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AN INVESTIGATION INTO APPRAISAL METHODS FOR INDUSTRIAL PROJECTS

BY

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I, **Ian Robert Möller,** submit this thesis in part fulfilment of the degree of Masters of Science in Engineering. I claim that this is my original work and that it has not been submitted in this or in a similar form for a degree at any University.

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SYNOPSIS

A wide variety of tools exist for appraisal in general. There are, however, very few widely accepted guidelines governing their specific application in industrial projects. It would be useful to a practicing project appraiser to be able to discern which appraisal methods are most applicable to a particular situation.

This research has therefore undertaken to investigate the relationship between the appraisal methods available and their application to industrial projects. As such, a number of specific objectives have been discerned. The first of these was to analyse the literature in order to determine the general views held. The second was to corroborate the views of literature with actual industrial trends. The final objective was to compare theory and practice in order to develop broad guidelines for future project appraisers.

The procedure adopted to meet these objectives firstly involved conducting a survey of the literature. This yielded a number of conclusions which suggest a preferred approach to appraisal. To evaluate this approach an appropriate questionnaire was compiled. This questionnaire was then circulated to a representative target area, namely the industrial sector of the South Western Cape. The response to this survey provided a database of actual industrial projects. From this database trends were extracted using a number of statistical techniques, such as Analysis of Variance, Contingency Analysis and Log-linear Modelling. The results of this analysis were then used to complement the conclusions of literature and to confirm the preferred approach to project appraisal.

The conclusions from the literature where consensus was found to exist involve the following issues:

- The chronological position of appraisal in the project life-cycle.

- The types of study that should be included in project appraisal.

- The chronological order of these studies.
- The extent to which formal techniques should be used.
- The background that the appraisers should have.
- The extent to which project characteristics influence the appraisal approach.

The database provided by the industrial survey consisted of 173 projects conducted in 33 different organisations. Analysis conducted on this database yielded a number of simple one-to-one relationships between project success, appraisal method used and project characteristics. From these relationships a picture of the reality experienced in the South Western Cape could be formed. Such a picture was compared with literature in order to form an overall set of guidelines for use by the practising project appraiser.

As a result of the analysis and the subsequent comparison between literature and practice, conclusions were drawn concerning a number of aspects in the research. Such aspects include the success of the research method, uncertainties of the industrial survey, consensus between literature and practice on appraisal procedures and the existence of a preferred approach to project appraisal.

A number of recommendations could also made with regard to two areas of interest. The first concerns recommendations for further research in the field of project appraisal. These include extending the database so as to accommodate multi-variate analysis, researching the formal techniques available for operational suitability and technical feasibility studies and adopting a different mode of survey to that of a posted questionnaire. The second area of interest recommends a set of broad guidelines to the practising project appraiser. These guidelines rationalise such issues as the influence of project characteristics on the use of appraisal methods, the chronological position of appraisal within the project life-cycle, the type and chronological order of studies that should be conducted in the appraisal procedure and the techniques and expertise that should be utilised within each study.

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1. INTRODUCTION

As suggested by the title, the intention of this thesis is to evaluate the methods presently in use for project appraisal with a view to discerning the more favourable approaches existing as regards success. More specifically the objectives of the thesis are as follows.

- To analyse the views on project appraisal expressed by previous researchers, as well as the trends existing in practice with regard to the success achieved from using particular appraisal methods.

- To compare the views expressed by previous researchers with any trends existing in practice in order to establish the extent of consensus that exists.

- To develop/verify a preferred approach to appraisal based on the information established during the research of this thesis.

The reason for adopting this direction of research is that the approaches to project appraisal are at present extremely varied, with very little information existing that compares entire appraisal approaches. As such, it is not clear when the use of a particular approach is preferable for a particular application. By conducting this research it is hoped that the clarity of the situation will improve sufficiently to allow organisations practically involved in project management to gain a clearer understanding of how to choose a suitable appraisal approach. In this way, it is hoped to assist organisations in avoiding unsuccessful projects.

The procedure adopted for conducting the research of this thesis firstly involved an analysis of the literature existing on the topic. The intention here was to obtain the opinions of previous researchers in the field. Once these opinions had been collated into a logical form, a practical survey was then conducted of a particular industrial area within South Africa in order to evaluate the views of literature.

To this end, the region chosen was that of the South Western Cape and the survey method adopted was one of a posted questionnaire. Once the survey was complete its results were analysed statistically in order to establish suitable trends. These trends were then compared to the literature in order to establish the existence of any consensus and to delineate a preferred approach.

2. LITERATURE SURVEY

An investigation into contemporary literature has resulted in a substantial accumulation of information concerning project appraisal. This information is discussed below under six sub-headings. The intention is to portray the information in a logical format. In this way, it is intended to provide an overall picture of theory's attitude towards appraisal.

2.1 INTRODUCTION TO PROJECT APPRAISAL

The prime issue under discussion in this first sub-section is that of what project appraisal actually entails. In this regard, no standard definition is available to cover its explanation. A fairly realistic idea of the term has, however, been established through consideration of descriptions given in a number of articles on the topic. Such descriptions are detailed in the paragraphs that follow.

The first is one by Jose [17], in which he refers to appraisal as "the selection of projects based on factual information and investment evaluation criteria". Such is a general description which appears to enjoy widespread support. Within the realm of this description, however, views tend to differ on a number of individual issues.

The most important of these appears to be that of where the emphasis should be placed, with regard to factual information. In this regard, Hicks [13] tends to limit appraisal to the financial by only examining finance under the global title of "An overview of modern project investment appraisal".

Jaafari [16] and Handscombe [12], however, both appear to disagree with this. Jaafari stresses that monetary appraisal of a project is not the sole criterion for decision making. He includes technical feasibility studies, as well as economic feasibility

studies in his theory for project appraisal. Handscombe in concurring with Jaafari notes that "Project appraisal is no longer essentially a financial analysis exercise". He rather sees the engineer as part of a team of managers, who between them will plan and revise all aspects of the project, technical and financial.

Consideration of the views expressed above should provide a basic idea of project appraisal. It is now necessary to consider, where such appraisal should fit into the overall project management process. According to the literature, it appears that appraisal should occur just before the planning phase begins and that there should be a certain amount of overlap between appraisal and planning. This is reflected in the views expressed by Dowsland [11], de la Mare [8], Barrie [3] and Pearson [22].

As will be seen from examination of the respective articles, Dowsland regards project appraisal as the first of four stages in the life cycle of a project, while Barrie refers to the closeness of the relation between appraisal and broad-scale planning. De la Mare emphasises the overlap between appraisal and planning and Pearson states that project selection is an ongoing process in research and development projects.

2.2 THE NEED FOR APPRAISAL

The impression given by most of the literature found on this topic has been that accurate appraisal of projects is extremely important to an organisations financial well being, as it involves investment decisions for large amounts of corporate finance. Good decisions are considered to be positively related to high profit margins and company competitiveness, while bad decisions are considered to be related to the opposite. As such, it appears to be worthwhile to conduct thorough appraisal investigations before embarking on a project. In support of this impression some specific articles are referred to below.

Posner [23] holds the view that a major factor separating successful and unsuccessful organisations is their choice of "lines of activity" (e.g. projects to undertake). In his article he notes that organisations in producing output cannot escape the influence of the marketplace as it is here that the cost and availability of inputs and the demands for output are set. He, therefore, notes that organisations should not attempt to avoid the marketplace, but that they should rather attempt to "anticipate it's blows" in order to obtain the best advantage for a given market situation.

To be able to do this, Posner states that the weaknesses of all potential investment projects must be fully exposed so that the dynamic nature of the marketplace can be fully accounted for in making any financial decisions. This, in turn, requires the thorough appraisal of all such projects. As such, Posner is acknowledging the requirement for the project appraisal exercise within an organisation undertaking projects.

Handscombe [12] can be seen to concur with Posner as he states the following: "A company's results are much influenced by the quality of its investment decisions; and project appraisal is today a vital management task in improving competitiveness". He then, however, goes further than Posner by saying that there is not only a need for financial appraisal, but also a need for the appraisal of other factors such as customer and competitor strategies, process and material technology, and social and political trends. According to Handscombe, one cannot realistically make strategic decisions without considering such factors.

Veale [30], in an article on a company producing electrical components in Britain, gives a practical illustration that enhances the views given above. In the article, Veale recounts how the particular company began losing its market share, through becoming complacent and uncompetitive. He then discusses how the company had to adapt to regain its market position. During the discussion he analyses what he believes to be the two main reasons for the

deadline. The first is that the organisation tried to make a profit without considering long term competitiveness in its decision making and the second is that management did not have sufficient knowledge of their industry in making decisions. Such analysis provides for two morals in management, namely:

a. Do not favour immediate profit to the detriment of all other factors.

b. Conduct a complete and thorough appraisal of all aspects of a situation before making strategic decisions.

2.3 TYPES OF APPRAISAL

The attitude apparent in the greater portion of the articles analysed has been that, while a variety of other aspects have some merit, finance is of paramount importance. The reasons visualized for the existence of such an attitude are firstly, that the consequences of good or bad decisions manifest themselves in financial terms and secondly, that the financial component of appraisal is relatively easy to handle on a formal basis.

In a small portion of the literature, however, it is emphasised that other factors besides finance must receive thorough consideration before a realistic estimate of project success can be made. These factors appear to be grouped into two categories.

a. The first considers operational suitability. Its intention is to answer the question: Will the option be suitable in accomplishing the tasks for which it is required?

a. The second considers technical feasibility. Its intention is to answer the question: What must the organisation do to achieve this option?

Following this reasoning, the complete evaluation of a project will require three studies, namely a technical feasibility study, an

operational suitability study and a financial viability study. In the opinion of the author such a view clearly has merit. A possible reason for it not having greater support is that many researchers are unaware of this train of thought. Some specific references that do support it are discussed below.

The first such reference concerns a statement made by de la Mare [8], in which he refers to the financial calculation as being only "the tip of the computational iceberg". He continues to say that besides finance one must also consider the inventing, implementing and operating aspects of a project as these contribute considerably in coming to terms with risk.

Barrie [3] appears to concur with this view, as he sees a project beginning with technical and economic feasibility reports and environmental impact reports. Clough [5] also is supportive as far as operational suitability is concerned as he advocates the establishment of operational requirements such as location, performance criteria, size, configuration, layout, equipment and services, against which project options can be compared.

Stahl [29] restricts his view to research and development projects. He does, however, support Clough in emphasising the importance of setting operative goals for an organisation, against which projects can be compared for evaluation purposes. Primrose [24], also in support, states: "Performance measures are critical to quantifying the benefits which form the financial evaluation". This comment clearly supports the idea that an operational suitability study is a critical part of the foundation on which a financial viability study is built.

Having advocated the implementation of three studies, the question now arises as to the chronological order in which they should be conducted. Analysis of the available literature reveals a model indicating an answer to this question.

The model is described in an article by Jaafari [15] in which he questions the practice of emphasising financial viability in the project appraisal process. According to Jaafari, excessive failures have occurred in projects adopting this approach. He therefore suggests that an approach rather be adopted which integrates the project planning and appraisal processes. As a guide, he proposes a model consisting of a series of steps which accomplishes this function. These steps are listed below:

1. Project idea.

2. Informal/broad analysis.

3. Formal/strategic assessment.

4. Technical feasibility studies.

5. Economic appraisal/optimisation.

6. Finalisation of project configuration/implementation of master plan.

As can be seen, this model incorporates the essentials of the three studies already defined. The essentials of the operational suitability study are incorporated into the informal/broad analysis and formal/strategic assessment stages of the model and the technical and economic appraisal stages then follow. From this arrangement, it can be seen that Jaafari considers operational suitability studies to be conducted first, followed by technical feasibility and finally economic viability studies.

This is a logical order, as one would firstly want to know the organisations requirements and which project options meet these requirements. One would then want to know whether these options are technically possible and once the complete range of suitable options are known, one would then consider economics in order to choose the option with the best value for the money available.

2.4 APPRAISAL TECHNIQUES

Having established which studies are necessary for the comprehensive appraisal of projects, it is now logical to consider which techniques would be suitable for implementing each study type. From the literature, it appears that the study most amenable to formal techniques is that of financial viability appraisal. Articles considering operational suitability and technical feasibility studies tend rather to propose a reliance on the judgement of experienced personnel who identify parameters important to a particular application. Such parameters are then used for comparing the project options.

The only articles found to consider formal techniques for operational suitability and technical feasibility studies are those by Shah [27] & [28]. Techniques that he quotes are the following: linear programming, inventory models, queuing models, markov chains, simulation and basic statistical methods. These techniques can only be suitably applied under special circumstances. Such circumstances include the ability to quantify all decision making variables, to compare all options via a standard unit and to apply all constraints using this unit. Bearing in mind that neither operational suitability nor technical feasibility studies are exact disciplines, the inclusion of such circumstances severely limits the applicability of these techniques within the studies.

Their use also need not be restricted to the aforementioned studies alone. In fact, it appears as though many of the techniques are more applicable to financial viability studies. They are, nevertheless, still usable within these studies and as such, they have been mentioned at this point of the analysis.

Other techniques that would be useful are the Ranking and Weighted Ranking Techniques. These are, however, not referred to in the literature and, therefore, will not be discussed any further.

Hence, the rest of this section will concentrate on financial techniques in existence.

An overview of the better known financial techniques is given by Hicks [14]. In his article he describes each technique and then compares them with respect to several predetermined criteria. His intention appears to be to establish an overall best method. This does not seem appropriate for two reasons:

a. The test relies on the subjective allocation of merit to each option for the criteria considered.

b. Different techniques are suited to different financial applications.

The article, nevertheless, has merit as it provides insight on how each method functions. It also enables available techniques to be categorised for the purpose of easy discussion during this section. The three categories so developed are as follows:

1. Simple summation and ratio techniques that do not include a discount rate.

2. Techniques including a discount rate.

3. Techniques involving risk analysis.

Another article covering similar ground to that covered by Hicks is that of Au [2]. In this article Au describes a number of financial viability techniques. It is advantageous to read this article in conjunction with the one by Hicks as it not only considers techniques omitted by Hicks, but also gives differing opinions on their individual values.

Examples of techniques included in category 1 are the Trading Profit (TP) Method, the Return on Investment (ROI) Method and the

Payback Time (PBT) Method. As can be seen from Hicks, most of these are fairly limited, some of them merely being ratios of figures drawn from the balance sheet of a project. They can, however, suffice for financially small projects of short duration.

They can also be used in financially larger projects for particular applications. An example of such an application is when the speed at which an investment is repaid is critical. In such an instance, it is worthwhile using either the Payback Time Method or the Return on Investment Method. The chosen method should, however, not be applied on its own. It should rather be applied in conjunction with a more comprehensive technique from either category 2 or 3.

Category 2 consists mainly of two techniques. These appear from the literature to be the most popular financial viability techniques in use and are known as the net present value (NPV) method and the internal rate of return (IRR) method. Riggs [25], De Garmo [7] and Au [1] together provide a comprehensive description and evaluation of these techniques. Their combined views are summarised as follows.

The NPV technique is regarded as a good general purpose financial evaluation technique. The main reasons listed for this are that; it is relatively easy to implement; it takes into account the time value of money; it can cope with comparing projects of unequal lives; and it avoids involving empirical depreciation techniques characteristic of ratios to the income statement. One shortcoming listed is that it does not take into account the differences in scale between projects. For example, one project could yield a NPV greater than another and could thus be regarded as more favourable. The apparently favourable project option could, however, have required that a far larger capital investment be made. As such, while showing a higher NPV, it could, in reality, generate a smaller percentage return on the investment it requires for its implementation.

The IRR Method, in comparison, also takes into account the time value of money, avoids involving depreciation techniques and is able to compare projects of unequal life-span. It is, however, limited in that it is more difficult to calculate. It's output being a percentage, however, often makes it more attractive to management, as they find it easier to relate to a percentage rate of return than an NPV figure.

As such, the IRR method appears to be competitive. Au, however, has a further complaint with it. He states that the results of this method are misleading as they do not properly reflect the intensity and timing of the use of capital within a project (i.e. No consideration is given to the return generated on money, before it is used by a project or after it is returned). As a more suitable alternative he suggests the use of what he terms the Overall Rate of Return (ORR) Method. This, he claims, not only overcomes the problem, but also is easier to calculate. The unique feature of this method is that it defines a company "hurdle rate". This is a rate of return that the company perceives it can achieve on money when it is not invested in a particular project. In appraising an investment via this method, all monetary outlays are discounted at the hurdle rate to the start date of the project and all monetary returns are compounded to the end of the project life. The two values so achieved are then processed using the standard IRR calculation to find the ORR.

As already stated, category 3 consists of techniques involving sensitivity analysis. Before considering the techniques themselves, however, it is necessary to consider the philosophy behind them.

According to Dickson [9], a manager has three alternatives against which to apportion a projects risk, namely risk reduction, risk retention, and risk transfer. With no further constraints, the logical approach would be for an organisation to retain little or no personal risk. This, however, has its limitations because, when more risk is transferred and reduced, the project costs increase.

It is, therefore, necessary to establish a balance that will limit the risk sufficiently, while still allowing an acceptable project cost.

In this respect, sensitivity analysis is a useful tool as it considers how a variation in each of the applicable parameters affects the success of a project. Using such a tool makes it possible to establish the limit to which a parameter can vary, while still allowing the project to be successful. One can then more easily determine the amount of risk that can be retained for each parameter and the amount by which the risk must either be reduced or transferred.

The literature has identified two categories of technique for such analysis. These are known as the deterministic approach and the probabilistic approach. In reality, they are not categories of techniques, but rather ways in which existing techniques, such as the NPV Method and the IRR method, can be adapted to allow for variations in input.

The deterministic approach, as described by Riggs [25] and Jaafari [16], consists of repetitions of a discounted cashflow calculation for various inputs. The calculation that generally appears to be used is the NPV calculation. The reason for this is probably that it can quickly be re-iterated for small variations in input. The procedure is initiated by conducting a calculation using the most likely values for the input parameters. Each input parameter is then taken in succession and varied by successive amounts, while the other input parameters remain constant. In this way, the value of each input parameter is established, at which the project no longer is viable.

Although this is a popular technique in practice, it does have an obvious shortcoming. That is it does not consider conditions where a combination of parameters varies adversely. As such, it does not give an overall impression of all of the possibilities that exist.

The probabilistic approach appears to overcome this problem. To give insight into how it does so, a specific technique using this approach is analyzed. The technique is known as the Monto Carlo Assessment Technique and its application is described in two separate articles by Jaafari [16] and Moerman [21].

As can be seen from these articles, the technique involves treating each input to the investment appraisal calculation as a variable with a Gaussian Distribution. Using a computer, specific values can then be chosen from these distributions to be used as inputs in successive iterations to a NPV appraisal calculation. Each iteration of the output produces a NPV together with a probability of its occurrence. The intention is that the outputs of successive iterations are plotted to form a probability distribution which provides an indication of the overall acceptability of a project, given uncertain conditions.

As such, this approach displays a much more comprehensive indication of the acceptability of a project. It does, however, require considerably more effort than the first approach and will therefore probably only be worth using in situations where the investment is large and accuracy is of critical importance.

Having completed a discussion on the basic techniques available for financially appraising projects, a final article to consider on the overall topic of "Appraisal Techniques" is one by Blank [4]. In this article, Blank advocates the use of a pilot study to predict the accuracy of a particular project scenario. According to him, the pilot study can take the form of a prototype, a survey, a model, or an experiment. The essential requirement is that it must be much quicker and cheaper than the project itself. Blank feels that by conducting such a study, experience can be gained with regards to the intended project and hence a more realistic scenario of the consequences that result can be built.

Considering this view, it becomes apparent that the financial appraisal techniques considered thus far only predict the success

of a predetermined project scenario and that the assumptions on which the scenario is based must be made through experience. This suggests that maybe financial viability studies, and not only operational suitability and technical feasibility studies, rely on experience and background for the establishment of the basic project scenario. It is just that financial viability studies require formal techniques to manipulate this scenario into a form which more readily shows its success.

2.5 FACTORS INFLUENCING THE TECHNIQUES USED.

The factors influencing appraisal techniques fall into two basic categories namely environmental factors (i.e. factors influencing the environment in which a project is conducted) and characteristics (i.e. factors influencing the character of the project itself). Articles considering environmental factors, such as those by Might[19] & [20], Cohenca [6] and Pearson [22] have produced a comprehensive list including among others organisational structure, managerial authority, speed of response to changes and weather conditions. Although these factors affect the success of the project as a whole, they are not involved in considering the potential that a project may have. As such, they are not of interest in this research. Analysis will therefore be confined to those factors that are project characteristics.

It has not been possible to develop a comprehensive overview of the influence that project characteristics exert on the use of appraisal techniques as the literature is too sparse. Nevertheless, a few references have been established which address three pertinent issues concerning this topic. The issues consider whether or not three particular characteristics should affect the choice of an appraisal technique. They are as follows:

a. The <u>value</u> of the project to the organisation.

b. The <u>complexity</u> of the project's cash flows.

c. The type of project under consideration.

Two of these issues, namely project value and project complexity, have been considered in a series of two articles by Hicks [13] & [14]. The main intention of these articles has been to give an overview of the more well used financial appraisal techniques available. As such, once the techniques have been described, they are compared against certain predetermined criteria in order that they can be categorised. A secondary result of this procedure, however, is that a number of trends have been produced. One trend is of special significance to this discussion as it shows that the techniques producing the most comprehensive appraisal information are also those requiring the most effort.

The articles also state an important basic truth, namely that the ideal technique for evaluating a problem is the one requiring the lowest degree of numerology for the required realism. As such, these articles support the idea that a balance exists between effort expended and accuracy required. This implies that effort should not be wasted on evaluating projects to accuracies that are not required because this effort consumes valuable resources of money and time. Instead, the project should be evaluated in terms of its value and the complexity of its cash flows before an appropriate appraisal technique is chosen.

It is unfortunate that no further literature concerning these issues could be found for the purpose of either supporting or disputing Hicks' views. It is, nevertheless, felt that the views have merit and as such, they will be used as the basis of further investigation within this dissertation.

The rest of this section will consider the third issue revealed in the literature, namely whether or not the type of project influences the appraisal technique to be used. Because of limited available literature on this issue, however, fairly severe restrictions are placed on this discussion. The articles found all

have considered the differences that exist in appraising research and development(R & D) projects, as opposed to other types. As such, the discussion must of necessity be limited to this. It is felt, nevertheless, that such a situation still has considerable merit, because it not only deals directly with R & D Projects, but also enlightens one to the possibility that variations exist between the appraisal requirements of other types of project.

