Available online at www.sciencedirect.com
SCIENCE DIRECT®
Technovation 25 (2005) 185–193
technovation
www.elsevier.com/locate/technovation

An R&D options selection model for investment decisions

Simon Coldrick[a,*], Philip Longhurst[b], Paul Ivey[a], John Hannis[c]

[a]School of Engineering, Cranfield University, Cranfield MK43 0AL, UK
[b]School of Industrial and Manufacturing Science, Cranfield University, Cranfield, UK
[c]Alstom Power UK Ltd, Lincoln, UK

Abstract

Technology centered organisations must be able to identify promising new products or process improvements at an early stage so that the necessary resources can be allocated to those activities. It is essential to invest in targeted R&D projects as opposed to a wide range of ideas so that resources can be focused on successful outcomes. Typically, a number of options and tradeoffs are encountered; the selection of the most appropriate projects is the aim of R&D selection models. Although capital budgeting and financial portfolio management offer a similar style approach, the techniques used for the solution of those is different to that used for R&D project selection. The reasons for this are that project selection is complicated by many factors, such as uncertainty, interrelationships between projects, changes over time and success factors that are difficult to measure. Thus, a mathematical optimisation approach in isolation is not practical. Project selection models not only have to consider these problems but also that there are different types of R&D. The spectrum of R&D ranges from low budget exploratory research to large budget product development. This paper reviews the development of a project selection and evaluation tool that can be applied to a wide range of research, technology and investment decisions. Firstly, the background on project selection models is given. This is followed by the introduction of the model and its application to a sample group of projects. Finally, some conclusions are discussed as to the applicability of such models.

Keywords: Project selection; Portfolio management

1. Selection model usage

Most organisations use some form of project selection/justification tool, which, according to Liberatore (1987) is usually one of the standard financial analysis methods, such as cost–benefit analysis or discounted cash flow. Techniques such as mathematical programming are not widely used due to the diverse nature of the projects. A wide variety of project selection models have been assembled over the years, including linear programming, scoring models and checklists. Many early selection models were based on an optimisation approach. Given a number of projects and a pool of resources, the portfolio of projects was optimised to a certain criterion. This usually involved the conversion of the attributes of a project into a single monetary value. There is little information on the application of these early models to project selection decisions. For R&D type selection decisions, Moore and Baker (1969) suggested that the models were not entirely suitable due to a lack of input data. The complexity of the models and the problems of application can be a deterrent.

The fact that models were not being used was summed up by Moore and Baker (1969): “Management is not likely to use any model in deciding between projects, the use lies in the range of information generated for making selection decisions”. In other words, the process of gathering the information was perceived as the main function of the model. Schmidt and Freeland (1992) describe traditional optimisation processes as “classical” models, where the focus is on the outcome. “Decision event” or “systems” models focus on the process by which the outcome is reached. The result of a systems approach is that the information generated in applying the model is used in the subsequent decision making. An improvement on the classical type of model, and a direction of subsequent research, was “Multiattribute Utility Theory” (MAUT), of which an overview is given by Pearson et al. (1996). Individual projects are rated on different merits using processes such as scoring models or checklists. Rather than

* Corresponding author. Tel.: +44-1234-750111..
E-mail address: s.coldrick.1999@cranfield.ac.uk (S. Coldrick).

0166-4972/$ - see front matter
doi:10.1016/S0166-4972(03)00099-3

having a single constraint to which the project portfolio is optimised, MAUT encompasses a number of different areas, such as risk, reward and resource allocation amongst others.

Recently, studies of applications of models have concluded that the models do work. A survey by Cooper et al. (2001) on the uses of portfolio management models concluded that using some form of portfolio selection tool or system is greatly beneficial. These benefits included a better balanced and aligned portfolio. Farrukh et al. (2000) present a workshop approach to the problem of the design and application of a selection method. The involvement of multidisciplinary teams in the sessions enables a broad view of the problem and the application of more than one evaluation method. Findings by Cooper et al. (2001) showed that those that use more than one selection method have the best results, since no single method has the best attributes in all areas. It appears that the trend in applying selection models is to move away from the application of a single method and to move towards a composite approach of using a number of selection methods. Those criteria that produce effective programmes involve information on markets, customer needs, competitors and regulatory and environmental concerns (Adler et al., 1992). Incorporation of these factors into a selection method hints at the use of a composite model.

