will help to bring about a structured discussion between users and developers in an early stage of development. Such a discussion will give insight into the expectations that exist among the people involved and might get rid of some faulty assumptions. Often problems during development and introduction of a system are caused by the fact that developers and users do not agree on goals and starting points (Genuchten and Koolen, 1991). Early detection of these differences in opinion will prevent problems later on.

The idea behind this method is that several parties are involved in making the analysis. Together they have to come to an agreement as to the costs and benefits that they are likely to incur. The final analysis will have to be based on a consensus. Not only will this increase the mutual understanding, it will also raise the commitment towards to project.

Given the number of parties involved, a meeting aimed at performing a cost-benefit analysis will have to be prepared thoroughly. Everyone will have to try and estimate the CBA-data beforehand. During the meeting attention can then be focused at the perceived differences in opinion. The final result of this meeting should be that everyone agrees on the analysis which can then be presented to top management.

The analysis can also be used as a basis for project control. It is an explicit statement of the goals that are to be attained. It also puts down in writing some of the assumptions that underlay the project. If any of these assumption change this will most of the time mean that either the required quality cannot be achieved or that the budget will be exceeded. With the analysis as a guideline it is now again possible to enter into a structured discussion in which the pro's and cons of any proposed solution can be weighted.

Finally the results of the analysis can be incorporated into the experience database where the data will be available for the analysis of future projects.

Comparing project proposals
The second application area of the method is the consistent evaluation and ranking of project proposals. Top management will have to indicate in which phase of system development they want to evaluate a project. On the one hand they will want to carry out this evaluation as early as possible to prevent money and resources being spent on a project proposal that might never be carried out. On the other hand one has to take into account that a proper evaluation is possible only after sufficient data have been gathered and a sound judgement has been made possible. Furthermore, the moment of evaluation will also vary with the size of the system. For a large proposed project more time and effort will have to be spent if one is to

obtain sufficient information to base a decision on. It is advisable to evaluate a large project several times, for instance after the preliminary analysis and after functional design. Organisation related factors will have to decide when to perform this evaluation.

Given a set of proposals it is now the task of top management to rank the proposals on the basis of expected costs, benefits and risks. The main problem here is assessing the relative importance of the various non quantifiable factors. The explicit assignment of weights to these factors might be a useful method. Final judgement on a project will have to be made by balancing expected benefits on the one hand versus costs (direct and annual) and associated risks on the other hand. Final ranking of the projects can never be a mechanical process but will remain a management decision, based on incomplete information. The advantage of using the CBA-form is that uncertainty is reduced as much as possible and that all proposals are described in a consistent uniform way.

CONCLUSIONS AND FINAL REMARKS

In this paper a method for cost benefit-analysis was described. The method was based not only on development costs but also on the costs of maintenance, management and usage and on the risks involved. Furthermore care was taken to include not only monetary benefits but also intangibles. The method has been accepted by the commissioning organisation. We will conclude with two final remarks.

Success of this method depends totally on its acceptance by all parties involved. This acceptance can not be enforced. Therefore it was decided not to fix the method in a set of obligatory procedures. Past experiences with this approach showed that most of the time effects were hardly noticeable if not negative. The method has been made available to everyone. At first use of the method will be confined to a voluntary use at project level. If after some time it has been accepted in a second phase it will become a recommended practice to deliver project proposals for top management in this format. It is hoped that by adopting this careful approach acceptance will be easier.

That the method has been put into use in the organisation does not mean that it is now finished. It is to be expected that during use in practice changes will occur. A department within the organisation has been made responsible for the maintenance of the method. Already some suggestions for changes have been put forward by people who used it. By not fixing the method but by keeping the options for change explicitly open it is hoped that the method will evolve together with the organisation and that a future mismatch may be avoided.

LITERATURE

Genuchten, M.J.I.M. van, Koolen, J.A.H.M., *On the use of software cost models*, Information and Management, July 1991.
Parker, M., Benson, R., Trainor, H. *Information Economics*, Prentice Hall, Englewood Cliffs, N.J., 1988.

Curriculum Dr. Rob J. Kusters

Dr. R.J. Kusters, born in 1957, received his MA in Econometrics in 1982 from the Catholic University Brabant in Tilburg (The Netherlands). After his graduation he worked for five years as a research assistant at the Eindhoven University of Technology. In 1988 het received his Ph.D. from this institution on the basis of a thesis 'admission planning in general hospitals' in which production control principles were applied to a non-profit environment. Since 1987 he works as an assistant professor of management information systems and automation at the same institute. His main topics of research are the subjects software cost estimation and the control of software projects. On these subjects he published more than 25 papers. Besides his work at the university he is active as a consultant in his research area.

Curriculum Dr. Fred J. Heemstra

Dr.ir. Fred Heemstra, born in 1950, received his MA in Industrial Engineering and Business Administration in 1976 and his Ph.D. in 1989 from the University of Technology in Eindhoven (the Netherlands). Dr.ir. Heemstra is an associate Professor of Management Information Systems and Automation at the University in Eindhoven. He teaches Software Development and Software Cost Estimation and Control courses. Since six year he is project leader of the research group "Software Cost Estimation" at the University. Two years ago he is installed as manager of a large research program, financed by the government and titled "Human and Organizational aspects of Automation".

Before joining the University in Eindhoven in 1985, dr.ir. Heemstra spent two years in industry. He was the director of the consultancy organization Infologic. He was served as a consultant to a lot of organizations. Before joining Infologic he was working at the University of West-Brabant and taught courses on computer science. Beside that he was a member of the management staff of this University.

The last seven years the research of dr.ir. Heemstra has been focused on the subject "Software Cost Estimation and Control". He published more than 50 articles: the majority on this subject. His Ph.D. Thesis is titled "What costs software ? Estimation and Control of Software Development". Heemstra has done much consultancy in software cost estimation in industry, government and insurance companies.