Analysis of the available articles immediately reveals considerable support for the idea that the appraisal of R & D Projects should be conducted via a different approach to that normally used. Seireg [26] categorically states that there is "no convincing way to analyse the costs and benefits of innovative engineering, or the possible return on investment in research and development." Pearson [22] concurs by noting that standard quantitative procedures do not provide a complete solution in the case of R & D projects.

Primrose [24] offers a reason for the existence of this idea by noting that many benefits of new technology are not only intangible, but they also tend to manifest themselves in different departments from where the development was conducted. According to him, it is therefore difficult to evaluate all benefits in monetary terms for the purpose of equating them to costs. As a means of overcoming this situation, Primrose proposes a process involving the estimation of these benefits. Such estimations, however, are prone to fairly large inaccuracies, which undermine the benefits offered by the more comprehensive appraisal techniques. The result is that it no longer becomes viable to use these techniques in appraising R & D Projects.

In the final article considering this issue, Lee [18] is seen to analyse a survey on project evaluation techniques used in a particular developing country (Korea). His analysis shows that this country mainly uses screening models to evaluate exploratory R & D projects, while they use economic analysis to evaluate high risk new business development projects. Such a trend makes one realise

that variations exist, not only between categories of project, but also between subdivisions within each category.

2.6 CONCLUSIONS FROM THE LITERATURE.

The literature described in this survey highlights a number of issues where a consensus of opinion exists. Such consensus implies a fair amount of accuracy and it can therefore be assumed that a conclusion based on such circumstances is reasonably reliable. For this reason, it has been deemed acceptable to draw a number of conclusions from the literature in order to aptly describe its emphasis. They are expressed as statements in the following paragraphs.

a. Appraisal is the first major phase in a project's development, being succeeded by planning. There is a certain amount of interaction between these two phases in most instances. This results from the requirement that a certain amount of planning must be done, before sufficient knowledge of the plan is gained to allow for accurate appraisal.

b. Financial appraisal is insufficient on its own for the evaluation of a project. The project's technical and operational aspects should also be considered as they not only need to be evaluated in their own right, but are also required as foundations for the financial evaluation. Preferably separate studies should be conducted, namely operational suitability and technical feasibility studies.

c. By implication, input to the appraisal process is required from technical personnel, as well as from finance. Each would need to deal with their own area of expertise.

d. The chronological order of analysis should be that of firstly considering operational suitability, secondly considering technical feasibility and finally considering financial viability.

e. Financial viability studies employ formal techniques to a large extent, while operational suitability and technical feasibility studies do not. This implies that the requirement for technical experience/expertise would be greater for the latter techniques as there is no assistance from a technique.

f. Certain project characteristics influence the approach taken with respect to project appraisal. Those of particular importance are project type , project duration and project financial value.

3. THEORY AND RESEARCH METHOD

From the conclusions to the literature discussed in the previous section, there appears to be a certain preferred theoretical approach to appraising projects. Concrete evidence supporting this is, however, disjointed and sparse. The reasons for this are firstly that most articles only consider certain aspects of the approach and secondly that variations of opinion are manifest in certain of the issues discussed. One cannot therefore be totally sure of the validity of the preferred approach.

It does, nevertheless, display a certain intrinsic logic and as such, the practical research for this thesis has been devoted to its deeper investigation. In this investigation the more important and debatable issues that have been considered are the following.

a. The type of studies that should be conducted.

b. The chronological order that should be adopted in conducting these studies.

c. The techniques that should be used within each of these studies.

d. The expert input that should be involved in appraisal.

e. The influence of project characteristics on appraisal.

3.1 BACKGROUND TO RESEARCH

With the parameters of the investigation established, it became necessary to decide on a method of implementation. To this end, it was decided to embark on a practical survey into how industrial organisations actually appraise their projects. In this way, the comparison between theory and practice would be obtained. This would provide a means for evaluating the proposed theory.

There were, however, two important issues that needed to be resolved before implementation of the industrial survey could commence. The first concerned establishing the target of the survey and the second concerned defining the exact form that the survey would take.

Investigation of the implications of the first issue, namely that of the target of the survey, revealed the following.

a. Time available for the survey was limited.

b. Appraisal trends vary from region to region.

c. Projects are not only limited to the industrial environment.

It was, therefore, decided that analysis should be limited to that of industrial projects conducted in the South Western Cape, as in this way, the factors listed above would be accommodated. At first glance, these limitations may appear excessive. It is important then to realise that the intention in this thesis is not to establish a universal truth, but rather to provide support to a train of thought already in existence.

Considering the particular form that the survey should take led to the realisation that basically two criteria govern. The first concerns the natural preference to consider as many projects from as many different organisations as possible, while the second concerns extracting as much appropriate data from each individual project as possible. It was further realised that these two criteria are in conflict with respect to the criterion of limited research time. The ideal survey mode would, therefore, be one that supplied a balanced compromise between the two criteria and could also be performed within reasonable time.

The mode deemed suitable for survey under these circumstances was the posted questionnaire. It was felt that such a survey mode would not only enable a wide variety of organisations to be reached, but

it would also allow the balanced consideration of all projects. Should further information on a particular project then be required, it may be possible to organise a personal or telephonic interview with the organisation concerned.

3.2 QUESTIONNAIRE

When embarking on the formulation of a suitable questionnaire, it was realised that this task, together with the actual survey, would be fairly labour intensive. It was therefore decided to collaborate with a researcher, conducting studies parallel to those of this thesis, for the purpose of data collection.

The result was a combined questionnaire, a feat made successful by the similarities of the studies being conducted. It was found that, because a fair amount of required information was common to both studies, the questionnaire could fulfill all needs while still remaining compact. The details of the questionnaire were established by considering two topics. The first involved the content of the questionnaire and the second involved its format. These two topics will each be discussed in a separate sub-section to follow.

3.2.1 Questionnaire Content.

Reference to the conclusions drawn from the literature on project appraisal, as well as to an article by Might [19], led to the realisation that the appraisal concept considers three significant categories of information. These are project characteristics, project appraisal philosophies and project success. It was further realised that, in order to evaluate the applicability of such a concept, one needs to obtain information covering these categories from practically conducted projects.

It was therefore decided that the questionnaire would need to be divided into at least three sections. Each section

could then be devoted to extracting information on a particular category. The decision had favourable results because it led to the realisation that two sections of the questionnaire could be used as common to both studies. The sections included those referring to project characteristics and project success.

The overall decision with respect to the grouping of questionnaire content was therefore that there should be four sections to the questionnaire in total. Two would be common, while the other two would be exclusive to each of the studies being conducted. The three sections particular to the study of this thesis will be discussed individually in the paragraphs that follow.

The establishment of detail with respect to project characteristics was relatively straightforward as all of the characteristics referred to in the literature amount to only three. It was therefore unnecessary to choose between them. They all could be incorporated into the questionnaire. Furthermore, it was decided that these characteristics, namely project type, project duration and project value, were by far the most significant that could be conceived. As such, only one further characteristic was deemed necessary to be included. This was project age and the reason for its inclusion was mainly that it complemented the characteristic of project value.(i.e. It supplied an indication of the validity of the cost comparison, as well as input information for a discount calculation, should this have been necessary.)

The section detailing project success was more difficult to finalise, as no standard method presently exists for its measurement. It was therefore necessary to research project success, in order to obtain a more formal idea of its meaning. Only in this way would development of a suitable measurement scale be possible.

In this regard, an article by Might [19] came to the fore, by showing how six performance criteria were developed for the purpose of measuring a project's success. The criteria are as follows.

a. The overall success of the project.

b. It's ability to meet/exceed budget costs.

c. It's ability to meet/exceed time schedule goals.

d. It's ability to meet/exceed technical standards set by the initial plan.

e. It's ability to meet/exceed the technical standards set by other projects.

f. It's ability to quell technical problems before they reach crisis proportions.

From careful analysis of Might's research, it was decided that these six criteria could be successfully condensed into three for the purpose of the research at hand. As such, the following were accepted as criteria of performance.

a. The project's ability to meet/exceed budget costs.

b. It's ability to meet/exceed time schedule goals.

c. It's ability to meet/exceed it's planned technical performance.

With this established, however, the question of how exactly success would be measured, still remained unanswered as there was no measurement scale. To overcome this problem a five point scale was developed which ranged from "met no

expectations" at the one extreme to "exceeded all expectations" at the the other. It was now possible to subjectively rate projects in a survey against the established criteria in such a way that their ratings could be compared. As such, all background information was now available and the questions for this section could be phrased.

The final category to receive detailed consideration was that of project appraisal philosophies. In this regard, the foundations to appropriate questions were already defined in that the issues listed at the beginning of this chapter would need to be covered. All that remained was to decide on the specifics of each question to be asked. To this end, it was decided that the following would be asked with respect to each project.

a. What studies were used to appraise it? (e.g. Technical studies, operational studies, financial studies etc.)

b. In what chronological order were they considered?

c. Were formal techniques used to evaluate technical feasibility and operational suitability?

d. What were they?

e. What techniques were used to evaluate financial viability?

f. What was the discipline of the personnel conducting the appraisal.

Should the exact phrasing of any questions in the three categories be of interest, a sample questionnaire can be found in Appendix (A).

3.2.2 Questionnaire Format

With the content of the questionnaire thus established, attention was turned to questionnaire format. In this regard, three criteria were realised to be of utmost importance as far as the success of the survey was concerned. They were the following.

a. Number of respondents. The questionnaire should encourage as many of the target population to respond as possible. In this regard, it should have two attributes. Firstly, it should require as little effort from the respondent as possible and secondly, it should allow the respondent to remain anonymous should he/she so wish.

b. Number of projects. Each questionnaire should attempt to access information on as many projects as possible. Assistance in this direction would contribute to the task of establishing as large a project database as possible.

c. Form of information. The information accessed should be in an appropriate form to allow suitable statistical analysis to be conducted.

With these criteria in mind, the following decisions were made which dictated the format of the questionnaire.

a. The questionnaire would be multiple choice.

b. Questions would be formulated in such a way as to allow the choice of increasing integers to correspond to an increase in a particular attribute. (This would yield information highly receptive to a statistical application in subsequent analysis.)

c. Five answer columns would be provided to allow all questions to be answered for up to five projects.

d. The questionnaire would allow the respondent to remain anonymous should he/she so wish. This would be accomplished by making the supply of personal information, such as "name of individual" or "name of organisation", optional and by wording questions so that they do not ask for company specific information.

3.3 DATA ANALYSIS.

The fundamental decisions with regard to the questionnaire could at this stage be said to be complete. What remained was its detailed completion and its postage to various organisations. This proved to be a relatively straightforward task which culminated in the return of a number of completed questionnaires. The result of such returns was the formation of a large database, with information concerning a number of different projects. This would require rigorous analysis in order to establish the validity of the theories hypothesized by literature.

To this end, a generalised method of analysis, together with intended goals, had already been planned in sufficient detail to allow processing to commence immediately. The reason for such early planning was that it provided certain information necessary to finalise the questionnaire.

All that remained was to action the plan as set. This consisted of conducting two types of analysis, namely a descriptive analysis and a trend analysis. The details of these types will each be discussed under a separate sub-heading in the paragraphs to follow. The order of discussion will be that of the chronological order of their implementation.

3.3.1 Descriptive Analysis

As the title suggests, the first stage of the analysis was concerned with describing the database established through survey. As such, its intention was to develop frequency distributions for the answers to each question of the questionnaire. In this way, it would be possible to determine the biases that exist within the database. Such information would be of great assistance in refining the direction of the research to come.

The method adopted for developing these frequency distributions incorporated the use of a computerised spreadsheet. Graphs of the distributions were then plotted using a specific function of the spreadsheet. These were analysed and biases in the database were determined.

3.3.2 Trend Analysis

With information now available on the database under analysis the validity of theories proposed by literature still needed to be researched. As will be remembered, these theories proposed relationships to exist between three distinct categories of variable, namely success, appraisal technique and project characteristic. Suitable research would therefore include a procedure whereby such relationships could be tested in a database compiled of practical information on projects.

The approach adopted for verifying such relationships was the methodical one of testing all possible relationships between the three categories, namely project characteristic, appraisal technique and project success. This entailed the following:

a. Taking each category in turn and correlating each variable for that category against every other variable

from the other two categories.

b. Correlating all success variables against all two variable combinations of characteristic and appraisal philosophy.

The reason for adopting this approach was that there may be relationships other than those referred to by theory. In the interests of attempting to reveal the entire picture therefore it was deemed prudent not only to check those relationships already highlighted, but rather all possibilities.

The initial tool chosen for conducting such tests was once again that of a spreadsheet package. The intention was to quickly obtain a rough idea of any strong trends that exist. For this purpose a "data extract" function was utilised within the spreadsheet to develop frequency distributions of the relationships between project variables. It was hoped that in this way such trends would be highlighted.

The indications obtained were, however, limited in that they could only display a general variation in the distribution of one variable with respect to variation of another. It was not possible to gauge the likelihood and strength of a relationship. For this type of information a statistical tool would be required.

The first statistical tool to be scrutinised for applicability was that of regression. It was revealed to have been successfully employed by Might in a similar type of analysis and as such, it was thought that it would be suitable in this instance. Such was, however, not the case as investigation revealed a number of shortcomings with the application. These are as follows.

a. For multifactor analysis, regression can only consider linear relationships. This would have been insufficient for this analysis, as the correlations most certainly are not linear.

b. Regression is only suitably applicable to continuous data. It would therefore not have produced accurate results on the categorical data supplied by the database of this research.

c. Regression is particular about the ordering within each variable.(i.e. It requires levels within a variable to be ordered incrementally.) Such a requirement would not be met by the data of this research, as a number of variables are impossible to order. One such example is the characteristic of project type. As can be seen, one cannot provide any justification for a particular order between research projects, developmental projects and construction projects.

Attention was therefore turned to a similar statistical technique which appeared to overcome these problems to a large extent. The name of this technique is analysis of variance(ANOVA) and its underlying function is to test the validity of a "null" hypothesis which says that all variations in a given set of data are due to random "unexplainable" effects. To investigate this hypothesis, the technique divides the total variations in the data into two components, one reflecting variation in response due to any explainable factors and the other reflecting variations due to error. These components are then formulated into a ratio called the F ratio, which is intended to indicate the strength of a possible trend in relation to random factors.

The assumption is that, if $F \leq 1$, the variations that are explainable are on average less than those due to error. One

can therefore clearly not reject the "null" hypothesis that the variations are due entirely to chance. On the other hand, if F>1, the "null" hypothesis can still not be immediately rejected. One must first establish whether the effect of explainable variations is significant. This is achieved by using a table displaying critical rejection values for a given significance level. (The significance level used is usually 5%) Only once it has been established that the F ratio is significant, can it be assumed with some certainty that a relationship does exist.

For a deeper understanding of this technique it is suggested that Walpole [31] be consulted. For this research, however, understanding in such depth has been unnecessary because, although the technique was adopted as a tool for establishing the existence of relationships within the surveyed data, a statistical computer package was also adopted. This package was able to import the already developed spreadsheet data and was then capable of conducting the one and two factor ANOVA manipulations without any significant further input being required from the user. As such, it was merely necessary to realise two facts, namely that multiple inputs, as well as a single input, could be compared with a particular response variable and that the end result of each manipulation was given as a probability that the "null" hypothesis is true for the particular relation under consideration. Manipulations could then be conducted and each result could be tabulated and analysed.

At this point, it is sufficient to say that such analysis produced some very significant results. However, a certain limitation with respect to the application exists. The limitation involves the fact that ANOVA is primarily meant for use on continuous variables. As such, it does not allow for a particular requirement in the analysis of categorical data, namely that there should be an even spread of data

through all category levels within each variable involved. Instead, it produces results without giving any indication as to their reliability.

This is not to say that ANOVA has no place in the analysis of categorical data, but rather that it should be applied carefully and that maybe it should be combined with some other technique when used.

To enhance the validity of the results produced it was therefore decided to re-analyse for the existence of relationships, using an approach more suitable to categorical data. The resultant approach chosen for this purpose was that of contingency analysis.

As will be seen by considering Walpole [31] and Dobson [10], the theory behind this technique again involves the testing of a "null" hypothesis which proposes that the variations in a particular data sample are due to random effects. The test itself is, however, somewhat different. It involves tabulating frequencies of projects corresponding to each combination of categories between input and response variables. Such a tabulation is usually visualised as a table, the dimension of which is dependent on the number of input variables involved. To illustrate this a hypothetical example of a two dimensional table is shown in Figure 3.1 below involving a single input and a single response variable.

Figure 3.1: Example of a contingency table.

PROJECT TYPE	SUCCESS		
	bad	average	good
research	20	13	10
implementation	15	12	5
construction	4	20	2

NOTE: The number given in each square of the table represents the frequency of projects with that particular attribute combination of type and success.

From this table of information a procedure is then used to generate a second set of frequencies. These are known as predicted frequencies, as opposed to actual frequencies, and they represent the frequencies that would have existed had their been absolutely no relationship between the input variables. (i.e. If the variables had been totally independent.)

A formula is then applied to the two frequency distributions called the Chi-squared formula (X^2). This tests the strength of any trends present between the variables. Such a formula is represented mathematically as follows :

$$X^2 = \Sigma \frac{(o_i - e_i)^2}{e_i}$$

where o_i : actual frequency in each category of the data table.

e_i : predicted frequency in each category of the data table.

Using predetermined tables the dimension produced from this calculation can be converted into a probability fraction that the null hypothesis is true. This would make any results obtained comparable with those achieved from ANOVA. It would now be possible to state with some certainty which variable combinations validly show a strong relationship to each other and which are uncertain. It would not as yet be possible to indicate the nature of any of these relationships.

Such an indication would require a further manipulation known as log-linear modelling. In this analysis the predicted frequency distribution developed earlier is subtracted from the actual frequency distribution by subtracting each predicted frequency in the table from its corresponding actual frequency. The values so produced are known as standard residuals and, when placed into a table like that

already shown, they indicate the trends that exist between the variables in the following manner.

a. Regions in the table displaying values with negative signs denote variable combinations that are less likely to occur than independence would suggest.

b. Regions in the table displaying values with positive signs denote variable combinations that are more likely to occur than independence would suggest.

To conduct the entire test procedure of contingency table analysis and log-linear modelling, the tool utilised was once again that of the computer package available. This analysis produced a probability for each successively processed relation which indicated the strength of the particular relationship under scrutiny. This allowed a decision to be made as to whether or not to process the particular relation any further. The results of suitably strong relations were then imported into the log-linear analysis function of the statistics package. This would allow further manipulations to be conducted for the generation of the residuals referred to earlier.

Only a small percentage of the relationships tested in contingency analysis were found to be strong enough to warrant being processed through the log-linear analysis stage. It is therefore deemed necessary to justify the requirement of 5% probability. This justification is given in the following list of points:

a. Only if a correlation is shown to be strong will its nature be of any significance.

b. Log-linear analysis is time consuming. As such, it is not worth conducting such analysis for insignificant results.

c. The results that it produces are bulky. As such, to produce all of them would make the thesis unnecessarily long.

With the contingency and log-linear manipulation complete the purpose of analysis could be said to be achieved in that trends in the data were fully described. All that remained was to document these trends and compare them with the theoretical proposals extracted from literature. The description of these tasks is given in the chapters to follow.

4. RESULTS

Because of the various analysis procedures performed on the industrial survey data, results are present in various forms. As such, it has been necessary to divide this chapter into a number of sub-sections. Each will discuss the results produced during a particular phase of the analysis.

4.1 SURVEY STATISTICS

The survey questionnaires, together with covering letters from the University of Cape Town, were posted to various organisations towards the end of August 1989. It had been hoped that the returns would be received by the end of September, but in reality the last returns only arrived in mid November. After some analysis the performance of this survey was established to be as follows:

a. Number of questionnaires posted: 200.

b. Percentage of questionnaires returned: 27%.

c. Number of organisations to respond: 33.

d. Number of usable project descriptions received: 175.

e. Number of project descriptions rejected: 2.

The actual information received from each questionnaire was then loaded onto a computer spreadsheet. A hard copy of this spreadsheet can be seen in Appendix (B). For its interpretation, however, re-examination of the sample questionnaire in Appendix (A) will be necessary. This is because the particular variable headings in the spreadsheet are not descriptive of the variable themselves. They correspond to the numbers of the questions in the questionnaire from which the variables originated.

With regard to the content of the spreadsheet, the following points should be noted, as they have bearing on later analysis and discussion:

a. The variables 13a through to 13f on the spreadsheet shown in Appendix (B) have been combined into a single variable, 13g, in order to provide an overall comparative rating to financial analysis techniques. (NOTE: The label of 13g was used, because the original question attached to it generated no response in the questionnaire returns.) The variable consists of four levels:

    1. Subjective techniques.(e.g. gut feel.)
    2. Simple ratios and summations.(e.g. Trading Profit and Return on Investment(ROI) Methods.)
    3. Discounted analysis.(e.g. Net Present Value(NPV) and Internal Rate of Return(IRR) Methods.)
    4. Sensitivity analysis.(e.g. Monte Carlo Simulation.)

b. The characteristic variable of project age (var 1) has been converted from continuous to categorical. As a result, five categories have evolved. These are as follows:

    1. 0 - 1 year.
    2. 1 - 3 years.
    3. 3 - 5 years.
    4. 5 - 7 years.
    5. > 7 years.

c. The answers to question 12 of the questionnaire are listed seperately in Appendix (B). They concern formal techniques for operational suitability and technical feasibility studies that respondents deem they have used. A number of these techniques, however, appear to be suspect. As such, the merits of individual techniques are not considered in this thesis. Only the merits of using formal techniques as an overall entity are considered.

