SELECTING INFORMATION SYSTEMS PROJECTS:
PROBLEMS, SOLUTIONS AND CHALLENGES

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ABSTRACT

Allocating scarce resources to Information Systems (IS) projects is a critical problem for most organizations. The IS project selection literature has focused on the selection of independent projects. Frequently, however, the costs and benefits of IS projects are affected by other projects under consideration. Neglecting these interdependencies can result in poor selection decisions. In addition, in estimating a project's value, the emphasis has been on user-oriented benefits. Project benefits resulting from a project's impact on future projects are not considered. Failure to consider these benefits can result in a selection bias against projects that have a greater long-run impact on the organization. Addressing these issues presents both theoretical and practical problems. How these problems can be addressed and the challenges they present are discussed in this paper.

INTRODUCTION

Over the last three decades, information systems (IS) budgets have increased rapidly in most organizations. However, the demand for IS resources has increased at an even faster pace. Consequently, allocating scarce resources to IS projects (i.e., allocation of resources among competing projects) is a critical activity in most organizations [21, 23, 24]. In a recent field study it was determined that project selection was one of the most serious problems facing senior IS executives [5].

Project selection problems seem to be, figuratively speaking, everyone's concern. Strategic planners, economists, operations research analysts and financial analysts all work on the problem [1, 7, 8, 13, 28]. Each has a unique perspective and point of view; each tends to concentrate on a different type of problem because of slightly different environments and goals; and each tends to use a different set of tools and techniques. The literature in each of these fields has grown rapidly over the last three decades. Unfortunately, project selection approaches developed by researchers in these disciplines cannot easily be applied to the selection of IS projects. The IS project selection problem, in—spite of its importance, has only begun to receive attention over the last decade [3, 6, 9, 12, 21, 23, 24, 29].

The literature suggests that the major source of problems in IS project selection decisions arises from the fact that it is often difficult to assign consistent and comparable values to the benefits users receive from IS projects, i.e., the basic worth of individual benefits is difficult to determine [17, 18]. For example, typical benefits may include: cost reduction, better understanding of the business, faster response to unexpected situations, improved communication, time savings, etc., many of which are difficult to quantify [15]. Because of the difficulty in determining the monetary value of some of these benefits, much of the research has focused on benefit measurement. This stream of research has improved measurement of both costs and benefits, has developed methods to enable comparison of costs and benefits, and has improved our understanding of the ramifications of using various selection techniques.

Earlier approaches to the problem have focused attention on the measurement of "user-oriented" benefits, i.e., benefits to the functional area, group or individual for whom the system will be developed. IS projects, however, can have a significant impact on an organization, beyond the functional area, group or individual for whom the system is developed. Investments in "new technology" projects are a good example. These projects can seldom be justified on the basis of user-oriented benefits alone. However, they can have a significant impact on the organization's ability to undertake future projects using the same technology. Hence, an important benefit of these projects may be derived from projects that may be undertaken at some time in the future. By ignoring these "other benefits," project selection decisions are biased against projects with certain characteristics. Another problem with earlier approaches is that they do not recognize interdependencies between candidate projects (i.e., projects currently under consideration). Ignoring interdependencies among projects results in in-
accurate estimation of costs and benefits and thereby leads to poor selection decisions.

This paper briefly reviews the IS project selection literature, points out the shortcomings of earlier approaches and discusses their implications. Approaches for addressing these shortcomings are presented, where possible, and directions for further research to address these problems are suggested.

**PRIOR RESEARCH**

Although individuals or groups responsible for selecting IS projects vary across organizations [12], IS project selection decisions generally follow a process similar to the one shown in Figure 1 [26]. A brief description of each step in this process follows.

**Step 1:** Initially, requests for new applications (projects) are gathered.

**Step 2:** For each project request, IS professionals together with users, undertake an analysis aimed at identifying the problem (or opportunity) and determining the scope of the project. This is a brief, inexpensive analysis aimed at obtaining a general idea of the problem and the scope of the project.

**Step 3:** Typically, for each project request, alternative application system solutions to solve the problem are developed. For example, an online vs. a batch design for an inventory control system, or a local area network vs. a mainframe-based electronic mail system. As in step 2, this activity also is brief, and includes few details of proposed solutions.