Pearson et al. (1996) argue that the process of project selection has given way to project evaluation. Rather than having an R&D budget and a pool of projects, the situation has become one of ensuring that the corporate requirements of the R&D function are met. This not only includes the initial evaluation of projects, but also continual review throughout their lifespan. The Stage Gate™ system of Cooper (1986) is a way to provide a frame for the constant evaluation of projects from initial idea to product launch. The idea is that at each stage of a project's life it is assessed. This can be in the form of a go/kill decision. This stage gate process was expanded by Cohen et al. (1998) to include basic research projects by adding an extra gate to the beginning of the process. A scoring model was used as the method of assessment.

2. New model

The model introduced in this paper has been developed by Lockwood (1999). The present study represents an extension of that work through a trial application to a sample group of projects; a flow diagram of the model is shown in Fig. 1.

Cooper et al. (1998) conducted surveys on the use of selection models in companies and found that the top 20% used business strategy to allocate resources. Although many used financial methods dominantly, these were found to have the worst performing portfolios. Other methods in use were strategic approaches, financial methods, scoring models and bubble diagrams. The conclusions of these surveys were that the best approach to portfolio management is the concurrent use of several selection methods. When faced with a project selection decision, the decision maker is faced with a vast amount of information and conflicting requirements. The incorporation of all these into a single selection model would result in it being overly complicated and practically impossible to use. As a result, any model must be a simplification of reality; therefore the most basic requirements of a project selection tool are as follows:

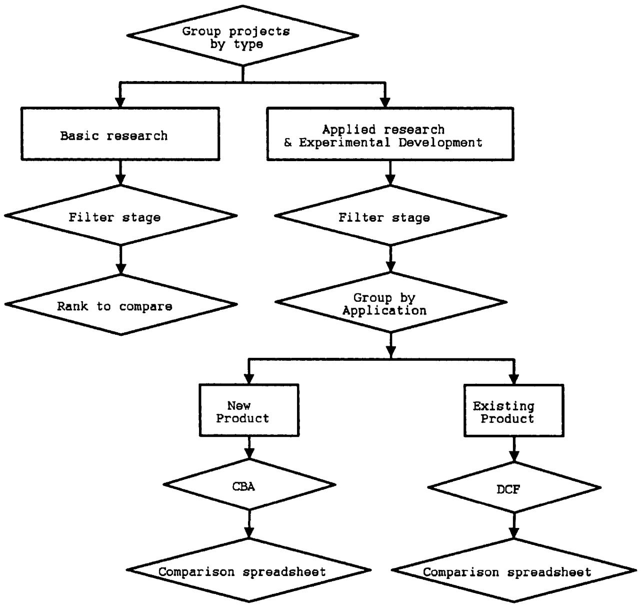

Fig. 1. Selection model flow chart.

- Project evaluation—examination of single projects to establish whether they are worth conducting.
- Project selection—examination of a range of projects to obtain an attractive portfolio.
- Application to the different types of research.

This range of requirements necessitates a multiattribute approach, since no single analysis method is applicable to all types of research. The most appropriate way to incorporate a number of different selection methods into one model is through a staged filtering approach. This allows unpromising projects to be discounted at an initial stage before much effort is spent.

3. Stages of the model and their applicability to the different types of research

3.1. Grouping stage

One of the most important aspects of project evaluation is that the evaluation tool should be suitable for use on that particular type of project. Although there are no clear cut definitions of the different types of R&D, there are some areas into which R&D activities can be grouped. This classification of R&D then allows the application of the most appropriate tools. Three broad areas can be defined,