4.2 DESCRIPTIVE RESULTS.

It will be remembered that the initial database analysis was descriptive and that its purpose was to investigate background database characteristics. It will also be remembered that it involved a spreadsheet procedure which produced graphical trends. The graphs so produced are displayed in figures 1 to 7. From scrutinising such graphs, it will be realised that the database under consideration displays some rather strong biases. The stronger ones are listed below:

a. The majority of projects were conducted less than five years ago.(figure 4.1)

b. The majority of projects are of the general purpose and construction types.(figure 4.1)

c. The majority of projects tend to be of higher financial value.(figure 4.1)

d. Most project durations tend to be between one and three years.(figure 4.1)

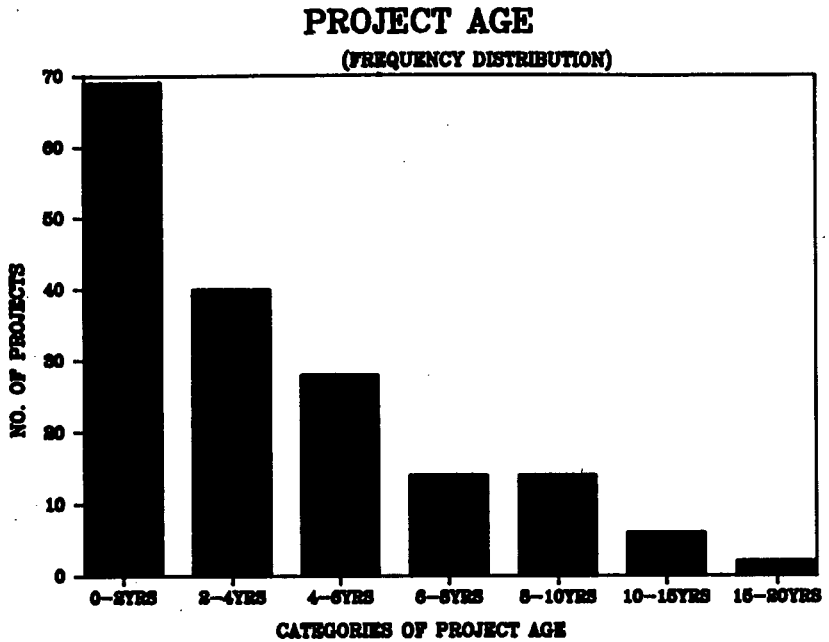
e. Effort expended on appraisal tends in most cases to be thorough.(figure 4.2)

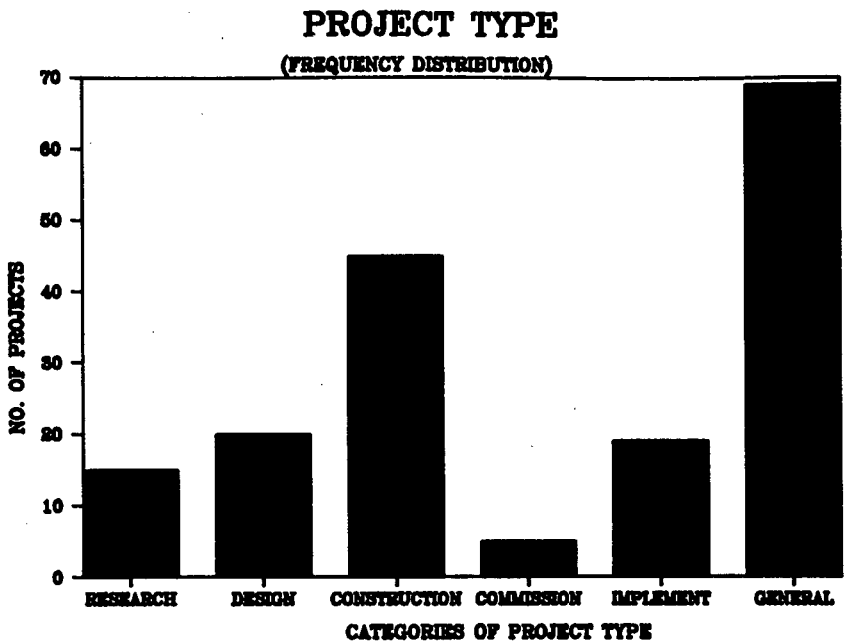
f. Operational and technical studies tend not to use formal techniques(figure 4.5). Those that do, tend to employ the techniques supplied in a list within Appendix (B).

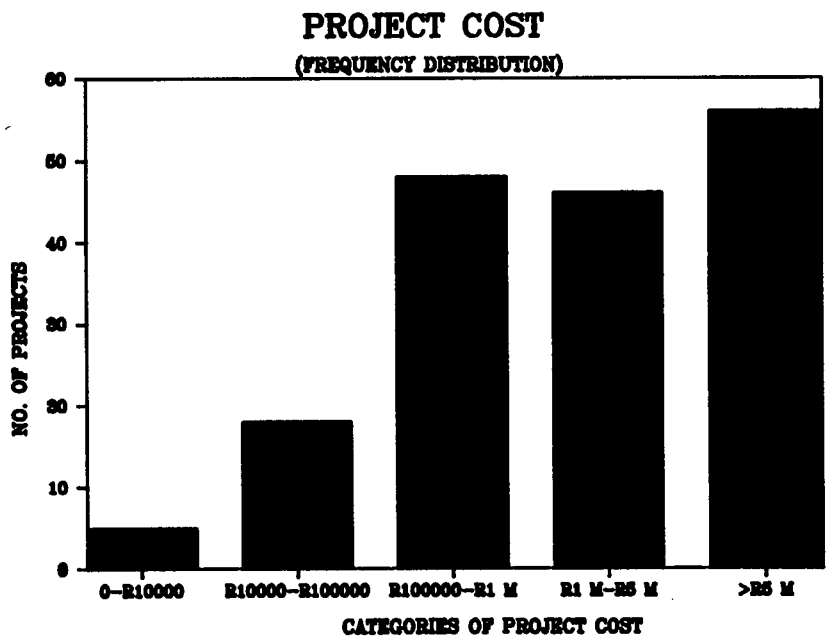
g. The vast majority of projects have used either a form of discount analysis, or a simple ratio or summation technique to financially appraise their projects. (figure 4.4)

h. Engineering and project management tend to be the main

Figure 4.1 : Project characteristic trends







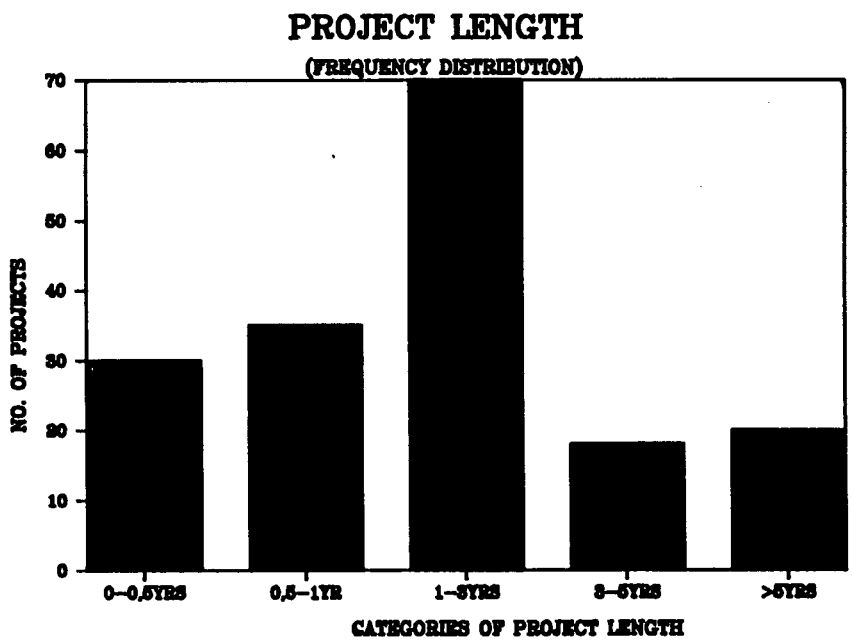


Figure 4.2 :

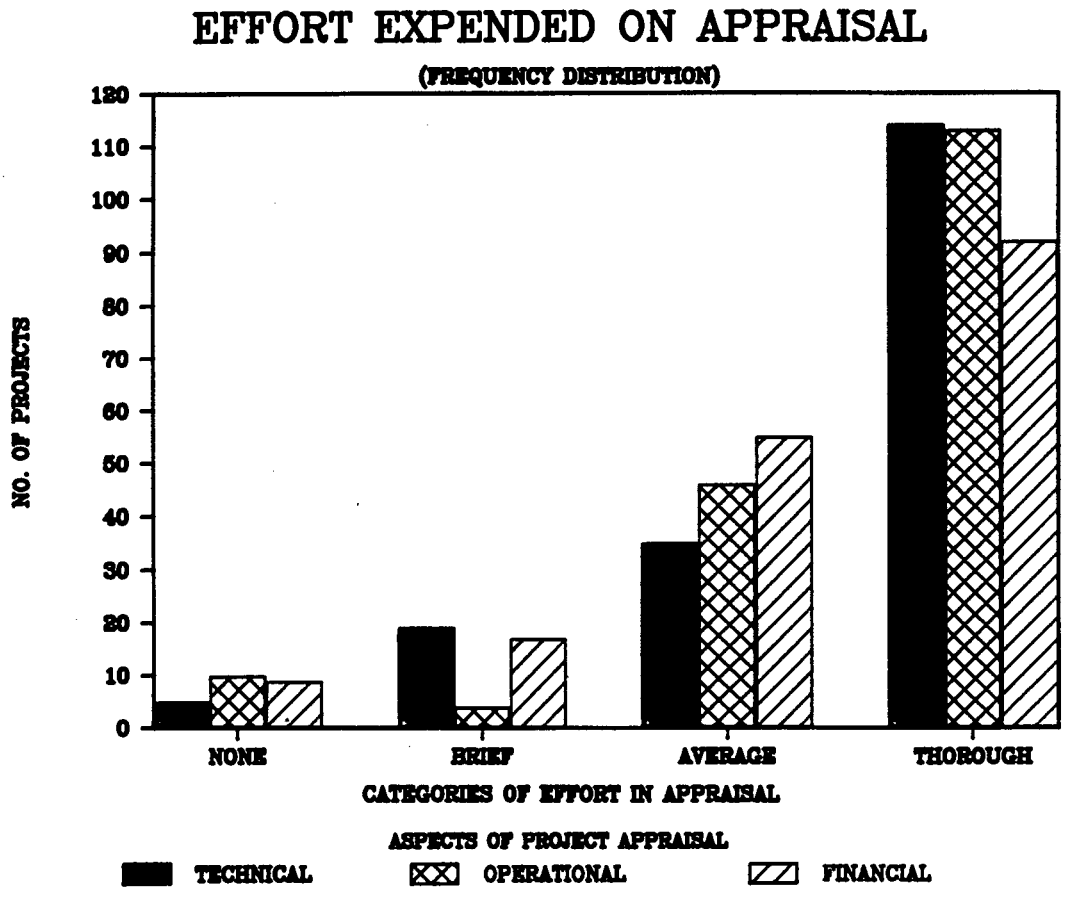


Figure 4.3 :

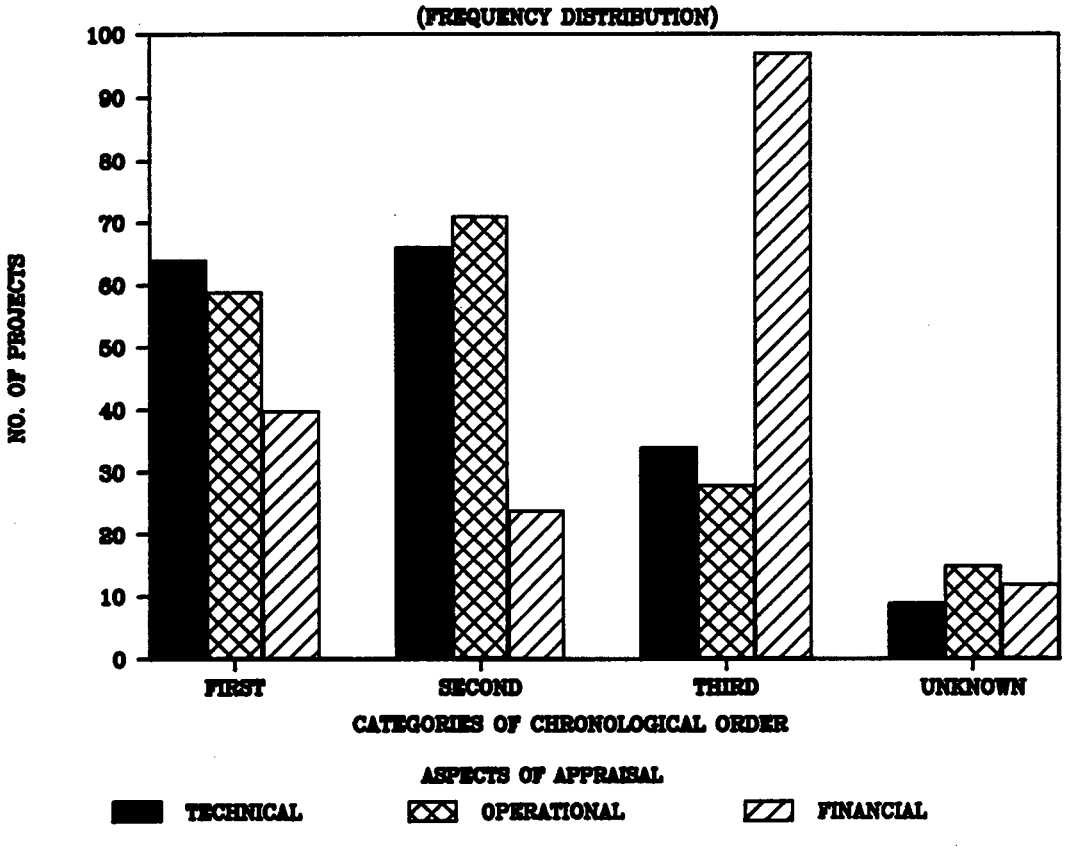


Figure 4.4 : FINANCIAL TECHNIQUES USED FOR APPRAISAL

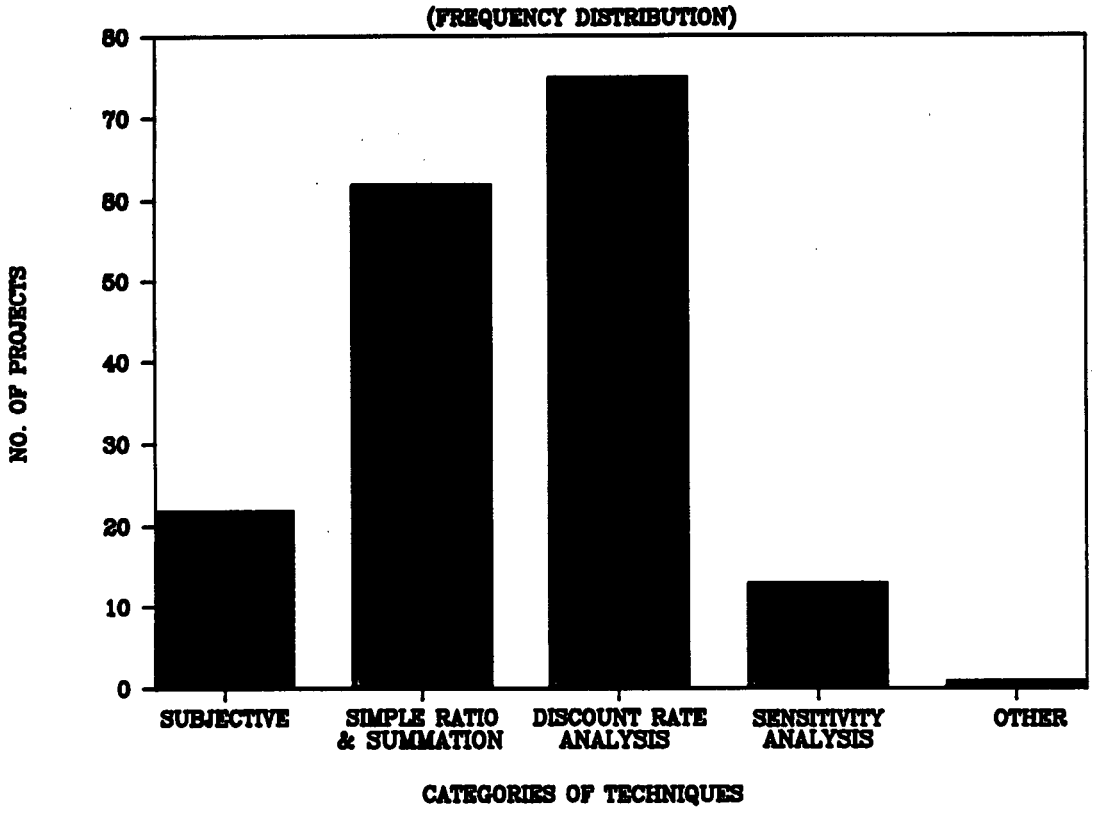


Figure 4.5 : EVALUATION OF OTHER PROJECT ASPECTS

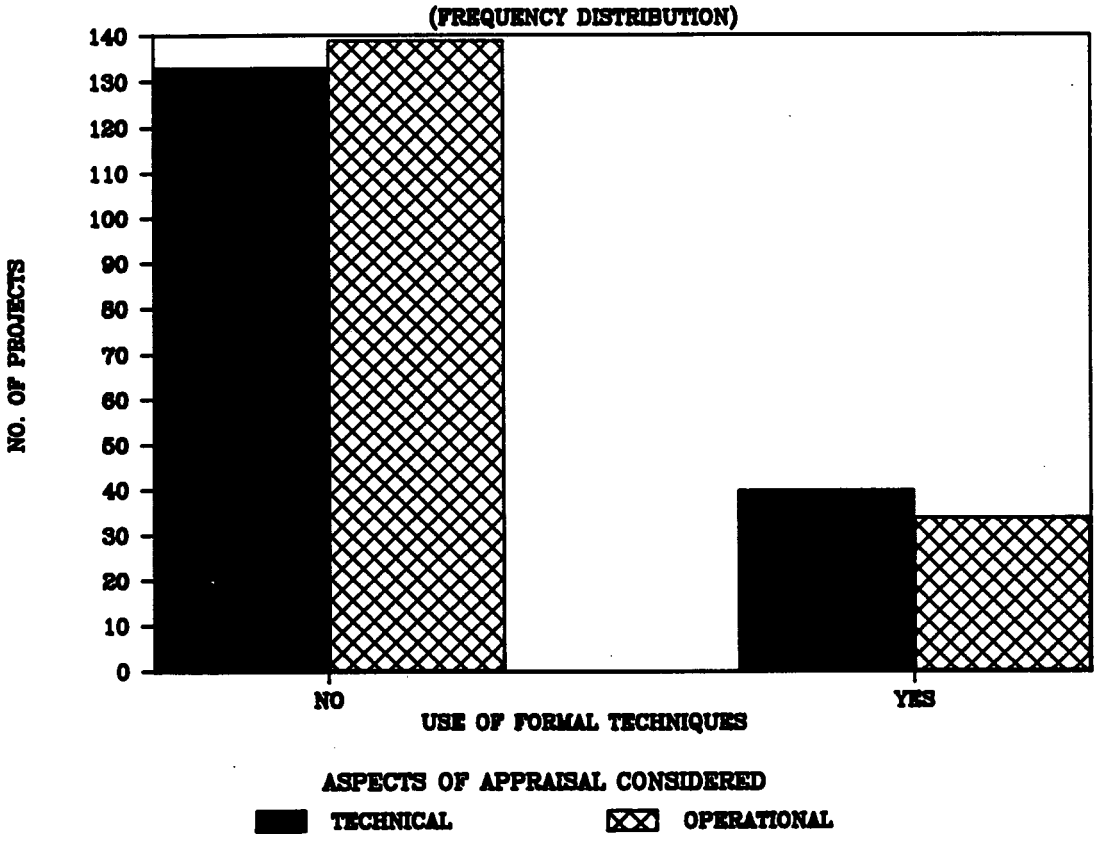


Figure 4.6 :

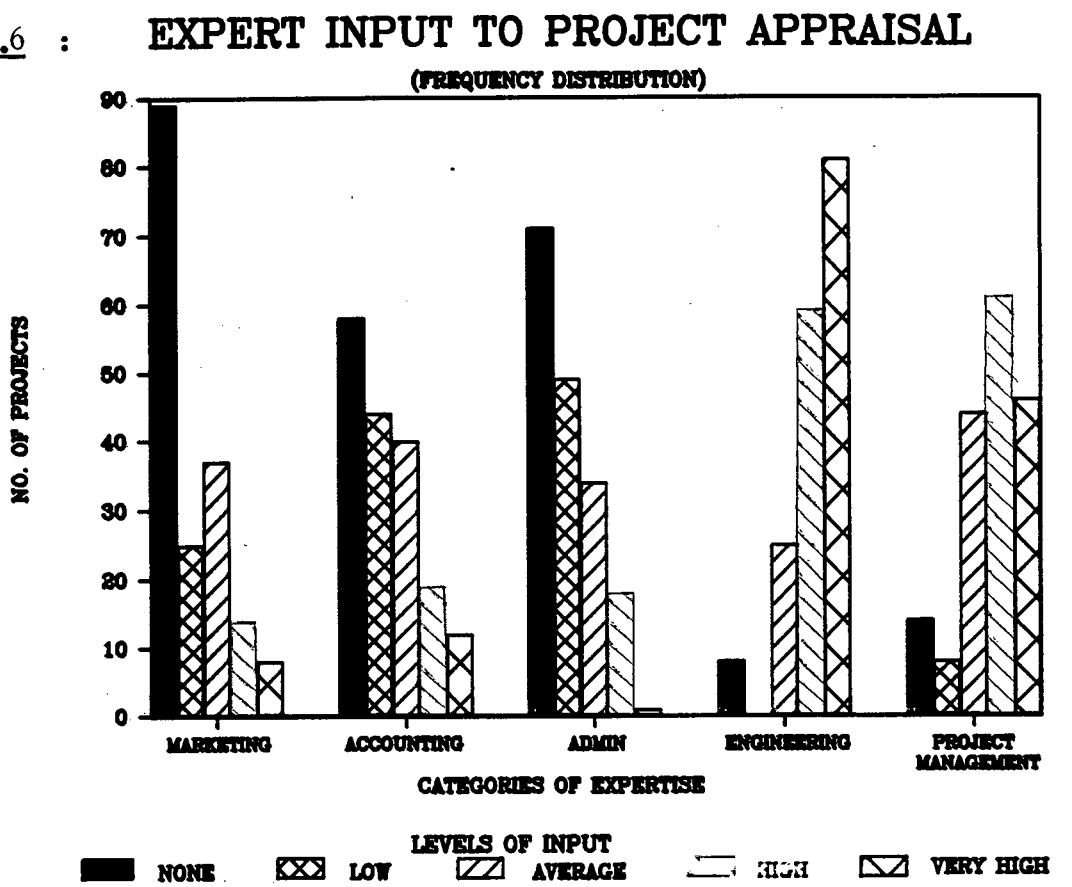
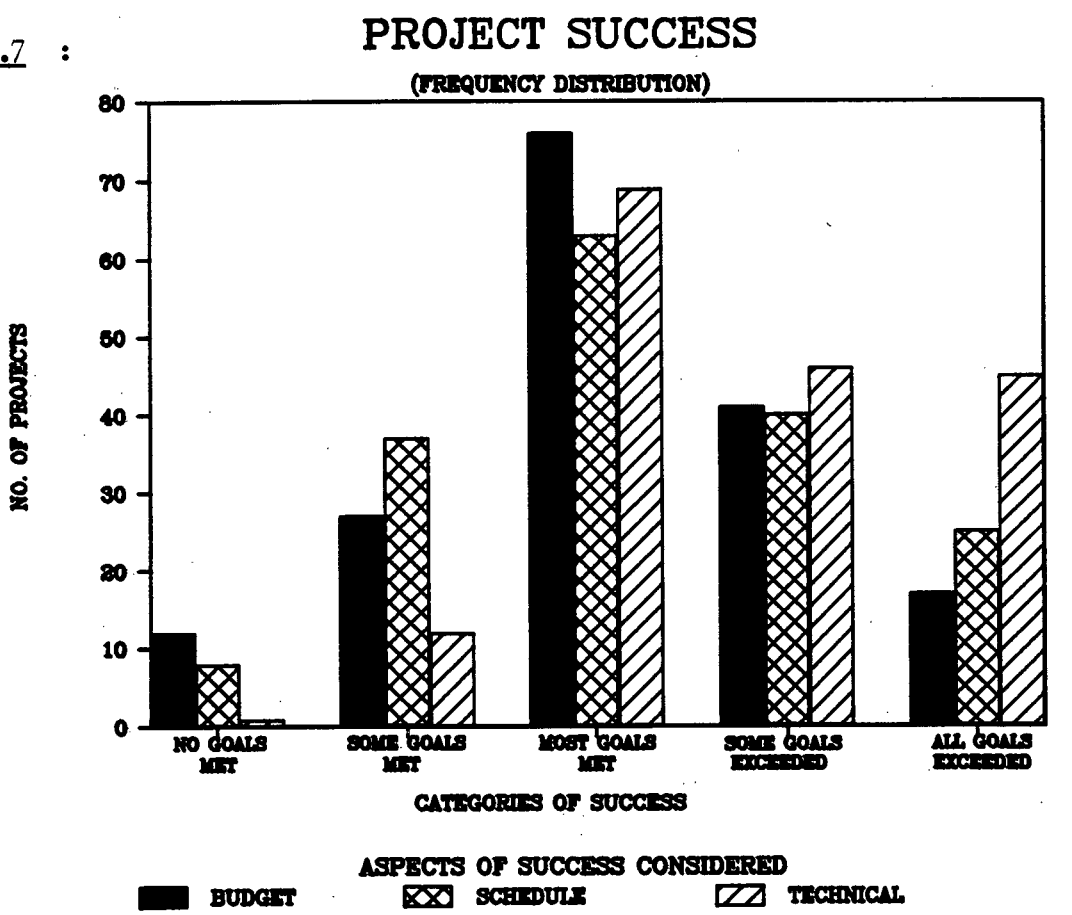


Figure 4.7 :



spheres of expertise used in project appraisal.(figure 4.6)

i. The majority of projects tend to be construed as having attained average success.(figure 4.7) This applies to all three success measurements, namely budget, schedule and technical.