**Step 4:** For each project request, the feasibility of each of the alternative (solutions) is determined. Generally, three types of feasibility are considered: technical, operational, and financial. An analyst interested in determining technical feasibility, is interested in determining whether the organization has, or can acquire, the technical resources (materials and labor) necessary to successfully complete the project. Operational feasibility is concerned with determining whether the organizational environment is ready to accept the changes that the new system will require (i.e., will the system work if it is developed and installed?). Financial feasibility is concerned with determining whether the financial benefits of the system will exceed its costs.

**Step 5:** The results of the feasibility study are used to select a single alternative for each project request. Typically, selection is based on financial considerations, while technical and operational feasibility are treated as necessary conditions.

**Step 6:** The selected alternatives for each of the project requests are compared and projects are selected in light of budget constraints.

As mentioned earlier, IS projects often provide benefits that are difficult to measure in monetary terms. Often this results in many benefits of a system being disregarded because they cannot be easily quantified. Consequently, it is difficult to apply well known financial methods such as return on investment, net present value, etc., when comparing different alternatives for a single project request (step 5), or different project requests (step 6).

In order to overcome this problem, researchers have attempted to find ways to measure all benefits [9, 17]. For example, Ginzberg [9] introduced a taxonomy to help identify the full range of benefits and suggested an approach to measure these benefits. King and Schrems [17] discussed the problems that arise in applying cost/benefit techniques to IS projects and how they might be overcome. This body of research has attempted to overcome problems encountered in trying to measure the less tangible benefits of information systems, e.g., improvement in customer service, increase in the accuracy of information, etc. By determining the monetary value of all benefits, traditional capital budgeting approaches can be used to select projects.

Another approach to the benefit measurement problem has been to assume that all of the benefits cannot be measured on a single scale. Instead, benefits are categorized so that different measurement scales can be used for different categories. Then a project's impact on each of these categories is measured and multiple criteria scoring models are employed to determine the overall value of each project [3, 21]. Scoring models are recommended because of their ability to accommodate subjectively evaluated criteria, such as the intuitive judgment of managers. This approach can overcome the problem of disregarded benefits. However, problems exist in determining the weights to be assigned to different criteria.

In addition to the problem of measuring different types of benefits, there is an estimation problem. Techniques developed to estimate costs as well as benefits are far from accurate in their predictions [10]. For example, even after detailed designs have been developed, estimation of programming costs alone are inaccurate, with the best methods resulting in variances of 15 percent and above for projects similar to the ones used to develop each estimation model [18]. Further, even the
easily quantified benefits are difficult to estimate accurately [17]. In fact, it is often difficult to measure benefits even after a system is in use [14].

<table>
<thead>
<tr>
<th>Step 1</th>
<th>Gather requests for new applications</th>
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| Step 2 | Identify problem or opportunity that application will address |

| Step 3 | Find alternative solutions for each request |

| Step 4 | Determine feasibility of solution: technical, operational and financial |

| Step 5 | Select the best alternative for each project |

| Step 6 | Select projects given budget constraints |

Figure 1. Typical project selection process

Partly because of estimation problems, it has been suggested that a portfolio approach be used to select IS projects. One approach is to include among the selected projects, those from different classes, such as: required maintenance, regular maintenance, enhancements, major new applications, innovative applications, etc. [24]. Another approach more closely adheres to concepts from the portfolio selection literature on financial investments [27]. In this approach, it is explicitly recognized that the costs and benefits of IS projects are not certain, i.e., the projects are risky. Consequently, it has been suggested that project risk be estimated and selection decisions consider risk in selecting a portfolio that reflects the risk an organization is willing to take at the time the decision is made [11, 22].

Yet another line of research has focused on the decision makers involved in project selection, rather than the process [6, 12, 23]. These decision making individuals or groups are involved in the selection of evaluation criteria as well as in the selection of projects. The objective of this research has been to determine who should make these decisions, i.e., senior corporate management, the IS department, a steering committee, etc.

**PROBLEMS WITH PRIOR APPROACHES**

There are two major problems with approaches suggested in the literature. First, candidate projects are assumed to be independent. While this assumption may have been reasonable for application systems that were developed through the early 1970s, it is no longer reasonable since strong interdependencies among projects are common. Application systems today are quite different from those of a decade ago. From the early 1950s through the early 1970s, application systems were developed as independent systems, with little impact on other application systems that were concurrently developed. Each application system was independent. However, application systems developed today often have a significant impact on other systems that are developed simultaneously. For example, an office automation system may require the installation and use of communication capabilities and equipment in offices. These resources and familiarity in using them can significantly affect the costs of other systems involving the same users and resources. Thus, application systems often are not independent of other applications that are under consideration. Assuming independence can cause errors in the estimation of costs and benefits and result in poor selection decisions. Second, only user-oriented benefits are considered in evaluating project requests. By not considering non-user benefits, selection decisions are biased towards projects with specific characteristics. In this section, these problems are discussed in greater detail.

**Project Interdependencies**

The project selection process described earlier implicitly assumes that projects are independent. In step
4 (Figure 1), for example, the financial feasibility of alternative solutions to a single request are considered independently of other projects under consideration. Decisions on the selection of an alternative for each project request are made without considering their impact on alternatives for other project requests. This is reasonable only if projects are independent. However, an alternative solution for one project request can be affected by one or more of the alternatives for other project requests.

For example, consider two alternatives for an inventory control system, one a batch processing solution, the other an online solution. Given the existing computing environment in the organisation, the batch processing solution might be the better choice. However, one of the other projects under consideration could be a new system software product (e.g., a report generation package) that would decrease the costs and/or increase the benefits of the online inventory application, thereby making it the better choice if the new system software product is also selected. In such a situation, the selection process described earlier may lead to poor selection decisions. Selection decisions in step 6 (i.e., after the best solution for each project request is chosen) will also lead to poor decisions, since cost and benefit estimates from step 4 are used and they have been obtained assuming project independence.

As discussed above, projects are frequently interdependent. Interdependencies between projects can arise if the resource requirements and/or the benefits of one project are significantly affected in magnitude or timing by selection or rejection decisions relating to one or more of the other projects under consideration. For example, two projects are interdependent if the net present value (NPV) and/or resource requirements when both are selected, are not equal to the sum of the NPVs and/or resource requirements of each project when undertaken alone.

Information system projects are often separated into one of two categories, (a) systems projects and (b) application projects. Systems projects are those that affect the operation of a computer system, its users and the application systems that are currently operational or under development, i.e., they help make application systems more viable by decreasing their costs and/or increasing their benefits. For example, buying and installing a new piece of hardware, a new operating system, a new language compiler, etc., are systems projects. Application projects on the other hand, directly affect some business function and provide business related benefits. For example, a budgeting system, a payroll system, an electronic mail system, etc., are considered application projects.

IS project selection research has focused on the selection of application system projects. However, system and application projects compete in many respects for limited IS resources and hence should be considered together. For example, they often compete for the same capital and labor resources. In addition to competing for the same resources, both the costs and benefits of application system projects can be greatly affected by the system projects that are undertaken during the same period (and, it can be argued, vice versa). For example, the cost of developing and operating an order entry application system can be affected by a decision to buy and install a database management system (DBMS). In addition, the benefits of an order entry system can also be affected by a decision to buy a DBMS. Restricting project selection decisions to application systems, results in poor decisions because of strong interdependencies between these two types of projects.

In addition to relationships between projects currently under consideration, IS projects frequently affect systems that are currently operational. For example, upgrading hardware can reduce the response time of existing systems and thereby increase their value. A new application system that is integrated with an existing application system could improve the timeliness of information available to users of the existing system and consequently the existing system's value. While these benefits often are not considered in practice, they do not affect the decision process described earlier, although they do present measurement problems.

Thus, we can conclude that two changes are necessary in the selection process described earlier: (1) systems and applications projects must be considered together when resource allocation decisions are being made, and (2) project interdependencies must be considered in this process. By not considering interdependencies, estimation of costs and benefits of individual projects are inaccurate. This may partially explain the estimation problems encountered in practice [16, 17, 20]. Inaccurate estimation will lead to poor resource allocation decisions.