Consideration of these biases shows that they do limit the capabilities of the database, as far as highlighting trends between variables is concerned. The reason for this phenomenon is that, when the data is unevenly spread, certain regions of a trend become more clearly delineated than others. Overall trends are, however, only as certain as their most unclear portion. A trend within an uneven database is therefore less significant than it would be if the distribution were even.

It is thus desirable to have the biases of a database kept to a minimum. This is, however, not always possible as data collection results are at the mercy of the respondents. In these cases, awareness of the situation during the interpretation phase of data analysis has to suffice.

4.3 SPREADSHEET ANALYSIS OF TRENDS.

Besides its use in descriptive analysis the computer spreadsheet was also used as a basic analysis tool for identifying any relationships between variables. The results of this analysis are shown graphically in Appendix (C). The basic format used is that of the bar graph. The application has, however, not been standard. Within each graph a full frequency distribution for the one variable is supplied on the x-axis for each category of a second variable also displayed on this axis. In this way, the two variables are related to each other and to frequency, all on a single two dimensional graph.

Each bar on the graph is also seen to display a percentage of the total projects present under a particular category rather than an actual number of projects. The reason for this is that it allows for the sometimes large numerical difference existing between categories of a graph. Without such an allowance the incongruencies present would be such as to make meaningful representation of all data impossible.

4.4 ANALYSIS OF VARIANCE.

Analysis of Variance (ANOVA) considers the strength of trend existing between variables. Before such trends can be suitably interpreted, however, it is necessary to be fully familiar with the idiosyncracies of the format in which they are presented. As such, the format of ANOVA results presented in Appendix (D) will be explained before their interpretation is discussed. In this regard, a typical sample table of single factor ANOVA (figure 4.8) has been copied from the appendix into the body of the text for reference.

Figure 4.8: Sample result for single factor ANOVA

	SUCCESS		
CHARACTERISTIC	Budget	Schedule	Technical
Age	-	0,010	-
Type	-	0,002	0,020
Value	-	-	0,004
Duration	0,000	-	-

Explanation of the format is given in a series of points as follows.

a. Each table of the appendix displays relationships between variables in two of the categories under examination.(i.e. success and project characteristics; success and appraisal philosophies; appraisal philosophies and project characteristics).

b. This is accomplished by representing each of the two categories on perpendicular axes of the table. In this way, specific table co-ordinates represent the relationship between specific variables.

c. The strength of a particular relationship trend is indicated by a decimal fraction at the appropriate co-ordinate. This number represents the probability that the null hypothesis is true (i.e. that the variables are independent). As such, it is desirable for this number to be as small as possible, because it is then certain that a strong trend exists.

d. Where dashes are displayed instead of numbers, the relationship is deemed to be too weak to warrant consideration. The probability has therefore been omitted. The limit above which this condition is deemed to exist is that of a probability fraction of 0.05 (or 5%).

e. The format used to display two factor ANOVA is similar to that used to display single factor ANOVA. The only difference is that in two factor ANOVA reference is made above each table to a variable from the third category under consideration (i.e. the category not displayed on either of the two axes of that table). This reference means that the particular variable has been incorporated into every probability displayed on the table. As such, there are two input factors to each relationship, namely the referenced variable and one from the appropriate axis of the table.

With the details of individual tables explained, it now remains to consider the arrangement of tables within the appendix. In this regard, it will be seen that the results of single factor ANOVA are represented in section D.1 of appendix D, while the results of two factor ANOVA are represented in section D.2. It will further be seen that the entire set of results from single factor ANOVA are displayed in three tables. Each table considers

the relationship between variables for two of the three categories established. The results of two factor analysis on the other hand are displayed in four tables. In this instance, each table displays the variables of success and appraisal philosophy on their axes and a specific project characteristic is referred to above.

4.5 CONTINGENCY ANALYSIS.

Although in the theory contingency analysis is closely related to the log-linear analysis procedure. The computer package utilised in this research deals with each issue separately. As such, under this sub-heading only the results of contingency analysis will be considered. These appear in tabulated form in Appendix (E). It will be seen that the presentation of these results are very similar to those of the results for ANOVA. Some differences do, however, exist. They are discussed in the paragraphs to follow.

The first such difference concerns the number of input variables utilised simultaneously during analysis. It will be seen that, while relationships between three variables were considered simultaneously for ANOVA (i.e. two factor analysis), only simple two variable analysis was considered for contingency analysis. The reason for this is that an attempted involvement of more than two variables invokes a warning with respect to the reliability of the results obtained.

The second difference concerns the presence of asterisks next to some results. As will be seen such notation does not exist in the ANOVA results. It is, however, present in the results of contingency analysis. Its purpose is to indicate results, where uncertainty is indicated as well as significance. In an attempt to rid trends of this uncertainty certain variables have been compressed. Such instances are visible in section E.2 of Appendix (E) as tables that have been repeated under a heading indicating such compression.

The extent to which compression in a variable has taken place can be determined by noting a third difference between these results and those of ANOVA, namely that a number exists behind the label of each variable for contingency analysis. Such a number represents the number of levels present in the variable against which a project can be classified in that particular instance. By comparing this number for the variables in the initial analysis to those existing for the subsequent compressed analysis, the number of levels by which the particular variable has been compressed can be determined. In this regard, the success variables for this analysis will be seen to be in constant compression, as they are always denoted as having three levels of classification while the survey questionnaire originally asked for five levels.

The final difference arising between the presentation of ANOVA results and that of contingency tables concerns the existence of brackets around some probability values in the contingency results. The purpose of these brackets is to denote probabilities which are not within the 0,05 probability fraction limit, but which are sufficiently close to warrant consideration.

4.6 LOG-LINEAR ANALYSIS.

It will be remembered that the purpose of conducting log-linear analysis is to analyse the nature of trends denoted as strong through ANOVA and contingency analysis. It will also be remembered that log-linear analysis is relatively time consuming, even with the help of a computer package and that therefore only selected relationships would be analysed by this method. Such relationships would be those displaying probability fractions of below 0,05 without a warning in the contingency analysis, with the exception of a few that have been denoted in brackets. As such, it should be realised that although the results displayed in Appendix (F) appear to be incomplete and disjointed,

they do nevertheless consider all of the important relationships that exist.

For their interpretation it should be realised that only simple two variable relationships have been considered. These are divided into three sections within Appendix (F). Section F.1 considers the relationships between success and project characteristic while section F.2 considers the relationships between success and appraisal philosophy and section F.3 considers the relationships between appraisal philosophy and project characteristic.

The second point to realise is that each table in the appendix considers a single relationship. It is therefore important to be able to understand each table on its own. As such, a fairly detailed explanation has been supplied for their interpretation and a sample table has been extracted as reference from the appendix in this regard. This can be seen as figure 4.9 below.

Figure 4.9: Sample result from log-linear analysis

		success	
duration	high		low
short	+0,7	+0,4	-1,5
	+0,8	+0,2	-0,7
	+0,6	+0,3	-1,2
	-1,6	-0,7	+2,9
long	-1,7	-0,2	+2,2

The explanation is given as a list of statements as follows.

a. The two variables involved in the analysis of the table are represented as scales on the two perpendicular axes of that table. As such, each value represented in the table can be seen to correspond to particular classifications of these variables.

b. The values displayed within the table are standard residuals. They represent the difference between percentage

actual frequencies(100% x actual freq/total projects) and percentage frequencies that would exist if the variables were independent.(100% x expected freq/total projects)

c. A grouping of residuals with positive signs indicates an area within the table where a greater number of projects exist than independence between the variables would suggest. This suggests in turn that there is a tendency in projects to adopt the variable attributes indicated for this area of the table.

d. A grouping of residuals with negative signs indicates an area within the table where a fewer number of projects exist than independence between the variables would suggest. This suggests in turn that there is a tendency in projects to avoid the variable attributes indicated for this area of the table.

The final point to realise is that all tables are interpreted in the spaces next to them. Such interpretations reflect the point of view of the author and as such, they may not always meet with agreement from the reader. They do, however, act as an aid to persons attempting to interpret the log-linear results for themselves and also provide an indication of the origins to certain statements made in the discussion to follow.

5. DISCUSSION

A number of milestones have been reached with regard to the research procedure being followed in this thesis. Firstly, the available literature was analysed and indications of a preferred approach to appraisal were revealed. The major issues involved in this approach were then selected for practical investigation. This consisted of a posted questionnaire survey to industry within the South Western Cape. Finally, the response to the questionnaire was statistically analysed in order to establish the trends that exist.

These trends will now be compared with the proposals of literature. To this end, the attitude towards appraisal existing in the particular region is secondary. It is mainly intended to try and develop a general picture of the situation that exists by considering the information available.

The discussion will be divided into three sub-sections. The topics to be discussed in each include; the limitations of practical research; the results of this research; and how practices in the South Western Cape compare to those expounded in the literature. The order of their discussion will be such as to promote a logical progression of thought.

5.1 LIMITATIONS OF PRACTICAL RESEARCH

Before one considers any of the trends highlighted as a result of practical research, it is important to have some idea as to the relevance of this information. Such an idea is usually obtained through analysis of areas in the research procedure where limitations are thought to exist. Four such areas have been delineated. The analysis of each is discussed separately in the paragraphs to follow.

5.1.1 **Limitations of the thesis topic.** The thesis topic involves certain variables for which no units of measurement exist. It has therefore been necessary to develop approximate scales for these variables, in order to facilitate their measurement for statistical analysis. Such scale approximations introduce uncertainties which must be allowed for during interpretation of the analysis.

5.1.2 **Limitations in the survey method.** The choice and development of the survey method suggest a number of limitations to exist with respect to the output data received. These limitations should be remembered in interpreting the results of final analysis. They are as follows.

a. In using a questionnaire it was necessary to utilise standard questions. As such, only essential information could be received in the raw data.

b. The questionnaire could not completely cover the aspects of appraisal without becoming too long. As such, it had to be limited to the more pertinent issues.

c. The questionnaire could not accommodate comprehensive explanations of all terms used without it becoming very long. As such, understanding of the questionnaire may have been impaired.

d. Because the questionnaire covered two surveys, it was fairly long. This could have an impact on the relevance of the data received as lapses in concentration during the answering of lengthy questionnaires are more likely than during the answering of shorter ones.

5.1.3 Limitations resulting from questionnaire distribution.
Because distribution of the questionnaire was based on an address list made up of people showing interest in project management, uncertainties are realised to exist with respect to the target area of the survey. These are as follows.

a. It cannot be certain that a balanced cross-section of organisations was approached during survey. As such, one cannot be sure that the response obtained is representative of the South Western Cape.

b. Secondly, it cannot be certain that the personnel at which the questionnaire was aimed were at the correct level within their organisations to answer it correctly. It is therefore uncertain as to whether the information received on all projects is realistic.

5.1.4 Limitations due to human nature of the respondents.
Unlike experiments in pure science, the results of this experimentation are dependent on human reactions, which are inconsistent. Such inconsistencies limit the interpretations that can be made on results, as they introduce uncertainty as to the validity of the database. Some causes of this uncertainty are as follows.

a. It is human nature to be careless. As such, as well as misinterpretation of questions occurring through lack of explanation in the questionnaire, it could also have occurred through carelessness on the part of the respondents.

b. It is also human nature to be biased or even dishonest in one's own favour. Responses of this nature on a particular project would reduce the validity of the interpretations to results obtained.

c. It is likely that organisations have answered the questionnaire with respect to their most successful projects. It is also likely that only organisations that have conducted successful projects have responded. The occurrence of such scenarios will have reduced the validity of the database in accurately representing the situation existing within the South Western Cape.

These uncertainties indicate fairly substantial inaccuracies to exist. The research is nevertheless still highly significant because the topic it considers is not completely predictable. As such, its intention is to highlight wide ranging trends and not the minor responses more characteristic of purely scientific research. Such trends should largely outway any inaccuracies caused by limitations.

5.2 RESULTS OF PRACTICAL RESEARCH

Although a number of different sets of figures have been generated as a result of analysis conducted, the discussion will focus on only one set, namely that of Log-linear Analysis. The rest of the results will be used for reference and comparison where necessary. This is not to say that these results are superfluous. The relevance of such techniques as analysis of variance(ANOVA) and contingency analysis in particular is that they aid in selecting trends strong enough to warrant investigation into their natures.

With regard to propagating the discussion in this particular section, it is intended to develop an overall picture of what practically occurs in the South Western Cape. To this end, results will be discussed in three sub-sections, each considering a particular category of relationship. The first will be concerned with the relations between characteristic and success, the second will be concerned with the relations between technique used and success and the third will be concerned with the relations between characteristic and technique used.

5.2.1 **Characteristics and success.** Only five relationships were generated from analysis on this category. It is therefore not possible to form a complete picture of the situation that exists. It is only possible to comment on particular features. The Relationships are represented in tables 1 to 5 of Appendix (F) and discussed in the paragraphs to follow.

Duration versus budget success. It appears that a strong relation exists between these two variables in which budget success decreases with increased duration. Such a relationship supports logic, because each task in a project carries a probability of budget overrun and it takes the overrun of only one task for a project not to meet time schedule. In a long project therefore where there are usually a greater number of individual tasks to be performed, there are more areas for failure. Its likelihood is therefore greater.

One would expect a similar trend to exist between schedule success and duration. Such a trend has, however, not arisen. The reason behind its absence can possibly be attributed to the size of the database generated through survey.

Compressed type versus schedule success. The reason for the compression of type has been to overcome the warning displayed during processing of its uncompressed equivalent. It has been achieved through the elimination of all commissioning projects from the analysis.

As reflected in the trend itself, research and implementation projects are seen as having a relatively high schedule success while construction projects are seen to have relatively low success. This is directly the opposite of what one would expect from the relations concerning research and

construction projects. In the case of research projects, the goals are usually highly indeterminate. In the case of construction projects analysis is usually conducted down to the finest detail for the purpose of appraisal, planning and control. One would therefore expect the association of trends with respect to these project types rather to be reversed.

An explanation for the existence of such an anomaly is that expectations of success differ in each case. In the case of construction projects, because thorough planning is conducted, high schedule success is expected while in the case of research projects, because uncertainties exist, conservative goals with respect to schedule are established.

Project age and schedule success. No logical trend is apparent in this relationship in spite of a strong indication produced by the contingency analysis. A possible explanation for this is that, while the variables in reality are independent, the frequency distribution has by chance been such as to assimilate a strong trend.

In contrast to this situation, the relationship between project age and budget success is shown to display a clear trend, as well as a strong interdependence between variables. Within the trend budget success appears to have improved with time. This indicates an improvement in the project management methodologies used within the South Western Cape. The improvement, however, need not necessarily have resulted from financial appraisal. It could also have resulted from improved planning and control techniques.

Project value and schedule success. Within this relationship schedule success is initially shown to decrease with increased project value. After a certain project value, however, a change occurs and it begins to increase. The

implication of such a trend is that schedule success is only actively considered in practice once a project's value exceeds a certain limit and that organisations should maybe begin this consideration earlier, if they want to improve the schedule success of their average value projects. Such advice should, however, not be taken too seriously without further investigation, as the significance level reflected for the strength of the overall relation is over 5%. (i.e. There is a certainty of greater than 5% that the variables under consideration are independent.)

5.2.2 Techniques used and success. In this category of the analysis, the approach adopted has been to group the individual trends displayed in Appendix (F) into topics for the purpose of individual discussion in the paragraphs to follow. This has been possible as a result of the more comprehensive coverage given by the analysis in this category.

Appraisal thoroughness versus success. In this regard two relations have been found to be of significance, namely that between technical appraisal thoroughness and schedule success and that between operational appraisal thoroughness and schedule success. These are illustrated in tables 11 and 12 of Appendix (F). In both instances, the trends indicate that success increases with an increase in the appraisal thoroughness. This phenomenon supports the hypothesis that operational and technical appraisal are of importance to the overall appraisal study.

It is unfortunate that statistics have not reflected further trends on this particular topic and that as such, a more statistically watertight argument cannot be put forward. Graphs displayed in the results chapter and in Appendix (D), nevertheless, show further qualitative support.

It will be seen from these graphs that, not only are industry using these forms of study widely, but they also appear to be attaining trends similar to those attained statistically for other relations involved under this topic. Such relationships include those of budget success and technical/ operational/ financial appraisal and those of technical success and technical/ operational/ financial appraisal.

In considering these relationships it will be noted that for a large portion of these relationships the trend is fairly certain. Only for the level at which no appraisal is said to exist does an anomaly exist. This anomaly involves a sudden increase in success after it has been decreasing steadily with appraisal thoroughness.

A possible reason for such an anomaly is that organisations are loathe to admit very low success. It is also possible that organisations that do not appraise certain aspects of a project also do not plan and control these aspects. They therefore would not be aware of low success here. In either instance the results reflected here would not be true.

Chronological order versus success. In this regard, three trends have been made available by statistics. They concern the effect that the chronological position of operational suitability and technical feasibility studies have on budget and technical success. Such trends are reflected in tables 6, 13 and 14 of Appendix (F). The reflections of these trends are that projects conducted in the South Western Cape display greater technical success when technical feasibility studies are conducted first and operational suitability studies are conducted last. They also display greater budget success when operational studies are conducted last.

As such, consideration of only the statistical trends produced leads to the belief that it is most favourable to

conduct technical feasibility studies first, followed by financial viability studies and then finally by operational suitability studies. This is, however, seen to be illogical when considering the rationale behind the appraisal procedure. It does not seem logical to only consider the operational requirements once the financial and technical implications of a project have been decided. It instead makes more sense to decide on operational requirements first, as these are necessary inputs to the other two studies. It would then make sense to conduct a technical feasibility study on the options that exist for technically attaining these requirements. Only once this is complete would it be feasible to consider cost, as then all of the necessary information would be available for a comprehensive analysis.

A graph in figure 4.3 indicates that organisations within the South Western Cape corroborate this, as it shows that the majority of projects in the sample follow the chronological order highlighted as logical above. Such would not be the case if the order was known to yield relatively unsuccessful results. It therefore seems likely that, either the results of the statistical trend are incorrect, or the organisations are unaware of the lower success attained through using this order, or there is some other factor in existence to which this analysis is not privy and which is influencing the order. With these three possibilities in existence it would seem logical to approach the reflected trend with caution.

Use of formal technical and operational techniques versus success. It will be seen from the respective trends displayed in the log-linear Analysis (Table 15 of Appendix (F)) that both types of formal technique positively influence technical success.

Such a situation appears logical, as the use of formal

techniques in both instances reflects on the objectivity of the appraisal. It would therefore be expected that in using such techniques the more technically suitable alternative is more likely to be chosen rather than one that may be subjectively favoured.

In Appendix (B) a list is given of formal techniques that are reportedly used. It will be seen that these techniques are widely varied and that in some cases their usage in technical and operational appraisal is illogical. Deeper analysis into the applicability of each techniques has, however, not been conducted. This is left for investigation by other researchers interested in the topic.

Use of formal financial techniques versus success. It has been realised that a comprehensive analysis of this topic is not possible with the information available in Appendix (F) alone. The trends available will nevertheless be discussed in conjunction with graphical information in order to represent some indication of the situation that exists.

The situation reflected is that the use of subjective financial analysis negatively effects budget and technical success. Usage of discounted summation financial analysis techniques, however, while also negatively effecting technical success, seems to have a positive effect on schedule. It therefore appears that, although the complexity of the financial technique used does not effect technical success of a project, it positively effects its schedule.

In considering this scenario it was felt that, although statistical support is sparse, there is a certain logic present. It was further felt that a similar scenario to that highlighted for schedule success applies to budget success,

because of the interlinking of the two success forms.(i.e. An overrun in schedule causes an overrun in the budget.) Such can be seen to be reflected in the appropriate graphs of Appendix (C). The influence carried by these reflections is, however, small, as they are strictly qualitative. For a better reflection, it is recommended that the statistical approach be re-iterated with a larger database.

Expert input versus success. Consultation of both the statistics and the graphs provided in the appendices show these trends to be weak. As such, no significant analysis can be considered.