Measurement of Benefits

In the literature there has been a great deal of attention paid to the measurement of benefits. The emphasis has been on finding ways to deal with different types of benefits. However, the focus has been on benefits that are "user-oriented." For example, reduced data processing costs, improving a user's understanding of the business, increasing the number of alternatives considered by the user, speeding up a user's response to unexpected situations, etc [9, 15, 17]. Besides user-oriented benefits, most IS projects (if not all) have other
benefits to an organization that are not considered in the literature. These "other" benefits are discussed here.

It is assumed that the organizations in which these decisions are made will continue to exist and to undertake other IS projects in the future (i.e., they are "going concerns"). One of the other benefits that accrue to an organization is greater experience in the use of a technology. For example, a project that involves development of a system using a specific technology, will improve the organization's technical ability to develop other systems using that technology, in addition to the user-oriented benefits of the system. This experience can affect the technological feasibility of future projects. Clearly, the value of these benefits will (at least) depend upon existing experience with the technology, new experiences the project provides in the use of this technology and the likelihood that these new experiences will be useful in future projects. These benefits are seldom discussed in the literature and are never considered in determining the financial value of a project.

It has been suggested that the riskiness of projects be considered in selecting projects [11, 22]. Projects requiring the use of new technology are considered risky. While this is true for user-oriented benefits of the system, benefits from "increased expertise in the use of a new technology" can help offset the risk associated with user-oriented benefits. In a model proposed for the assimilation of new technologies, Cash et al. [2] suggest that projects involving new technologies should not be subjected to rigorous cost-benefit analysis. Doing so, however, may result in "new technology" projects not being funded, or that they are funded on an ad hoc basis. Although these projects may be difficult to justify using user-oriented benefits alone, the expertise gained in using new technology can be very valuable to an organization because of its potential impact on future projects. While quantifying these benefits may be difficult, it is important that they be identified and measured if resource allocation decisions are not to be made on an ad hoc basis.

In addition to benefits from additional experience in the use of technology and user-oriented benefits, IS projects often have other organizational benefits that are not considered. One other benefit category that must be considered is benefits that can affect the operational feasibility of future projects as well as the cost of undertaking future projects and possibly, their benefits. For example, consider an office automation project involving the introduction of a network of workstations, mini-computers and mainframes that provide word processing, electronic mail and calendaring functions. Besides the user-oriented benefits from the introduction of these capabilities, this project will affect the feasibility of future projects requiring workstations, communications capabilities, etc., because the technology is already in place and users have experience in using the technology. Thus, it could affect the operational feasibility of future systems involving these same users, because their experience can affect their behavior towards future systems. It could also affect the costs of future systems by requiring less user training and providing easier access to resources.

From this discussion we can conclude that important benefits of projects are often not considered in the IS project selection literature. Exclusion of these benefits can cause selection decisions to be biased towards systems providing large user-oriented benefits and against projects that can have a significant long run impact on the IS products and services that are delivered. In the long run, this could seriously affect both the organization and the IS function.

**APPROACHES FOR ADDRESSING THESE PROBLEMS**

From the earlier discussion, it follows that the impact on the organization of the selected group of projects is determined by:

1. the user-oriented benefits and project costs for each of the projects, determined independently of each other. One should include each project's impact on existing systems (independent projects),
2. a project's impact (costs and benefits) on other projects that are selected (interdependent projects), and
3. each project's impact on the organization's future investment opportunities (other benefits). One could argue that joint impacts of selected projects on future investment opportunities should also be considered (impact on future projects).

Financial feasibility is often determined using discounted cash flow analysis (DCF). However, application of discounted cash flow encounters serious problems in dealing with the benefits described above. One of the problems pertains to financial estimation of benefits in each category. Related to the estimation problem is the selection problem, i.e., assuming estimation problems can be overcome, how should projects be selected? These problems are addressed in this section.

**Dealing with Independent Projects**

Procedurally, dealing with independent projects is straightforward. The selection process described earlier works well. The best alternative for each project is first selected. Then, projects can be selected in step 6 by solving the linear integer program.
subject to

\[ \sum_{i=1}^{n} d_i X_i \leq D \]

where the notation is defined as follows:

\( r_i \) = the net present value of project \( i \),
\( d_i \) = development cost of project \( i \),
\( D \) = maximum allowable expenditure,
\( n \) = number of project requests,

\[ X_i = \begin{cases} 
1 & \text{if project } i \text{ is selected} \\
0 & \text{otherwise}
\end{cases} \]

This selection problem is representative of a class of capital budgeting problem often referred to as the Lorie-Savage [19] problem. The optimum solution is obtained by picking projects in decreasing order of \( r_i/d_i \) and cutting off at \( i = j^* \), just before

\[ \sum_{i=1}^{j} d_i \leq D \]

cesses to hold. At this cutoff point, with \( p = r_j/d_j \), the quantity \( (r_i - p \times d_i) \) is positive or zero for the chosen projects, and is negative for the omitted projects.

Additional constraints could be added, but they are not germane to the discussion. Using this model requires the estimation of each project's future cash flows, costs and benefits of alternative \( j \) for project \( i \) to be computed. Also, the cost of individual projects must be estimated \( (d_i) \). The estimation of cash flows and costs of independent projects, while difficult, has been the subject of a good deal of research in the IS area [9, 15, 17]. Hence, it will not be discussed here. Thus, if projects are independent, the process shown in Figure 1 and the above selection model can be used to select projects.

**Dealing with Interdependent Projects**

The project selection process in Figure 1 does not readily deal with interdependent projects. It is a two step process, (1) selection of the best alternative for each project, and (2) selection of a subset of projects for development, using the financial estimates for the best alternative for each project. In situations where the financial impact of alternate solutions for each project may be affected by other projects, this process needs to be modified. Steps 1 through 3 will be similar to the process shown in Figure 1. The only difference is that both systems and application projects are included. First, alternative solutions for each request are identified in step 3. Next, interdependencies between alternatives for the different projects must be identified. For example, the costs and/or benefits of alternative 2 for project 3 may be affected by the choice of alternative 3 for project 1. In such a case, they are grouped together to form a new project, referred to as a compound project. After all compound projects are identified, the feasibility of each of the alternatives for each project request as well as the feasibility of each compound project must be determined. Finally, projects can be selected as described below. Figure 2 shows the modified process necessary to deal with a combination of dependent and independent projects.

Here each alternative is considered a separate project. Alternative \( j \) for project request \( i \) is referred to as project \( ij \). Assume there are \( n \) projects requested and for each project request, there are \( m \) alternatives. A group of projects is said to form a mutually exclusive set, if, selection of one project from the set renders all others in the set clearly unacceptable. By this definition, the \( m \) alternatives for each project request \( i \), form a set of mutually exclusive projects. Let \( r_{ij} \) and \( d_{ij} \) represent the net present value and development costs respectively, of project \( ij \). Projects \( ij, kl, \ldots, uv(i \neq k \neq \ldots \neq u) \) will form compound project \( c \) if the following conditions hold:

\[ s_c \neq r_{ij} + r_{kl} + \ldots + r_{uv} \]
and/or \( e_c \neq d_{ij} + d_{kl} + \ldots + d_{uv} \)

where \( s_c \) and \( e_c \) represent the NPV and development costs respectively, for project \( c \). The compound project \( c \) and all the alternatives for project request \( i \), form one set of mutually exclusive projects; project \( c \) and all the alternatives for project request \( k \) form another set of mutually exclusive projects; etc.