A possible reason is that the expert input to a project in most organisations remains balanced. As such, if the thoroughness of appraisal to a particular project increases, expert input to that project increases in a balanced fashion. Such a situation relies heavily on the discretion of the respondent, as he/she now must categorise all inputs somewhere on the scale. There is no room for comparison between inputs. A large data spread therefore arises.

5.2.3 **Characteristic and technique.** The initial intended emphasis of this thesis concerned the relationships between success and either the appraisal techniques used, or the project characteristics. A preponderance of trend data has, however, resulted concerning relationships between project characteristics and appraisal techniques used. These trends do not directly consider the issues addressed in the objectives of the thesis, but they do suggest viewpoints on certain issues. They also supply insight to actual occurrences of the South Western Cape, information which is of secondary interest to this topic. As such, they will be discussed at this point.

The trends will again be divided into topics for discussion which will be considered separately in the paragraphs to follow.

Project age versus the chronological order of conducting appraisal studies. Such trends are displayed in tables 18 and 19 of Appendix (F). It will be seen from considering the analysis on these issues that there has been a tendency over the past ten years to conduct technical feasibility studies earlier in the appraisal procedure. As such, while ten years ago this study appeared generally to be conducted last, today it appears to generally be considered first. It will also be seen that increased usage appears to have been made of formal technical and operational studies in recent years.

Both of these trends point to the conclusion that an increased awareness has been reached with respect to the necessity for conducting thorough technical and operational studies in appraisal. This in turn implies that improved success is synonymous with increased thoroughness of these studies. The logic attached to this implication is that optimisation of procedures usually occurs through time. A change towards increasing the use of a particular study could therefore be as a result of optimisation.

Project type versus the chronological order of appraisal studies. As will be seen from analysis, there are definite trends in existence (Tables 21, 22 and 23 of Appendix (F)). It will also be seen, however, that the applicability of these trends is limited to particular project types. In this regard, the projects receiving the greatest emphasis are development, construction and general engineering projects.

The trends reflect that, while development and general engineering projects tend to conduct technical and operational studies either first or second and financial

studies third, construction projects tend to conduct the sequence in reverse.

A possible explanation for the existence of such a phenomenon is that the appraisal of development and general engineering projects requires important decisions to be made with respect to its operational requirements and the technical implications of its implementation. For construction projects, on the other hand, these decisions have usually already been made as construction projects usually take on one of a number of standard forms. A more important reason for the existence of these studies in construction is for planning purposes rather than for appraisal. It therefore seems logical to conduct them more towards the planning phase which follows appraisal.

Project type versus appraisal thoroughness (Tables 26 and 28 of Appendix (F)). Trends are especially strong in the case of technical and operational appraisal studies. It will be seen from the results of a condensed analysis that technical studies appear to be conducted most thoroughly in the case of general engineering projects. This thoroughness appears less pronounced in the case of development projects and distinctly scant in the case of construction projects. Operational studies appear to have followed similar trends in the case of general engineering and construction projects. Development projects have, however, not been considered.

Project type versus the use of formal techniques in operational suitability and technical feasibility studies. It will be seen from analysis that research and general engineering projects tend to use formal techniques more often than one would expect, if independence had existed between the variables. It will also be seen that construction projects appear to make less use of formal techniques than

independence would suggest, while development and implementation projects appear to conform with independence.

Such trends support logic. For example, one would expect research and general engineering projects to require thorough technical and operational appraisal, because each is usually unique. Hence there would be a greater use of formal techniques. On the other hand, one would expect relatively scant technical and operational appraisal to be conducted on construction projects, because of the re-occurrence of standard procedures in this instance. For implementation and design/development projects one would expect the usage of formal techniques to depend on circumstance, as in each case there are instances where standard projects exist, as well as instances where completely new concepts must be designed or implemented.

Project type versus the use of financial appraisal techniques (Tables 24, 25 and 31 of Appendix (F)). Although the overall trend is not absolutely defined, variations do exist between project type and the techniques adopted. General engineering projects tend to use more complex techniques such as discount rate analysis and sensitivity analysis; construction projects tend to restrict their use to discount analysis and development/design projects appear to have very little use for any techniques at all.

Such trends seem logical in that development/design projects involve mainly design work. As such, they are concerned primarily with technical development requiring fairly extensive lateral thinking. The expenses involved in such a project are difficult to quantify. As such, it would be a waste to use a complex technique for evaluation, as this would imply accuracy that is not available. Should the project involve more than just design, or should the "sub-project" of design materialise into a "sub-project" of another type, it would not fall under the category of a design/development project. Other rules would then apply.

Construction projects are generally repetitions of standard projects. Judgement therefore relies on experience gained from the past. This experience is formalised into standard procedures and rates for method studies and time and motion studies. A discounted financial analysis technique can therefore easily be applied to such a project. Sensitivity analysis would, however, not be necessary because of the reliability with which basic assumptions can be made.

General engineering projects tend to be more varied. They also generally consist of easily quantifiable and appraisable tasks. The results of applying both discounted financial appraisal techniques and sensitivity analysis would therefore be more worthwhile.

Project value versus the chronological order of conducting appraisal studies. As will be seen from analysing Appendix (F), the statistical trends available with respect to this relationship are sparse. In fact, the only significant one is that between value and the chronological position of financial studies within the appraisal procedure. This can be seen in table 32 of Appendix (F) where it reveals that in the South Western Cape, financial studies tend to be conducted earlier in the appraisal procedure in instances of higher project value.

In attempting to provide a logical explanation for such a trend, it was realised that no suitable explanation exists. In the event of an increase in project value one would expect that the thoroughness of financial appraisal would improve. In fact, one would expect the thoroughness of all appraisal to improve. One would, however, not expect the chronological order to vary, because for all project values operational and technical studies still provide valuable inputs to the financial study and should therefore be conducted before it.

Project value versus the use of formal operational and technical evaluation techniques. It will be seen from the analysis (Table 33 of Appendix (F)) that a distinct increase in usage is displayed with respect to increase in project value. Such a trend can be justified by logic in that higher value projects run the risk of greater losses in the event of failure. Organisations would therefore logically be drawn to the use of more formal techniques which imply greater accuracy and objectivity in appraisal.

Project value versus use of financial techniques. Trend data in this regard is seen to be sparse. The only trend to be displayed by statistical analysis is that which classes simple summation techniques to have above average applicability for average value projects (i.e. R100 000 - R1 million) and below average applicability for low value projects (Table 34 of Appendix (F)).

On its own, such a trend can have little significance in establishing an order in which techniques are used with respect to value. Its only use is in giving an indication of actual values, should a particular ordering be chosen and even then this would not be very clear.

Project value versus expert input. Only a single trend exists in this regard. It concerns the relation between project value and the amount of input provided by administration. To this end, it shows the utilisation of administration in the appraisal procedure to increase with project value (Table 35 of Appendix (F)).

Such a trend appears logical, as the administration section is not directly involved in the conducting of industrial projects. It therefore only becomes involved in appraisal when projects are of sufficiently high value to warrant high level approval. At such a point, heads of departments would

probably become involved, one of which would probably be that of the administration department. Another possibility is that larger projects involve a greater number of personnel from different departments. The requirement for administration therefore is greater in order to service the requirements of such personnel.

Duration versus chronological order of conducting appraisal studies. Only one trend has been found to exist. It concerns the relation between duration and the chronological position of technical feasibility studies. It shows that these studies tend to be conducted earlier in the appraisal process in instances of longer project duration. Such a trend is reflected in Table 36 of Appendix (F).

A possible explanation is that short projects also tend to be cheaper and more simple. As such, formal technical appraisal becomes less necessary. The result is probably that organisations unwittingly incorporate technical issues into the financial studies. As such, when they are asked to consider technical appraisal, they confuse it with their technical planning and classify it as being conducted third. In reality, however, they could already have conducted it either first or second, but only mentally.

Duration versus the use of formal techniques for conducting operational suitability and technical feasibility studies. It will be seen that such techniques are used more often for longer projects (Table 37 of Appendix (F)). The rationale employed appears to be that longer projects normally involve greater expenditures. They therefore would entail greater losses in the event of failure. Longer projects normally also involve a greater number of individual tasks. As such, their scope for failure is higher, because all tasks carry a certain chance of failure. These failure probabilities are additive for the overall project. It therefore would be logical to conduct the more formal operational and technical

studies in instances of longer project duration, because such studies would provide for a more objective and quantitative assessment. In such an instance, the extra effort expended on these techniques would be worth the increased security that they provide.

Duration versus the use of financial analysis techniques. (Tables 38 and 39 of Appendix (F)). The available trends show both subjective financial analysis and discounted summation analysis to have increased usage in the event of longer projects. This is contrary to what would logically be expected. It would rather be expected that, as projects get longer, the reliance on discount rates in establishing accurate scenarios becomes greater. As such, it would be expected that, while discounted summation analysis has increased application for longer projects, subjective analysis would be limited to shorter ones.

Deeper analysis into the original data sheet of Appendix (B) shows that projects employing subjective analysis do not usually utilise this technique alone. They also usually employ a more sophisticated technique. The apparent contradiction to logic displayed by the relation under discussion can therefore be ignored and it can be assumed that, in lieu of further contradictions, the logical assumption of increased technique complexity with increased duration is plausible. This is not to say that it has definite support. It just has not been contradicted.

5.3 COMPARISONS BETWEEN LITERATURE AND PRACTICE

Having considered the logic behind industrial trends made manifest through the analysis of practice in the South Western Cape, the intention of the next step is to utilise this information as a basis for commenting on the conclusions drawn from literature. To this end, it has been decided to sub-divide this section into two.

The first sub-section will consider each of the conclusions drawn from literature in turn and will attempt to evaluate and extend them in the light of practical findings. The second will suggest an enhanced version of literature's theory as a result of considering the conclusion drawn. With regard to this enhanced theory, it should be remembered that it is just a proposal based on the limited information available. It should therefore be treated as such.

5.3.1 Individual comparisons. In order to enhance the clarity of this section, the discussion of each conclusion drawn from the literature will be represented under a separate sub-heading.

a. The effect of project characteristics on the appraisal approach used. The literature concluded that the applicability of a particular appraisal approach is governed by the characteristics of the project involved. In this regard, three particular characteristics were concluded to be of importance. They are project type, project duration and project value.

As will be seen from trends actually occurring in the South Western Cape, some practical support exists for this conclusion. It is, however, not as extensive as may initially be thought. On initial consideration the relationships between certain project characteristics and success may be thought to be highly supportive. On deeper analysis it will be realised that this support is too vague. While such trends could possibly have resulted because projects having certain characteristics are intrinsically more successful, they could also have resulted from a myriad of other reasons.

The more serious support for this conclusion actually appears to come from those relations between project

characteristic and appraisal technique used. Such relationships display trends actually occurring in practice. They could therefore be deemed to have a certain amount of respectability by virtue of practical experience gained. Such support is by no means conclusive. It is, however, also not contradictory to the conclusions of literature and it does seem logical. As such, the conclusion drawn from literature will be accepted as reasonable subject to verification by more extensive research.

The acceptance of such a conclusion has an important repercussion in that now, when one considers the remainder of the conclusions from literature, it is not possible to generalise with regard to trends that exist. The acceptability of an appraisal approach will now be realised to vary depending on the characteristics of the projects being analysed. A logical procedure would therefore be to attempt to relate all three categories of information, in order to obtain trends in which the success of particular techniques can be assessed for particular project characteristics. This is, however, not possible with the database presently available. For this thesis therefore it will be necessary to limit investigations to that of the simple relations that do already exist.

b. <u>The chronological position of appraisal within a project life-cycle</u>. Literature considers appraisal to be the first major phase of a project, being followed by planning with a certain amount of interaction occurring between the two phases. Practical verification for this conclusion is, however, sparse. It does, nevertheless, display a certain amount of logic and as such, it is deemed acceptable in the absence of any contradictory evidence.

successes experienced in certain project types, or it could be that the thoroughness requirements are different for different project characteristics. To gain more detailed insight into the actual reason, three factor log-linear analysis will need to be conducted on practical data between project characteristics, appraisal methods and success. This will require a larger database than already exists. As such, an extended survey will be necessary.

With all three studies having been concluded as essential to the appraisal process, the literature then goes further in postulating a preferred chronological order for their conduct. Such an order includes firstly conducting an operational suitability study, it then includes conducting a technical feasibility study and then finally conducting a financial viability study. The rationale behind this ordering is that one first needs to know whether or not the project result will be that which is required. One then needs to know what will be required to successfully complete the project. Only once all this is finalised is it necessary to consider finance.

Although this conclusion appears to be logical, no definite statistical support exists for it in practice. In the previous sub-section of the discussion all three categories of success were shown to favour operational suitability being conducted third, while technical success was shown to favour technical feasibility studies being conducted first. An analysis of actual occurrences in the South Western Cape show a number of variations to exist in this order with respect to variation in project characteristics. For instance, it is shown that technical studies now tend to be conducted first, whereas about ten years ago they tended to be conducted third in the appraisal process. It is also shown that, while development and general

engineering projects conduct technical feasibility and operational suitability studies first and second and financial viability studies third, the order is reversed in the case of construction projects. High value projects are also shown to conduct financial appraisal earlier in the study and longer duration projects are shown to conduct technical studies earlier.

Such statistical variances concerning actual variations in practice again point to a situation where project characteristics govern. Acceptance of this view, however, would entail a reliance on the historical experience of organisations and although views based on such a reliance have a certain respectability, actual practice could also very well be wrong. As such, because it contradicts some sound logic on this particular topic, it has been decided to ignore it in this particular instance in the light of an area of possible misinterpretation existing in the questionnaire. This area, as has already been discussed, concerns organisations conducting construction projects. In this regard, it is deemed possible that a number of organisations conducting construction projects are misconstruing planning as appraisal. Such a phenomenon is very likely, because construction projects are fairly standard and, therefore, have limited requirement for technical feasibility and operational suitability studies, as they have already been conducted in similar cases before.

It has been decided instead to adopt the order proposed by literature as this logic is deemed to be most reasonable. It has also been decided to adopt a policy in which this order is recommended for all project types, in spite of actual usage trends. The reason for this is that a variation in project characteristic

would affect the thoroughness of appraisal studies rather than the order.

Such a policy is, however, only a personal opinion based on the results and has not been proved. As such, before it can be accepted as a truth it must be more clearly verified. A possible avenue for attaining this verification is that of conducting three factor log-linear analysis between success, study order and characteristic. This should highlight trends in which project characteristic influences the success of a particular study order. As such, it should be possible to choose the order that is most successful for given project characteristics. The analysis will, however, require a much larger database then presently exists and, therefore, a greatly extended survey will be necessary.

d. The use of formal techniques within appraisal studies. Literature deems financial studies to employ formal appraisal techniques, while operational suitability and technical feasibility studies are less inclined to do so. This is definitely confirmed by practice within the South Western Cape, as can be seen by figure 4.5.

Practice then goes further in statistically noting the usage of formal techniques within technical feasibility and operational suitability studies to positively influence the technical success of projects. It also notes a strong relationship to exist between schedule success and formal technique within the results for single factor ANOVA. Although such a result has been stated to be not statistically applicable, the existence of such a relationship does suggest that a similar trend could apply for schedule success. Finally, it also shows that, as time progresses, increased use is being made of formal techniques within these studies.

Such trends support the belief that it is favourable to use formal techniques for such studies and they show that in reality organisations realise this. It appears just to be that familiarity with suitable formal techniques is limited. As they become more familiar, so their use becomes more extensive.

According to actual trends, the areas where they are mostly being used are those of research and general engineering projects, high value projects and long duration projects. Two possible reasons exist for such trends. Either these are the areas where application is most justified, or they are the areas where application is easiest. Immaterial of the reason, it is sensible to make use of these areas as guidelines for discerning where a concerted effort should be made in applying formal techniques.

It is not to say that one should not take advantage of applications seen to exist outside these areas. An overall guideline shows technical success to improve with the usage of formal techniques no matter what the projects characteristics are. As such, applications should be made wherever possible.

With regard to the usage of actual techniques in financial analysis, it will be remembered that a largely incomplete picture was drawn by statistics. A trend was, however, produced which provides support to logic rather than to the conclusions of literature. It concerns the effect that subjective and discounted summation financial analysis techniques have on technical and financial success.

As will be remembered, the only relation to show a positive trend has been that between the use of discounted summation and financial success. Discounted summation techniques are fairly comprehensive. As such,

it appears that the more comprehensive techniques better evaluate financial success, but that they do not correspond to an improvement in technical success.

Such a supposition is logical and as such, it is deemed sensible to include it with the rest of the conclusions drawn from literature even though its support is scant. It is reasoned that such a policy can be used as guidance to organisations until substantial contradictory evidence refutes it. The implication of the supposition is that organisations now need to decide which technique is most appropriate, as more complex techniques usually also require more effort in their implementation. In this regard, project characteristics are deemed to play a part in that they influence both the effort involved in application and the repercussion of inaccurate approval. No further detail can, however, be supplied because of a lack in practical evidence. To obtain more detailed evidence, a three factor log-linear analysis will need to be conducted. This in turn will require a larger database.

e. <u>The requirement for technical expertise in project appraisal</u>. According to literature it is necessary for technical expertise be involved in the appraisal process. Statistical verification from practice is, however, not available on this issue. The only information that is available is graphical and it concerns trends of actual occurrences in the South Western Cape rather than trends involving success. According to these trends engineering and project management constitute on average the highest levels of expert input for the project sample taken in the South Western Cape. As such, the views of practice are seen to concur with those of literature. It does not, however, conclusively mean that they are correct, as no practical relation has been established concerning success.

It only means that the views of literature can be considered to be more respectable, as practical support does exist and there is no contradictory evidence.

Consultation of the results produced from ANOVA and the contingency analysis show that a likelihood does exist of relations between expert input and success. The database presently in existence is, however, too small to allow reliable results to be highlighted in this regard. An investigation into these trends will therefore have to be left for a further research project.

5.3.2 Appraisal guidelines. As will have been seen from reading the previous section, actual trends occurring in practice within the South Western Cape have supplied certain useful criticisms of the theories expounded by literature. It is therefore deemed logical to propose an enhanced theory to that of literature, in order to include those suggestions made from practice which seem logical. The enhanced theory is given in a series of points below.

In considering these points it should be remembered that, while they are based on support from either literature or practice in the South Western Cape, they have not been conclusively proven to be true. They should therefore be treated as guidelines to organisations in appraising projects and not as absolute truths.

a. The applicability of adopting a particular approach to appraisal appears to be governed by the characteristics of the project involved. As such, one should be careful of generalising. Three particular characteristics of apparent influence are project type, project financial value, and project duration.

b. Project appraisal appears to be conducted as the first major phase in a project, being followed by project planning. A certain amount of overlap appears to exist between these two phases. The reason deduced for such an occurrence is that a certain amount of planning is usually required for appraisal to be completed.

c. In general, appraisal appears to be most successful when three separate studies are emphasized, namely that of a technical feasibility study, an operational suitability study, and a financial viability study. The extent of this emphasis also seems to vary with respect to the characteristics of the project concerned.

d. It appears that the use of formal techniques in all three studies is correlated to improved project success in some way. While formal financial techniques are generally accepted as being positively related to financial success, formal technical/operational studies appear to be related to technical success. The use of formal techniques in technical/operational studies appears, however, to be limited at present. A logical area for improvement in project appraisal therefore would be to increase formal technique usage within these studies.

e. It also appears that a certain chronological order is most favourable in conducting these studies. Such an order includes conducting the operational suitability study first. It then includes conducting a feasibility study. Finally, it involves conducting a financial viability study. The order is deemed to remain constant in spite of variations in project characteristic.

f. Finally, it appears that the expert input to appraisal should be fairly balanced, with the inputs of both engineering and project management being amongst the largest.

6. CONCLUSIONS

As a result of the investigations conducted during the research of this thesis, the following conclusions have been drawn with respect to the objectives set out.

6.1 RESEARCH PROCEDURE

The procedural objective was realised to the following extent.

a. A comprehensive picture of the views expressed by literature was formed, as an extensive collection of documentation exists on the topic. This picture shows that literature favours particular procedures with respect to appraisal.

b. A practical survey involving a posted questionnaire was conducted of industry within the South Western Cape. This provided a database of practical details concerning the issues expressed by literature on 173 projects. As such, it was possible to obtain a fair picture of actual procedures adopted in the South Western Cape, together with their success.

6.2 UNCERTAINTIES OF THE RESEARCH.

A certain amount of uncertainty was realised to exist in the results of the practical research for the following reasons.

a. The survey only covers a relatively small industrial area within South Africa.

b. The analysis procedure adopted has a number of intrinsic limitations. They concern the following issues.

   - The thesis topic chosen.

- The survey method chosen (i.e. the choice of a questionnaire survey.)
- The distribution of the questionnaire.
- The human nature of the respondents.

Project appraisal is not an exact science. The intention of this research has therefore been to highlight strong and extensive trends and not the minor variations. As such, possible errors due to uncertainty are envisaged as being minor.

6.3 Comparisons between literature and practice.

The comparative analysis between practice and the views of literature have resulted in the following conclusions:

a. The conducting of operational suitability and technical feasibility studies are just as necessary to successful project appraisal as the conducting of financial viability studies.

b. The use of formal appraisal techniques for all of these studies is positively related to success.

c. The most comprehensive financial analysis techniques are those requiring the most effort to implement. As such, implementation of a successful option depends on choosing one sufficiently comprehensive for the complexities of the particular project involved, but which requires minimum effort.

d. The actual use of formal techniques in financial viability studies is extensive within the South Western Cape. The most popular techniques are simple summation and ratio techniques (e.g. ROI and trading profit) and discounted summation and ratio techniques (e.g. net present value and

internal rate of return). Trends highlighted include the following.

- Simple summation techniques tend to be more often used in average value projects (between R100 000 and R1 million).

- Subjective financial analysis techniques (e.g. gut feel) tend to be more used in longer projects (duration > 3 years).

- Development/design projects use formal techniques infrequently.

- Construction projects tend to use discounted cashflow analysis without sensitivity analysis more frequently.

- General engineering projects tend to employ sensitivity analysis more frequently.

e. Considering the success of projects using formal techniques, their application does not seem to be sufficiently frequent in operational suitability and technical feasibility studies. The reason for such a phenomenon is attributed to a lack of knowledge of suitable techniques available.

Areas where such techniques are practically shown to be used more extensively are the following

- Research and general engineering projects.

- High value projects (Financial value > R1 million).

- Long duration projects (Duration > 1 year).

f. Project characteristics exert a large influence on the suitability of particular methods of appraisal. Such a phenomenon offers a possible explanation as to why the survey data is so varied on certain issues under scrutiny.

6.4 A preferred approach to appraisal.

Consensus between the views expressed by literature and the occurrences of practice was not found to exist on all issues investigated. It has, however, been possible to discern a logical overall approach to appraisal. This approach is detailed in section 7.1 of the thesis, as recommendations to the practicioner.