Let the sets \( S_c \) and \( R_c \) be defined as follows:

\[ S_c = \{ x: x \text{ is a project request such that one of the alternatives for } x \text{ forms the compound project } c \} \]
\[ R_c = \{ xy: xy \text{ (i.e., alternative } y \text{ for project request } x \text{ ) is one of the projects that forms the compound project } c \} \]
subject to
\[
\sum_{i=1}^{n} \sum_{j=1}^{m} d_{ij} X_{ij} + \sum_{c=1}^{p} e_{c} Z_{c} \leq D \tag{1}
\]
\[
\sum_{j=1}^{m} X_{ij} \leq 1 \quad i = 1, 2, \ldots, n \tag{2}
\]
\[
Z_{c} + \sum_{j=1}^{m} X_{ij} \leq 1 \quad c = 1, 2, \ldots, p; i \in S_{c} \tag{3}
\]
\[
\sum_{uj \in R_{c}} X_{ij} < |R_{c}| \quad c = 1, 2, \ldots, p \tag{4}
\]

where notations not defined earlier are as follows:

\( p \) = number of compound projects
\(|R_{c}|\) = the cardinality of \( R_{c} \)

\[
X_{ij} = \begin{cases} 1 & \text{if alternative } j \text{ for project request } i \text{ is selected} \\ 0 & \text{otherwise} \end{cases}
\]

\[
Z_{c} = \begin{cases} 1 & \text{if compound project } c \text{ is selected} \\ 0 & \text{otherwise} \end{cases}
\]

The objective function includes a term for each alternative for each project request. In addition, it includes a term for each compound project. The budget constraint is represented by (1). Constraints (2) and (3) are introduced because some of the projects are mutually exclusive. Constraint (2) (a set of constraints) ensures that only one alternative for each project request is selected. The rationale for constraint (3) is as follows: should a compound project \( c \) be selected, and one of the projects forming project \( c \) be an alternative of project \( i \), then none of the alternatives of project \( i \) can be selected. Further, if an alternative of project \( i \) is chosen, none of the compound projects that include any alternative of project request \( i \) can be selected. Finally, equation (4) ensures that all the independent projects forming a compound project cannot be selected, since, in this case, it is the compound project that must be chosen (since compound projects are formed because interdependencies exist).

A simple example will help clarify the formulation. Assume there are 4 project requests and for each project request there are 2 alternative ways of satisfying the request. Hence, we initially have 8 candidate projects; 11, 12, 21, 22, 31, 32, 41 and 42. Further, assume projects 11, 22 and 31 are interdependent. They form the compound project 1. Then,

\[
S_{1} = \{1, 2, 3\}
\]

and \( R_{1} = \{11, 22, 31\} \)

Figure 2. Selection process for interdependent projects

Then, the programming model for selecting independent projects can be modified to include both independent and interdependent projects, as indicated below.

\[
\max \sum_{i=1}^{n} \sum_{j=1}^{m} r_{ij} X_{ij} + \sum_{c=1}^{p} s_{c} Z_{c}
\]
Then, the formulation is as follows:

$$\max \sum_{t=1}^{4} \sum_{j=1}^{2} r_{tj} X_{tij} + s_t Z_t$$

subject to

$$\sum_{t=1}^{4} \sum_{j=1}^{2} d_{tj} X_{tij} + e_i Z_i \leq D$$

$$\sum_{j=1}^{2} X_{tij} \leq 1 \quad i = 1, 2, 3, 4$$

$$Z_t + X_{11} + X_{12} \leq 1$$

$$Z_t + X_{21} + X_{22} \leq 1$$

$$Z_t + X_{31} + X_{32} \leq 1$$

$$X_{11} + X_{22} + X_{31} < 3$$

$$X_{tij}, Z_i = 0 \text{ or } 1$$

The optimum solution depends upon the NPV and cost relationships that exist between compound projects and the projects forming a compound project. For the general case, a software package that solves linear integer programs (e.g., using the branch - and - bound algorithm) can be used to select projects. However, under certain circumstances, optimum solutions may be obtained in other ways. For example, when

$$\frac{s_c}{e_c} > \frac{r_{tij}}{d_{ij}} \text{ for } i,j \in R_c$$

holds for all compound projects, then all projects $ij$, forming compound projects can be eliminated. In this case, the optimum solution is obtained in a similar manner to that used to select independent projects. Projects are selected in decreasing order of $r_{tij}/d_{ij}$ ($s_c/e_c$ is used in the case of compound projects), as discussed for independent projects. However, when a project is selected, all other projects that belong to mutually exclusive sets that include the selected project are removed from consideration. Thus, the problem in this case is not in selecting projects in step 6 (Figure 2), but in the implementation of changes in the selection process to estimate the inputs that are required in step 6, i.e., changes to steps 4 and 5.