7. RECOMMENDATIONS

The recommendations arising from this research have been divided into two sections according to their target audience. Recommendations of the first section are intended as an aid to organisations practically involved in project appraisal while those of the second section are intended as suggestions for further research.

7.1 RECOMMENDATIONS TO PRACTICIONERS

These recommendations take the form of a set of guidelines that can be followed in conducting appraisal. Although they have not been conclusively proven, they are the results of using sound logic to evaluate the views expressed by literature and practice within the South Western Cape. As such, they can be deemed to possess a certain respectability. They are expressed in points of recommendation below.

a. A project's characteristics influence the effectiveness of using particular appraisal methods. It is therefore recommended that care be taken not to generalise too freely as to the applicability of a particular method with respect to all projects.

b. It is recommended that appraisal be conducted as the first step in a project to be followed by planning.

c. It is also recommended that it be conducted in at least three seperate studies, namely an operational suitability study, a technical feasibility study and a financial viability study.

d. It is further recommended that the chronological order of conducting these studies be that of firstly conducting an operational suitability study, then conducting a technical feasibility study and finally conducting a financial viability study.

e. In this connection it is also recommended that formal objective techniques be utilised in all three of the studies wherever possible.

f. Finally, it is recommended that a balanced input to appraisal be received from the technical, the project management and the financial/admin disciplines of an organisation.

7.2 RECOMMENDATIONS FOR FURTHER RESEARCH

a. In the conclusions it was noted that project characteristics exert considerable influence on the suitability of particular appraisal methods. With the size of database presently available, however, it has not been possible to elaborate on this influence. It is therefore recommended that, if this issue is of interest, the present database be extended sufficiently to allow meaningful contingency analysis and log-linear modelling to be conducted using two input variables and one response variable. In this way, it will be possible to compare each response variable with both an appraisal technique and a characteristic simultaneously in order to establish the usefulness of appraisal methods for projects of particular characteristics.

b. In the survey conducted for this thesis a number of formal techniques were highlighted as being used in operational suitability and technical feasibility appraisal studies. The applicability of some techniques named by respondents to the practical survey are, however, questionable. It is therefore suggested that the area concerning the usage of formal techniques within these studies be considered for further research.

c. It is also suggested that the survey be extended with regard to region. This would allow a far better generalisation to be made with regard to the status quo existing in South Africa.

d. Finally, it is suggested that some further research be conducted using a different approach. In this thesis the intention has been to obtain a relatively superficial impression from as broad a sample as possible. It may now be worth covering the same ground with a different emphasis, namely that of considering fewer organisations, but in more depth. This may involve the adoption of personal interviews instead of a questionnaire.

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APPENDIX A

INDUSTRIAL SURVEY QUESTIONNAIRE

UNIVERSITY OF CAPE TOWN

Department of Mechanical Engineering

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Telephone: (021) 650-3229; Telex: 521439SA
Fax: (021) 650-3240
Head of Department: Assoc. Prof. K F Bennett

24 August 1989

Dear Sir

As part of the ongoing research of the University of Cape Town, the Faculty of Engineering is investigating the use of project management techniques in our local industrial environment. This follows a survey from which it became apparent that this field of engineering management caused the greatest concern to many companies.

The University intends to create a centre of expertise in project management matters for the benefit of local industry. In order for our post-graduate students to validate their theoretical research, we are in need of real world information and as such would greatly appreciate your co-operation in completing the attached questionnaire.

As the information we are seeking is important to the study, and as it is desirable to obtain as many samples as possible, we will guarantee confidentiality of any information with which we are provided. Should you feel you know of someone else, possibly in your organisation, who could also contribute to this survey, it would be appreciated if you would either pass the questionnaire on or reproduce it for them.

We would like to begin processing the information by late September and look forward to a reply at your earliest convenience. Enclosed is a stamped self-addressed envelope for returning the completed questionnaire.

Thanking you for your co-operation.

Yours faithfully

Gordon Lister
Senior Lecturer

GUIDELINES FOR COMPLETING THIS QUESTIONNAIRE

1. It is recommended that the person completing this questionnaire have knowledge of the procedures adopted by his/her organisation for appraising a project and/or for planning and controlling time within a project.

2. In order to complete the questionnaire it is required that a range of up to 5 specific industrial projects conducted in the South Western Cape, within the past 10 years, receive focus. (If 5 suitable projects have not been conducted, focus on as many as you can.)

3. It is also recommended that the entire questionnaire be answered for one project at a time. (i.e. Complete the entire questionnaire with respect to one project and then repeat the procedure for any subsequent projects chosen.)

4. Should it not be possible to complete some questions, please do not refrain from completing the rest of the questionnaire and returning it.

5. Should you require clarity on any aspect of this questionnaire please contact either

Antony Möller PH 938 3094 (WORK)
PH 797 8422 (AH)

or

Ian Möller PH 87 3551 (WORK)
PH 797 4621 (AH)

SURVEY ON PROJECT APPRAISAL AND CONTROL

Considering a range of anything up to 5 engineering projects that have been completed in the last approximately 10 years, answer each of the following questions for each project, by placing a number in the block under the appropriate project column.

PROJECT NUMBER

1	2	3	4	5

GENERAL

1. Estimate the number of years ago that each of your selected projects began.

2. Which category below most aptly describes the type of project under consideration in each case? (A project may involve more than one category. Choose the number of the one which most closely describes it.)

   [1] Research project. (Development of a new concept).

   [2] Development/Design project. (Concept already developed. Details of the particular application to be finalised.)

   [3] Construction project. (Building/manufacture of a "one off" design concept).

   [4] Commissioning. (Bringing a system into operation).

   [5] Implementation project. (The construction and commissioning of an industrial process).

   [6] General engineering project (Contains elements of feasibility study, design, construction/manufacture and commissioning with no particular emphasis being placed on any one element).

   [7] Other (specify).....

3. Within which one of the following cost ranges does each of your chosen projects fall?

   [1] R0 - R10 000

   [2] R10 000 - R100 000

   [3] R100 000 - R1 MILLION

   [4] R1 MILLION - R5 MILLION

   [5] > R5 MILLION

4. Into which of the following duration categories do each of the chosen projects fall?

   [1] 0 - 6 MONTHS

   [2] 6 MONTHS - 1 YEAR

   [3] 1 YEAR - 3 YEARS

   [4] 3 YEARS - 5 YEARS

   [5] > 5 YEARS

PROJECT PLANNING AND CONTROL

1	2	3	4	5

5. Apply the scale:-

[1] Not used at all [2] Used on occasions [3] Used extensively

to rate the use of each of the following in controlling time schedule for each of the projects considered.

(a) Informal meetings and "walking around"

(b) Formal general meetings

(c) Regular, formalised reporting

(d) Bar/Gantt charts indicating work durations and % completion

(e) Milestones on a work breakdown structure

(f) PERT/CPM network

(g) Line of balance

(h) Progress "S" curves

(i) An integrated computer-based planning & control package

(j) Other (specify).....

6. Using the following scale :

[1] True [2] False

indicate for your chosen projects whether or not each of the following statements apply to the schedule control techniques you used.

The techniques used were :

(a) so complex that project participants struggled to understand them.

(b) too simple to be an adequate guide for time-schedule control.

(c) so powerful they were generally regarded as being "over-kill" for the project.

(d) specially adapted to meet our specific requirements on the project.

(e) widely accepted by project participants as being meaningful.

(f) structured so that they required minimal effort to institute.

(g) structured so that they required minimal effort to keep up to date.

(h) generally regarded as achieving the required level of schedule control.

(i) integrated with project cost and quality control mechanisms.

(j) applied throughout the full duration of the project.

(k) Other (specify).....

1	2	3	4	5

7. Who would you say is responsible for the planning of the time-schedule control techniques identified in question 5.

   [1] Project manager

   [2] Planning engineer

   [3] Planning department

   [4] Financial department

   [5] An administrative department or person

   [6] Other (specify).....

8. Use the scale:-

   [1] No influence [2] Slight influence [3] Strong influence

   To indicate how strongly each of the following (a - g) affect the choice of time-schedule control technique used to control the projects you have identified?

   (a) Project complexity

   (b) Project type

   (c) Project size

   (d) Management influence

   (e) Intuitive judgement

   (f) Client's contract

   (g) Other (Specify).....

PROJECT APPRAISAL

9. Using the scale : [1] None [2] Brief [3] Average [4] Thorough

   rate the consideration given to each of the following studies (a - c) when appraising the viability of each project.

   (a) Technical feasibility study (i.e. what technical considerations must be allowed for in order to successfully complete the project?).

   (b) Operational suitability study (i.e. will the completed project meet required operating specifications?).

   (c) Financial viability study (i.e. how expensive/profitable will the project be?).

1	2	3	4	5

10. Using the scale:-

    [1] Was considered first

    [2] Was considered second

    [3] Was considered third

    state the chronological order in which each of the studies given below was considered for each project. Should any of the studies not have been considered at all, leave the relevant space blank.

    (a) Technical feasibility study e.g. **2**

    (b) Operational suitability study **1**

    (c) Financial viability study **3**

11. Using the notation: [1] Yes [2] No

    state whether or not any formal techniques were used to appraise either the technical feasibility or the operational suitability of your chosen projects.

12. If your answer to the above question was "yes" for any of your chosen projects, please state the techniques used in the spaces provided below and show to which projects they apply by using the notation:

    [1] Used [2] Not used

    in the blocks provided for each project.

    Technical feasibility

    (a) .....

    (b) .....

    Operational suitability

    (a) .....

    (b) .....

	1	2	3	4	5
13. Using the notation : [1] Used [2] Not used					
decide whether or not each of the following categories of techniques were used to assess the financial viability of each of your chosen projects					
CATEGORIES / EXAMPLES OF TECHNIQUES					
(a) Subjective techniques — gut feel/intuitive preference					
(b) simple summation techniques — Trading profit					
(c) simple ratio techniques — Return on investment; Return on capital employed; Return on sales income; Payback time					
(d) summation techniques using discount rate — Net present value					
(e) ratio techniques using discount rate — Internal rate of return; Overall rate of return; Present value index					
(f) Techniques involving sensitivity analysis — Monte Carlo simulation; Re-iteration of the NPV technique for discrete variations of each project					
(g) Other (specify).....					
14. Using the scale: [1] None; [2] Below average; [3] Average; [4] Above average; [5] Extremely high					
rate the contribution made by each of the following disciplines in your organisation, in appraising each project. (NOTE: contributions by top management can be broken down into the backgrounds of the personnel at that level.)					
(a) Marketing					
(b) Accounting					
(c) Administration					
(d) Engineering / Technical					
(e) Project Management					
(f) Other (specify)					

PROJECT PERFORMANCE

1	2	3	4	5

15. Using the following scale as a measure of project performance;

[1] Exceeded all expectations

[2] Exceeded some expectations

[3] Met most expectations

[4] Could not meet some expectations

[5] Could not meet any expectations

how successful would you say each project was in terms of;

(a) Meeting budget costs

(b) Meeting time schedule

(c) Meeting technical requirements

****

- Please note that this questionnaire may remain anonymous should you so wish.

- If, however, you are able to supply your name and the name of the organisation in which you are currently employed, please do so in the space below. This information will still remain confidential but will enable us to correlate industrial trends.

  Your Name: .....

  Organisation Name: .....

- If you would be available for a short interview (should it prove necessary), could you please supply your telephone number in order for us to arrange a meeting at your convenience.

  Tel Number: .....

APPENDIX B

RAW SURVEY DATA

SURVEY QUESTION NUMBERS

Proj No.	1	2	3	4	9a	9b	9c	10a	10b	10c	11	12t	12o	13a	13b	13c	13d	13e	13f	13g	14a	14b	14c	14d	14e	14f	15a	15b	15c
1	2	6	5	3	4	4	4	1	2	3	1	1	1	2	1	1	2	2	2		2	1	2	5	4		2	4	1
2	4	3	4	2	4	3	4	0	0	0	2			2	1	1	2	2	2		1	3	4	4	4		2	4	3
3	5	3	4	1	4	3	3	0	0	0	2			2	1	1	2	2	2		1	3	3	5	4		4	4	3
4	5	3	3	1	3	3	2	0	0	0	2			1	1	1	2	2	2		1	3	3	4	4		3	4	3
5	6	3	5	3	4	4	3	0	0	0	2			2	1	1	2	2	2		1	3	4	4	4		4	1	2
6	1	3	4	3	3	2	4	1	3	2	2			1	1	1	2	2	2		1	1	2	5	4		3	4	3
7	3	2	3	3	4	4	4	1	2	3	1	1	1	2	2	2	1	2	2	1	3	3	3	4	3		3	2	3
8	3	2	3	3	4	4	4	1	2	3	1	1	1	2	2	2	1	2	2	1	3	3	3	4	3		3	2	3
9	2	6	2	2	4	4	4	1	2	3	1	1	1	2	2	2	1	2	2	1	2	3	3	5	1		3	2	3
10	3	3	4	3	4	4	4	3	2	1	2			1	1	2	2	2	2		4	5	5	3	4		3	3	1
11	2	6	5	2	4	4	4	2	3	1	1	1	1	1	1	1	2	2	2		1	4	4	5	4		2	2	2
12	4	3	4	2	2	3	2	2	1	3	1	1	1	1	2	2	2	2	2		1	3	4	5	3		4	5	3
13	1	3	3	1	2	1	3	1	0	2	2			2	1	2	2	2	2		1	1	3	1	3		2	4	0
14	1	2	3	1	2	2	4	1	2	3	2			2	1	2	2	2	2		1	1	3	1	3		2	2	0
15	6	6	4	3	4	4	3	1	2	3	2			1	1	1	2	2	2		1	2	1	5	5		3	3	3
16	3	6	4	3	3	3	3	1	2	3	2			1	2	2	2	2	2		1	1	1	5	5		2	4	3
17	4	6	3	3	4	4	3	1	2	3	2			1	2	2	2	2	2		1	1	1	5	5		3	3	1
18	7	6	5	3	3	3	3	1	2	3	2			1	2	2	2	2	2		1	1	1	5	5		3	3	3
19	9	5	5	4	4	4	3	2	1	3	2			1	1	1	2	2	2		2	2	1	5	5		3	3	2
20	6	3	3	2	3	4	4	1	2	3	2			1	1	1	1	2	2		3	4	4	3	3		3	3	3
21	7	5	3	2	3	3	4	2	1	3	2			1	1	1	1	2	2		4	2	4	4	3		4	3	4
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SURVEY QUESTION NUMBERS

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SURVEY QUESTION NUMBERS

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159	3	1	2	2	4	4	4	1	2	3	2			1	2	1	2	2	2		3	2	2	4	4		1	2	2
160	2	6	3	2	4	4	4	1	2	3	1			1	2	1	2	2	2		3	2	2	4	4		2	2	3
161	1	2	2	1	4	4	4	1	2	3	1			1	2	2	2	2	2		3	2	2	4	4		3	2	3
162	2	6	3	2	4	4	3	1	2	3	2			1	1	1	2	2	2		2	2	3	4	4		3	4	2
163	9	5	5	3	4	4	4	2	1	3	2			2	2	1	1	1	2		3	4	4	5	5		3	1	2
164	3	3	4	3	4	4	4	3	1	2	2			1	2	1	1	1	2		2	3	4	5	5		4	4	3
165	2.5	3	3	3	3	4	3	2	1	3	1			2	1	2	2	2	2		2	1	1	5	5		3	5	2
166	3	6	4	2	4	3	4	3	2	1	2			2	2	1	2	2	2		4	1	1	5	5		3	4	3

SURVEY QUESTION NUMBERS

Proj No.	1	2	3	4	9a	9b	9c	10a	10b	10c	11	12t	12o	13a	13b	13c	13d	13e	13f	13g	14a	14b	14c	14d	14e	14f	15a	15b	15c
167	5	6	5	4	4	4	4	3	2	1	1			2	2	1	2	2	2		4	1	1	5	5		3	3	3
168	3	3	2	1	4	3	4	2	3	1	2			2	2	1	2	2	2		2	1	1	5	5		2	2	3
169	4	3	3	3	3	4	3	1	2	3	1			1	2	2	2	2	2		2	1	1	5	5		2	4	3
171	1	6	2	1	2	3	3	3	1	2	2			2	2	1	2	2	2		4	2	2	4	4		3	3	3
172	1	2	3	1	2	3	3	3	1	2	2			2	2	1	2	2	2		3	2	2	4	4		3	3	3
173	1	3	3	1	2	3	3	3	1	2	2			0	0	0	0	0	0		3	2	3	4	4		3	3	3
174	3	4	2	3	4	4	4	2	1	3	2			2	2	1	2	2	2		1	2	1	5	1		3	4	3
175	1	3	2	1	3	3	3	2	1	3	2			1	1	2	2	2	2		1	2	1	5	1		3	3	2

B.2: OPERATIONAL SUITABILITY AND TECHNICAL FEASIBILITY STUDIES

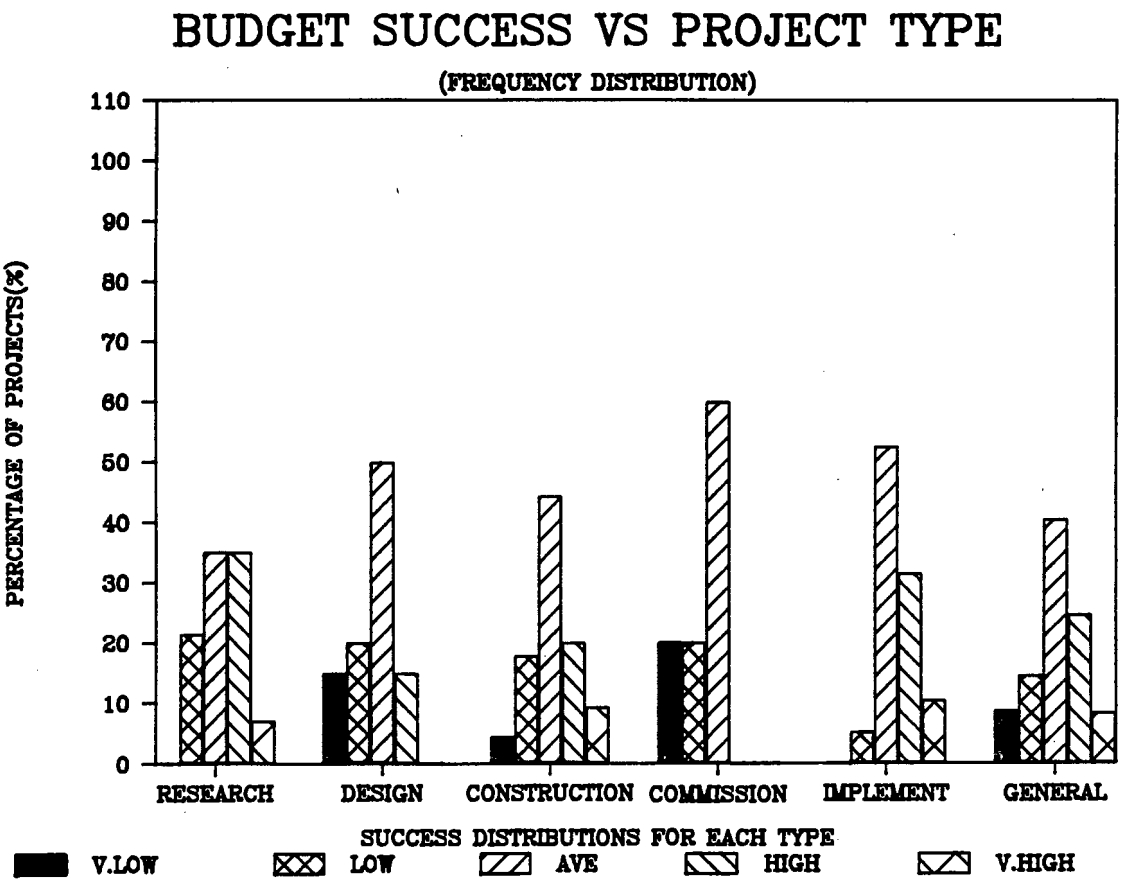
The following is a list of the techniques that respondents suggested to be operational suitability and technical feasibility studies in the industrial survey.

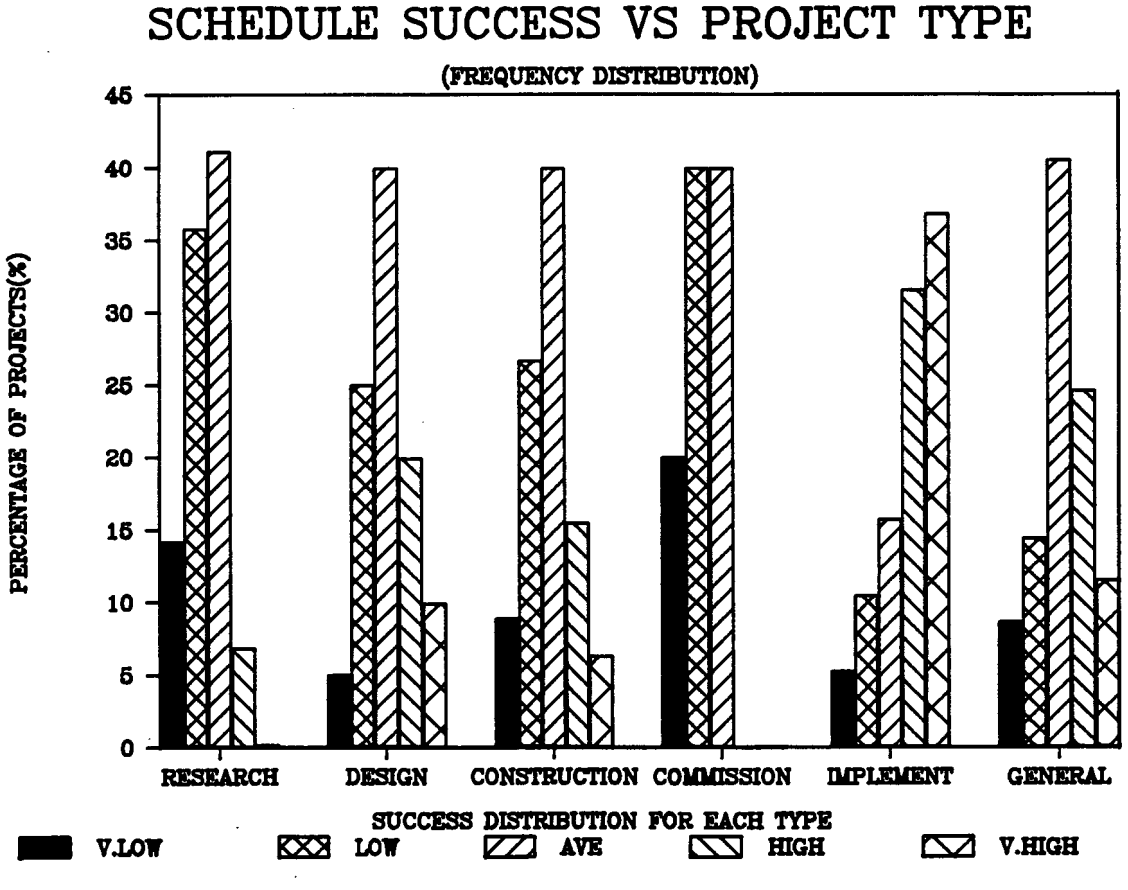
1. Scope Reporting
2. Optimise maximum output from plant
3. ASIB & NFPA
4. Haylett escalation
5. Self help housing
6. Scheduling techniques
7. Design criteria applied
8. Operational criteria applied
9. Hazard and Operability (HAZOP) study
10. Test site
11. Time and motion study
12. Project specifications
13. Quality acceptance tests
14. Operational breakdown and time estimates
15. Design meetings / visiting similar plants
16. Layout meetings / HAZOP studies
17. Production
18. Value analysis
19. Mathematical modelling
20. Reliability analysis / Computer aided system effectiveness modelling
21. Logistitions and Documentation department
22. Design to Cost
23. Project manager and project engineer
24. Small scale pre-production testing / Structuaral development detailed modelling / Technical performance monitoring
25. Principle contractor
26. Performance analysis
27. Comparative cost
28. Redundancy cost / potential cost of component failure

It is clear that several of these responses are not valid. As such, it is assumed that question 12 of the industrial survey has been misunderstood in a number of cases.

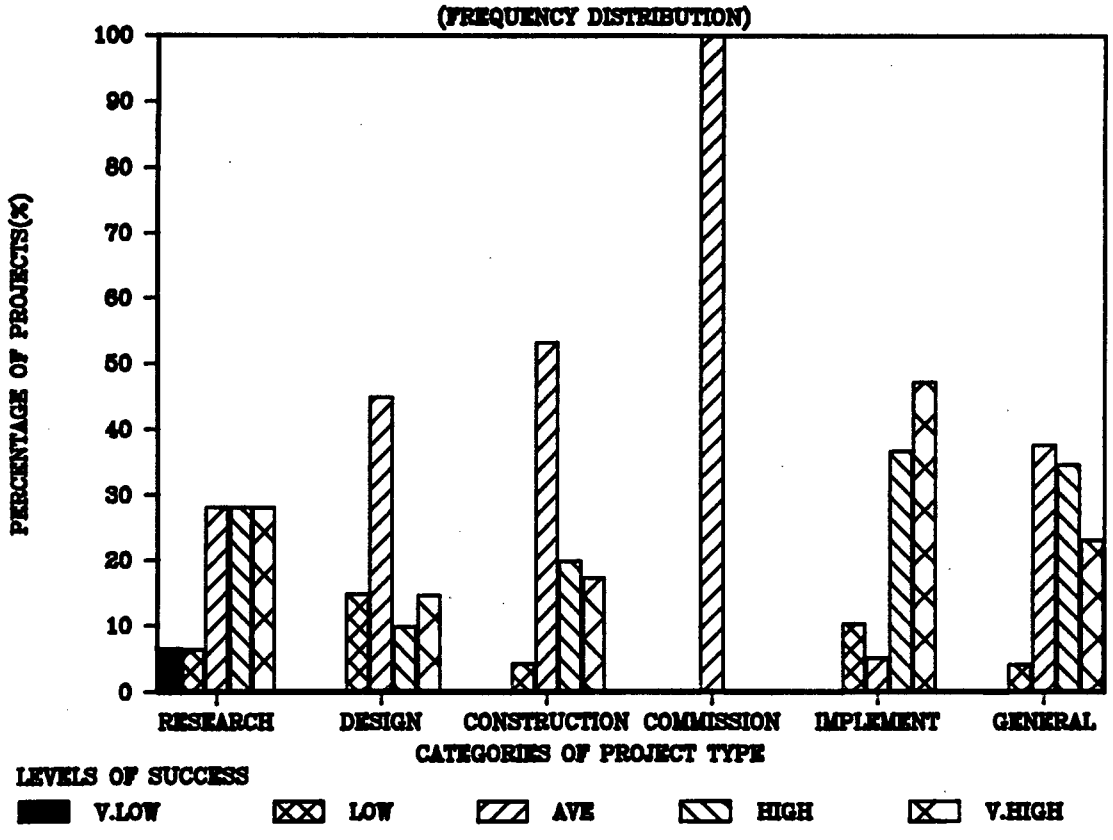
APPENDIX C

GRAPHICAL RESULTS

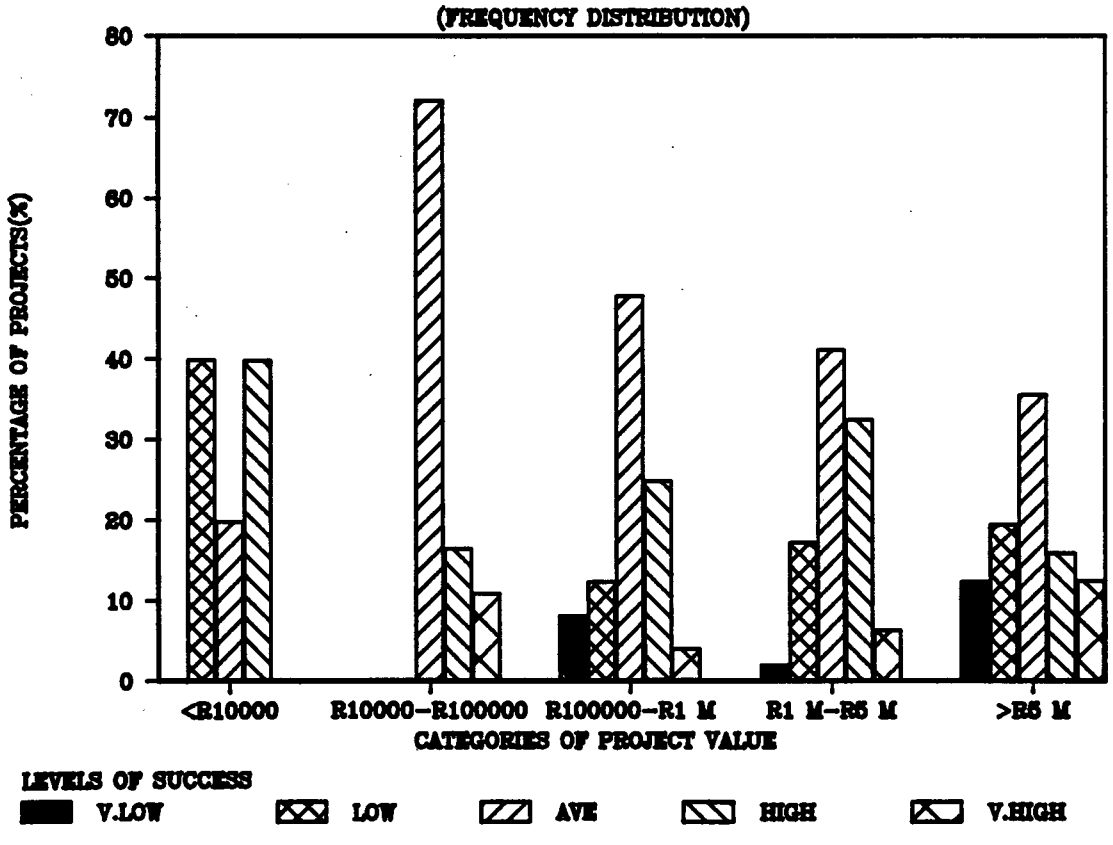

BUDGET SUCCESS VS PROJECT TYPE
(FREQUENCY DISTRIBUTION)
PERCENTAGE OF PROJECTS(%)
110
100
90
80
70
60
50
40
30
20
10
0
RESEARCH
DESIGN
CONSTRUCTION
COMMISSION
IMPLEMENT
GENERAL
SUCCESS DISTRIBUTIONS FOR EACH TYPE
V.LOW
LOW
AVE
HIGH
V.HIGH


SCHEDULE SUCCESS VS PROJECT TYPE
(FREQUENCY DISTRIBUTION)
PERCENTAGE OF PROJECTS(%)
45
40
35
30
25
20
15
10
5
0
RESEARCH
DESIGN
CONSTRUCTION
COMMISSION
IMPLEMENT
GENERAL
SUCCESS DISTRIBUTION FOR EACH TYPE
V.LOW
LOW
AVE
HIGH
V.HIGH