Implementation of this process poses many problems. Tracing relationships between projects is intrinsically difficult, i.e., identification of compound projects. When projects are not independent, analysts working on individual projects must interact with each other in order to identify compound projects and determine their feasibility. This could present a difficult problem in many organizations. Instead of individuals or small groups working independently to provide the necessary information (as in dealing with independent projects), communication among, and coordination of those working on the feasibility of individual projects is required to identify and determine the feasibility of compound projects. The problem may be made more difficult by inappropriate project definitions or boundaries, and an absence of adequate incentives to motivate individuals to make the necessary changes. Furthermore, the problem of identifying future cash flows for independent projects are magnified for interdependent projects. Further research is necessary to find ways to deal with these problems.

### Impact on Future Projects

Although the first two conditions identified present a number of difficulties, the relationship between a candidate project and future projects is even more difficult to handle. A popular capital budgeting approach for dealing with this situation is to extend the problem to multiple periods and consider multi - period compound projects [28]. This approach will not work. Suppose one of the projects the organization is considering involves the use of a new technology for the organization. Further, assume that financial estimates for this project are such that it would not be selected if its value as an independent project and its impact on other candidate projects is considered. Investment in such a project may be justified, however, because it provides a valuable second stage investment, i.e., expertise gained from this project may allow future use of this technology to be financially attractive on its own. The second stage depends on the first; the organization cannot take on the second stage project without taking on the first. Thus, there is a time - series link between projects, i.e., current investment decisions present potential opportunities in future periods.

At first glance this appears to be just another forecasting problem. Why not estimate the value for both projects together? The reason this will not work is that investments in future projects are not certain. Management is not committed to undertaking these future projects. Thus, investments in current projects present a future option that management may or may not exercise and conventional discounted cash flow methods do not value options properly. The future stage is an option because the organization is not committed to undertaking it. Management will go ahead with the future project only if the current project works out well and business conditions are such that the value of the future project makes it an attractive investment at the time that
a decision on that project is being made, i.e., at some time in the future. If the current project fails, or if the opportunity turns sour, the organization can stop after the current project, and cut its losses. Thus, investing in a current project, purchases an intangible asset: an option on future projects. If the option's value offsets the current project's poor financial returns, the current project is justified.

Methods for dealing with investments of this type have not been adequately developed. The challenge is to find ways to determine the value of the options that these projects provide. The theory of options pricing has been worked out in detail for a wide variety of securities for which options are traded [4]. Discounted cash flow methods, however, are never used for this purpose and options formulas look nothing like DCF formulas [25]. On the other hand, option valuation techniques may be applicable to the problem and should be investigated.

SUMMARY AND CONCLUSIONS

Allocating scarce IS resources to projects is an important management task that has only recently begun to be addressed in the IS literature. This literature has focused on the allocation of resources to application systems and assumes that the projects under consideration are independent. However, changes in technology have increased interdependencies among application systems. Further, there are good reasons to suggest that both systems and application projects should be jointly considered when resource allocation decisions are made.

Interdependencies among systems and application projects have always existed. Consequently, the project independence assumption often is not valid for decisions involving application projects and never was valid for joint consideration of systems and application projects. Selecting projects in the presence of interdependencies does not present methodological problems. Solvable selection models are easily developed. However, implementation of processes to gather the data necessary for these models may present formidable problems.

A significant problem in IS project selection is the estimation of a project's value. While many researchers have addressed the estimation problem, the emphasis has been on determining the value of a system to its users. Many projects, however, have a financial impact on the organization beyond their impact on users because of their impact on future investment decisions. These benefits are seldom considered in considering a project's value. Failure to do so can bias project selection decisions towards systems with large user-oriented benefits and against projects that may have a greater long-run impact on the organization.

While it is clear that these long-term benefits must be considered when project selection decisions are made, it is not clear how one should proceed to do so. Extending project selection models to multiple periods does not adequately address the problem. Further research is necessary to help identify and measure these benefits so that resource allocation decisions can be based upon their "true" impact on the organization.

REFERENCES