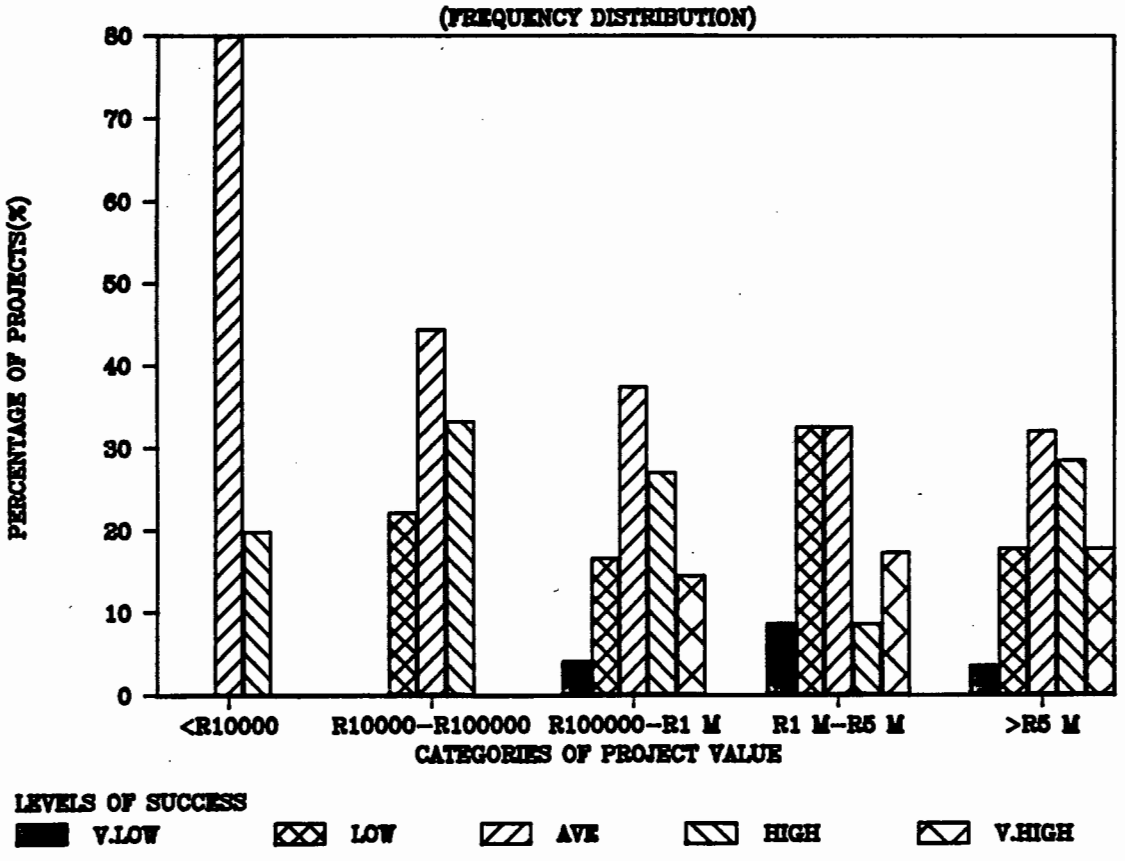
TECHNICAL SUCCESS VS PROJECT TYPE



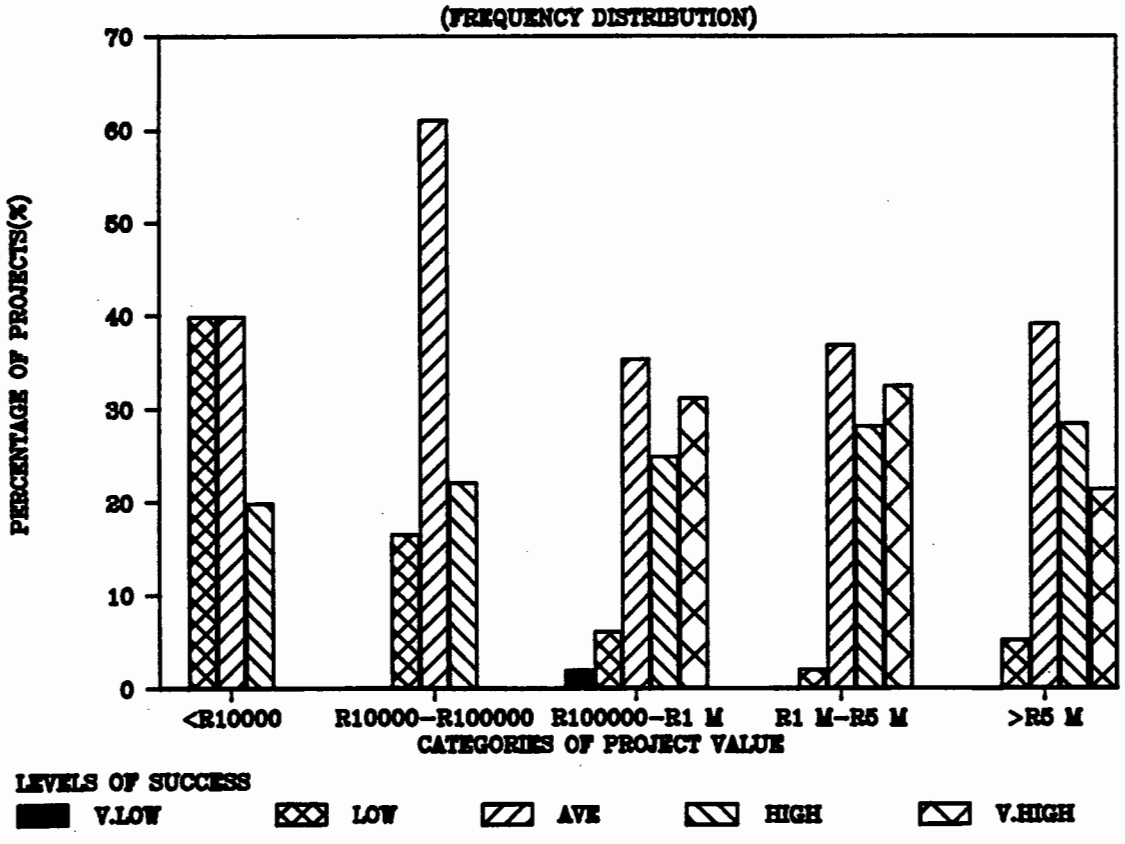
BUDGET SUCCESS VS PROJECT VALUE



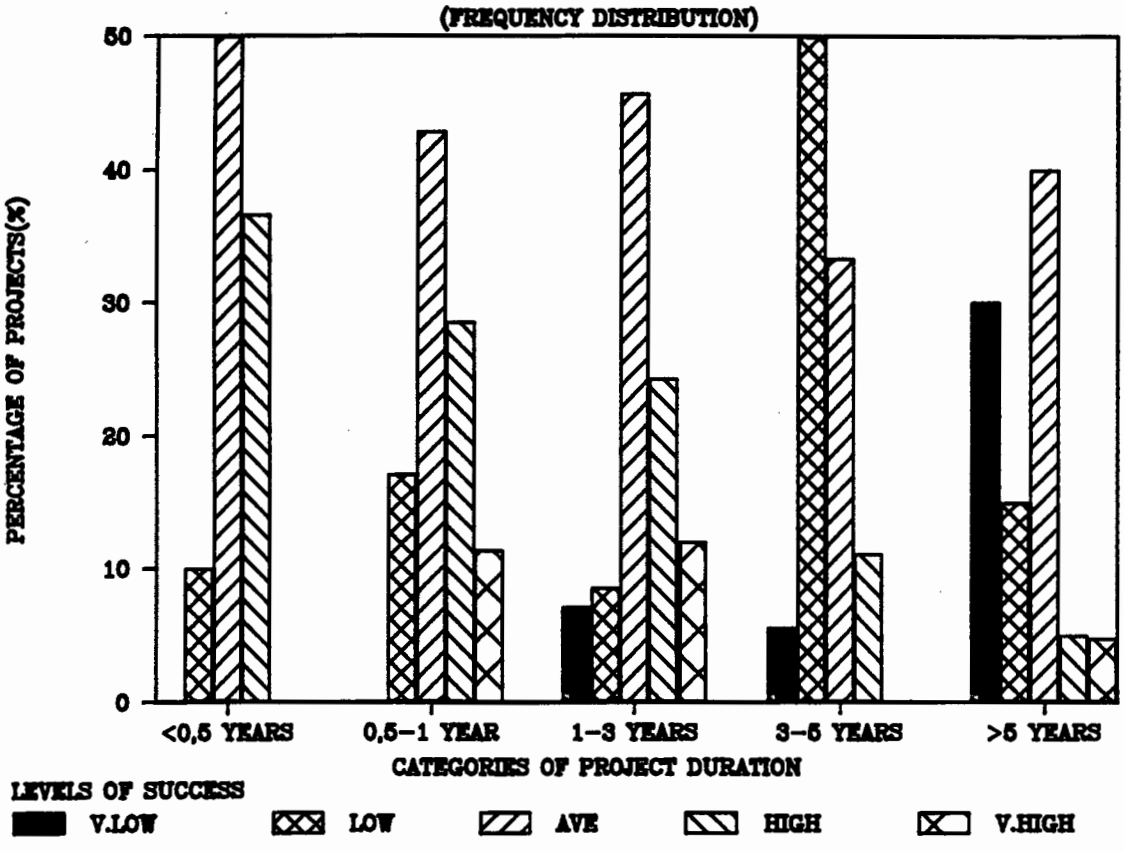
SCHEDULE SUCCESS VS PROJECT VALUE



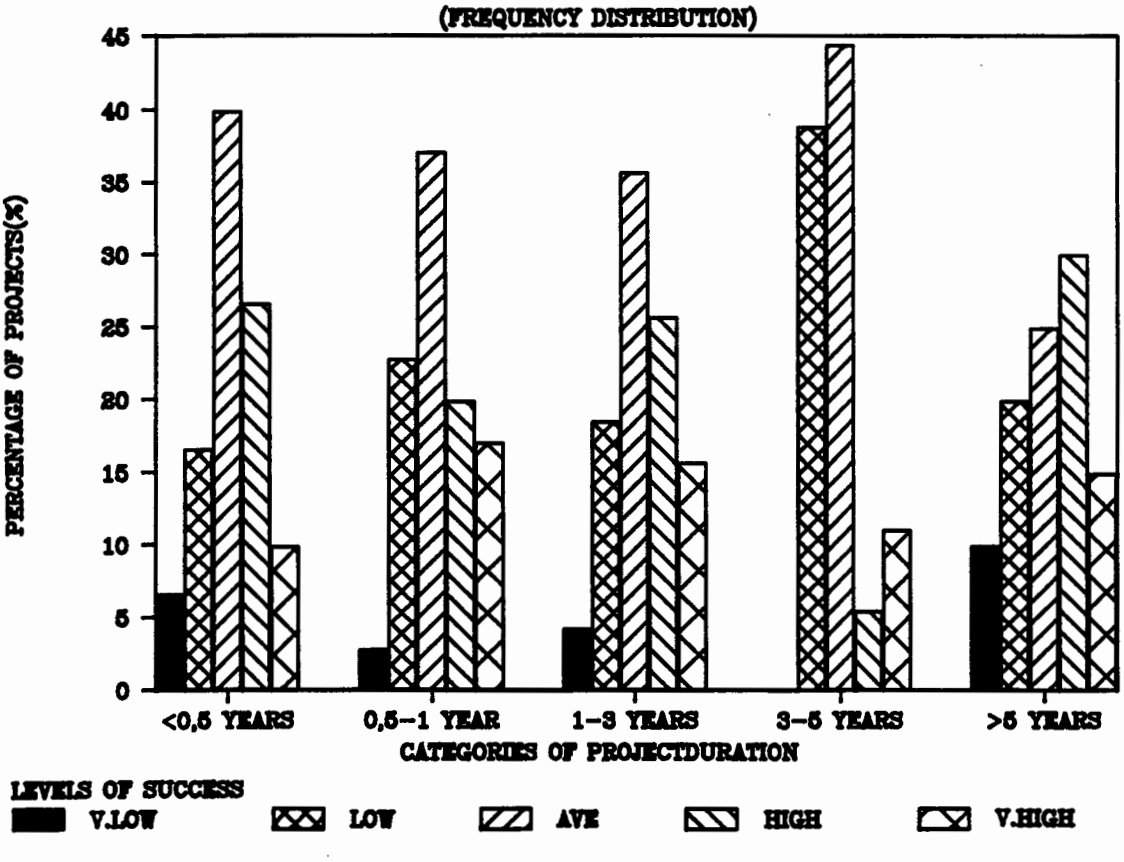
TECHNICAL SUCCESS VS PROJECT VALUE



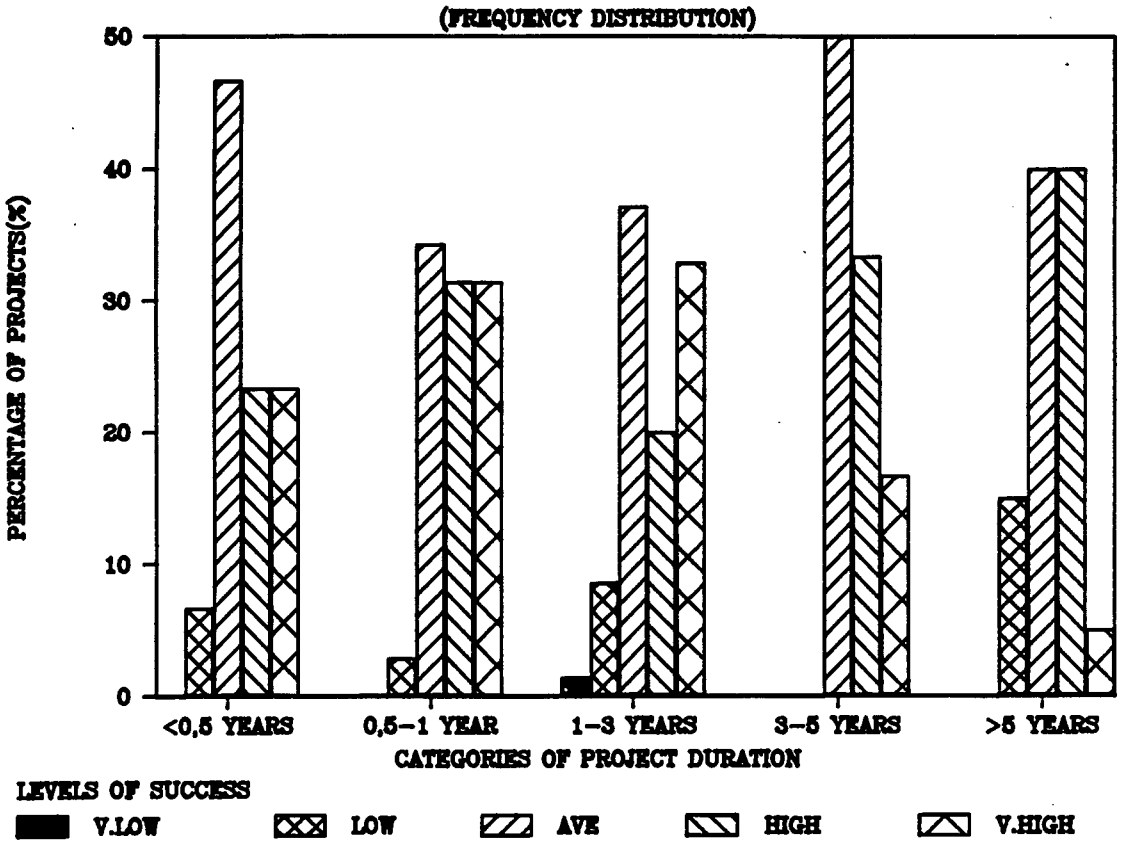
BUDGET SUCCESS VS PROJECT DURATION



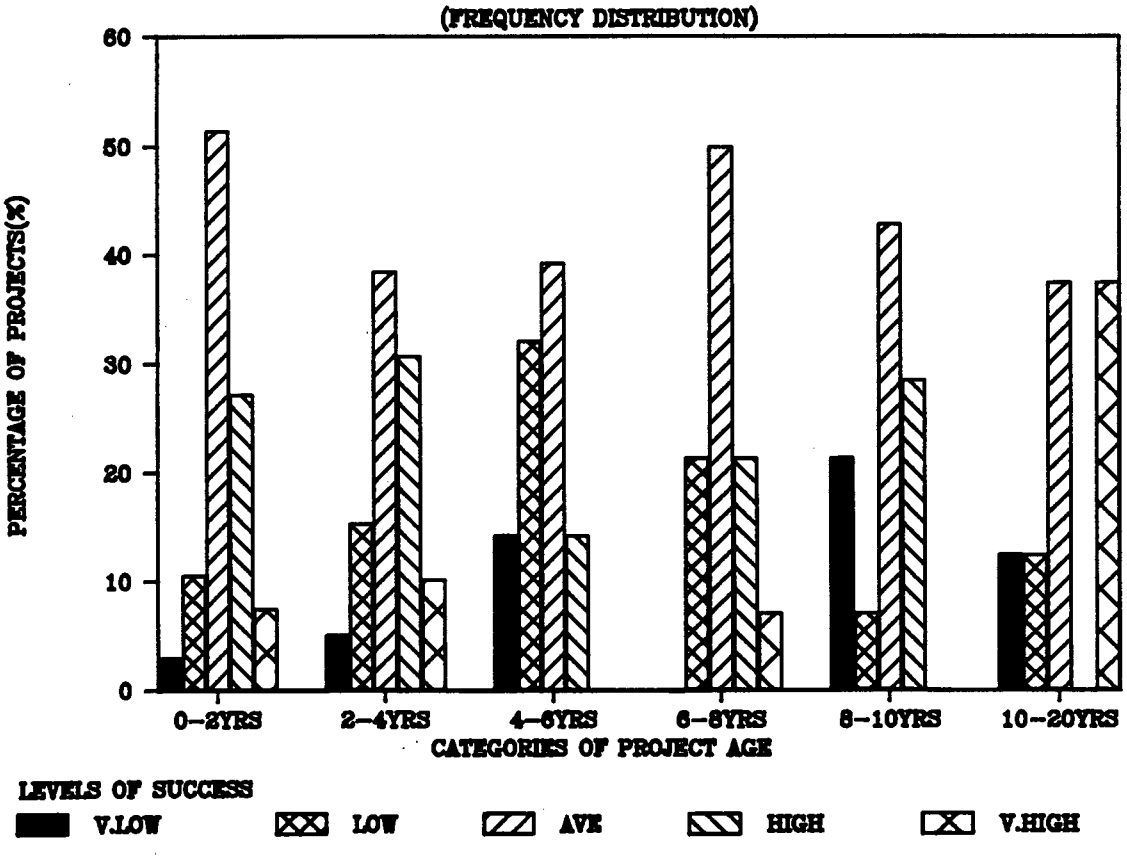
SCHEDULE SUCCESS VS PROJECT DURATION



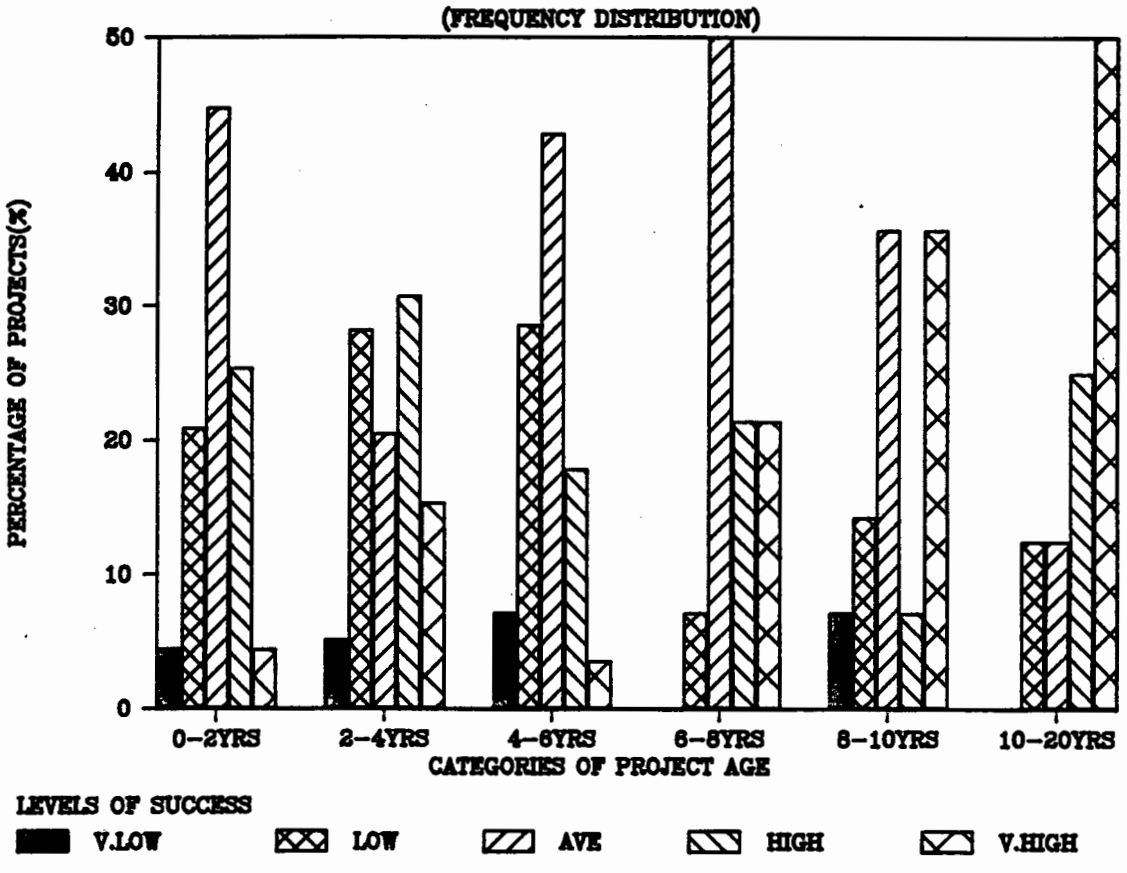
TECHNICAL SUCCESS VS PROJECT DURATION



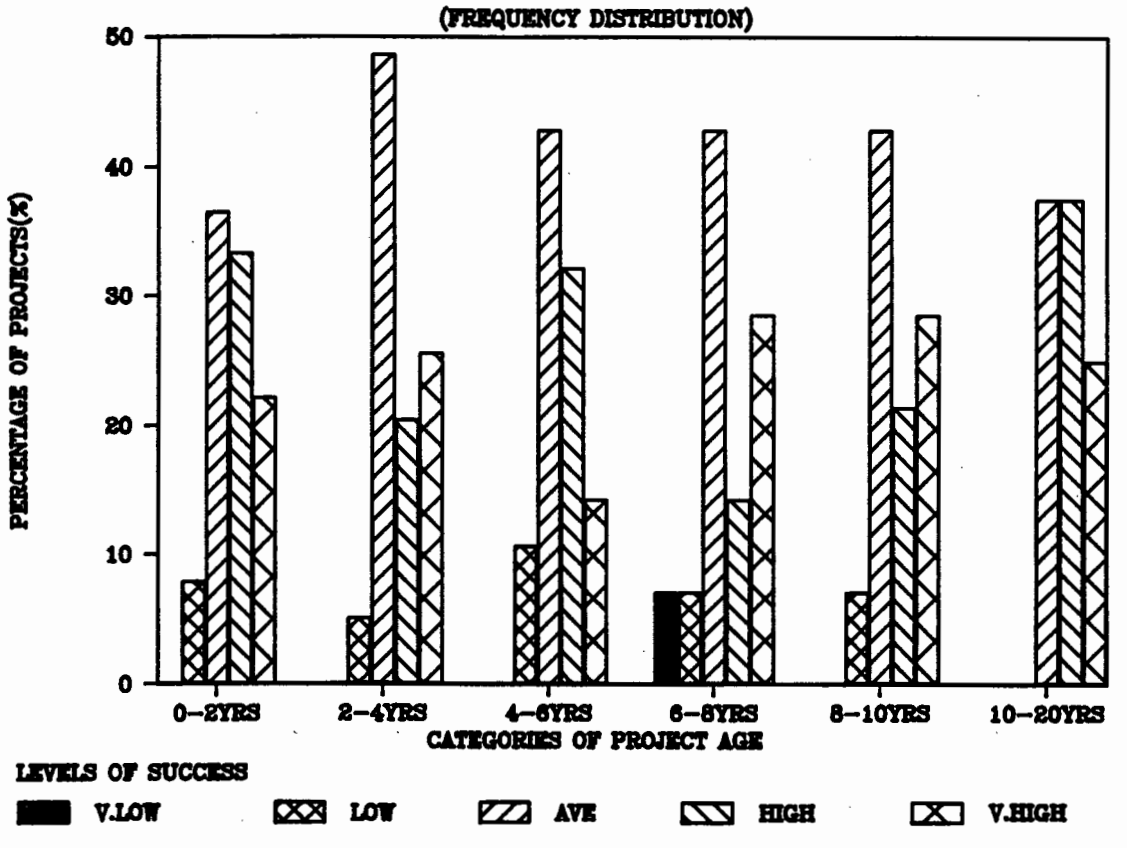
BUDGET SUCCESS VS PROJECT AGE



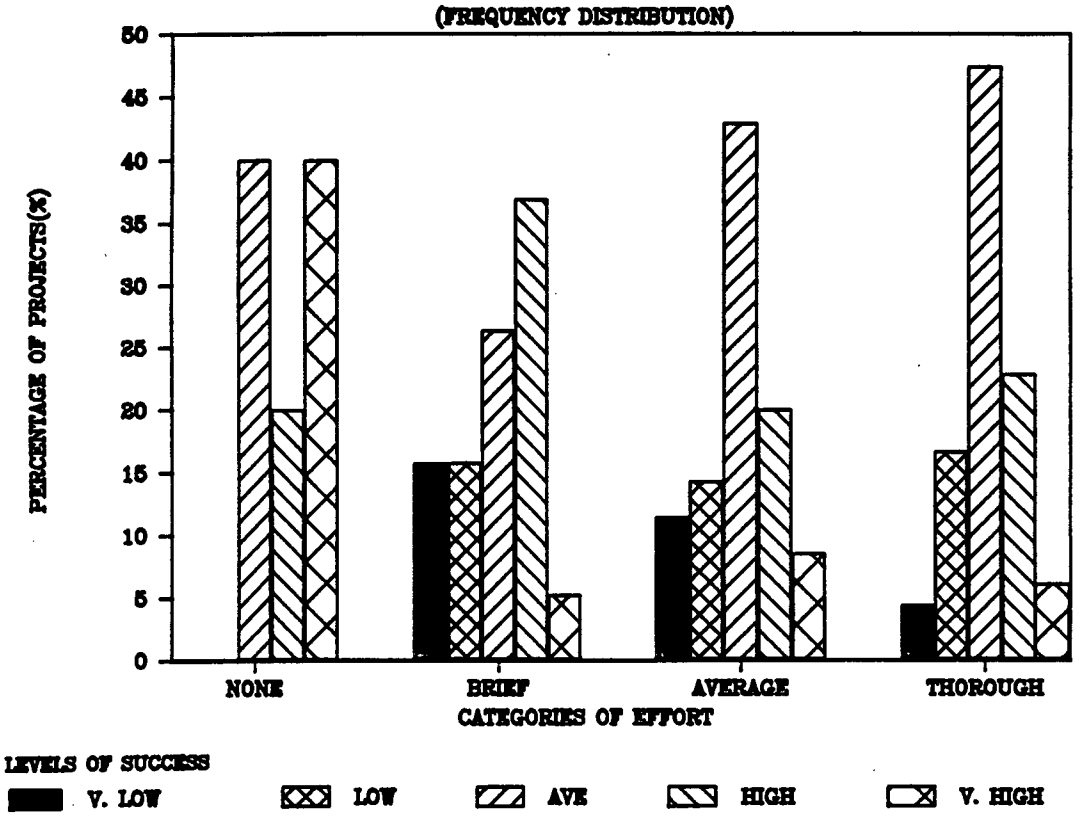
SCHEDULE SUCCESS VS PROJECT AGE



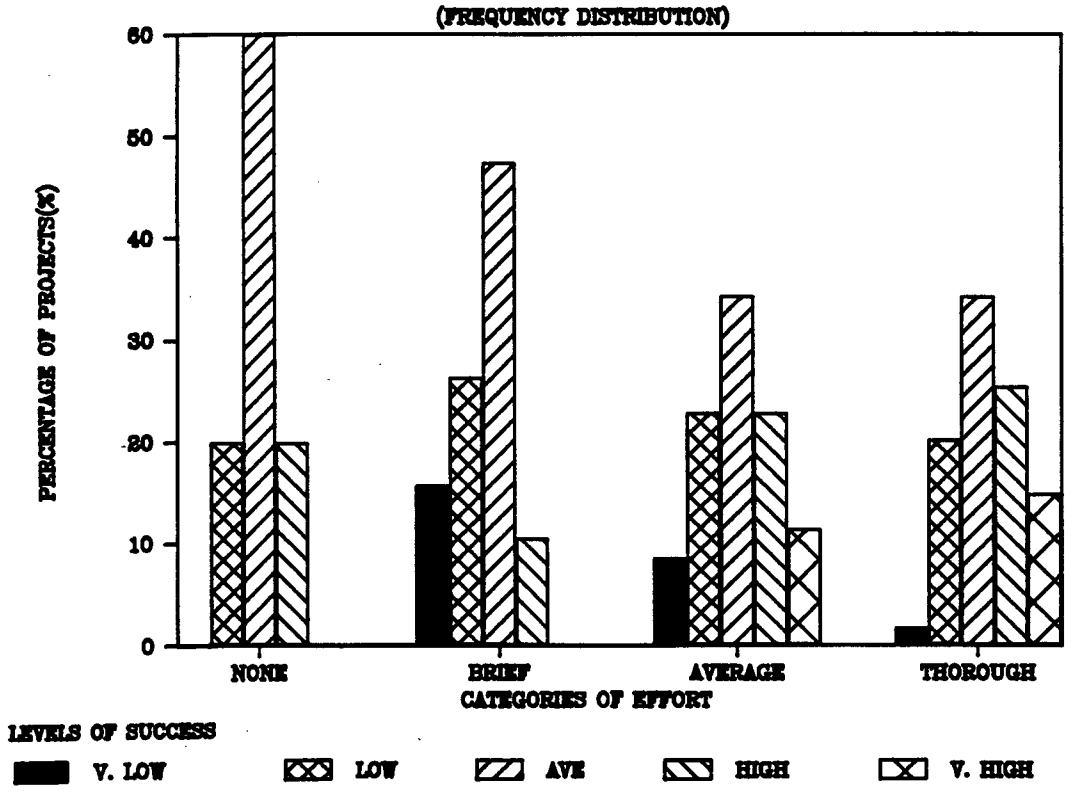
TECHNICAL SUCCESS VS PROJECT AGE



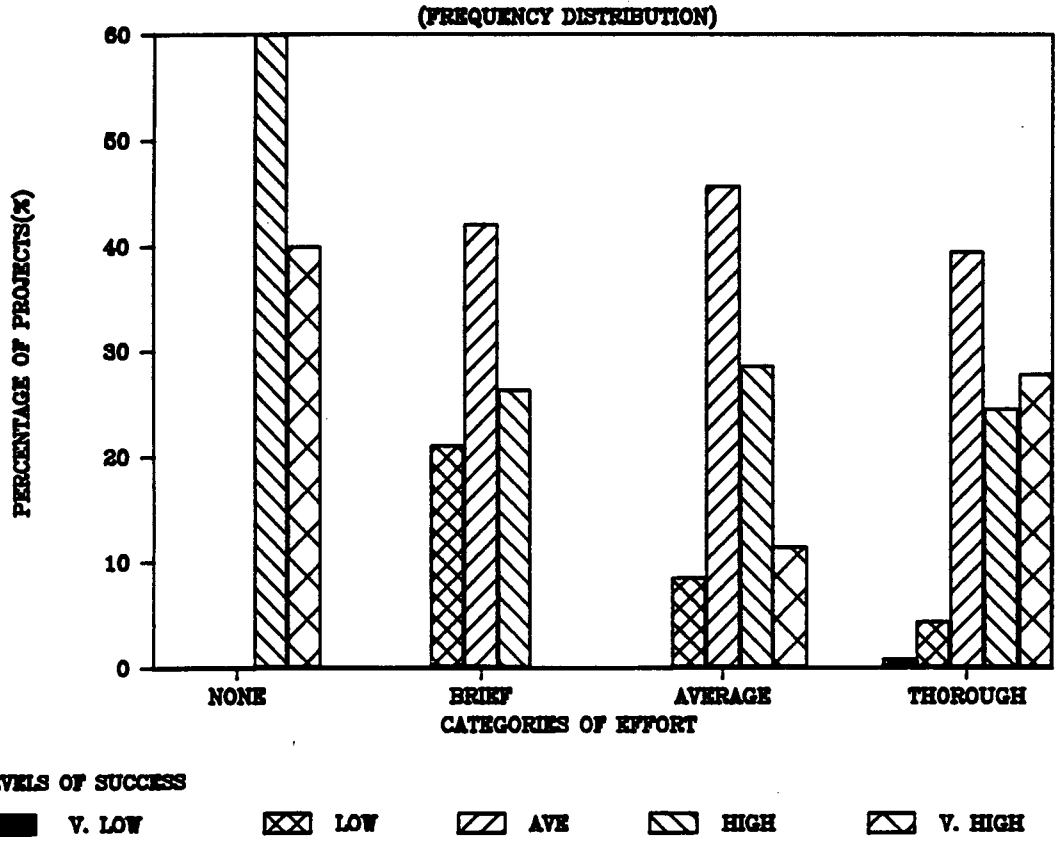
BUDGET SUCCESS VS EFFORT ON TECHNICAL STUDIES



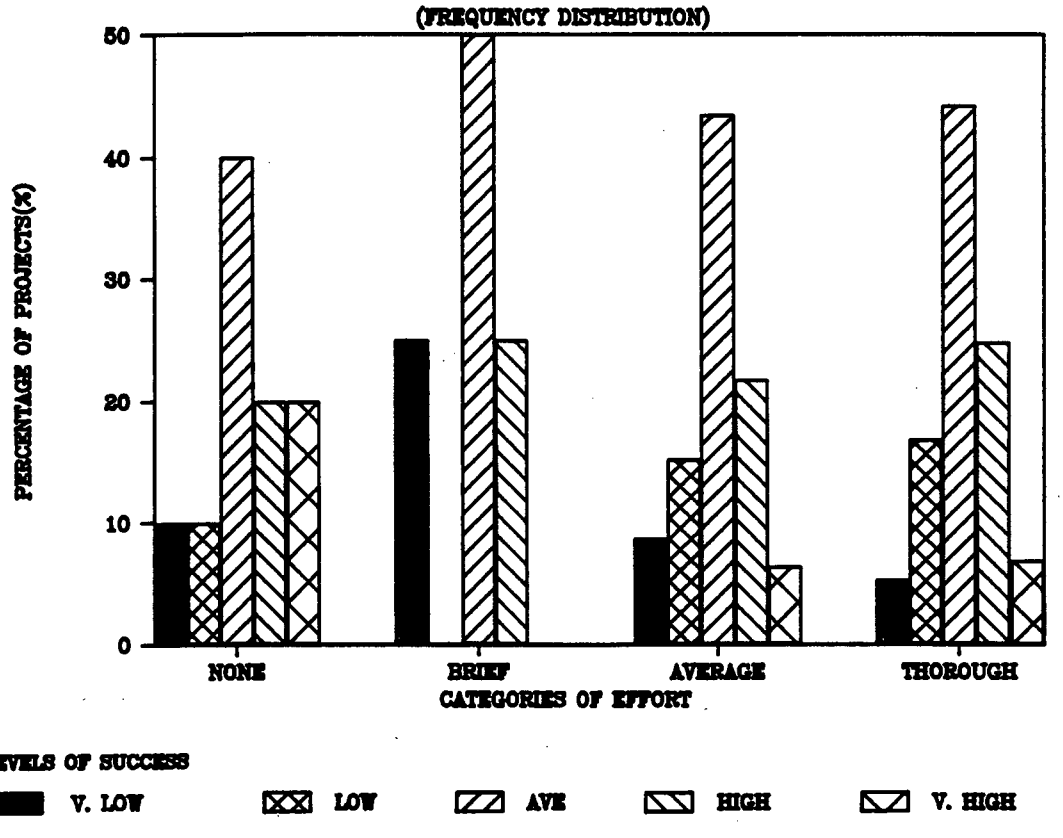
SCHEDULE SUCCESS VS EFFORT ON TECHNICAL STUDIES



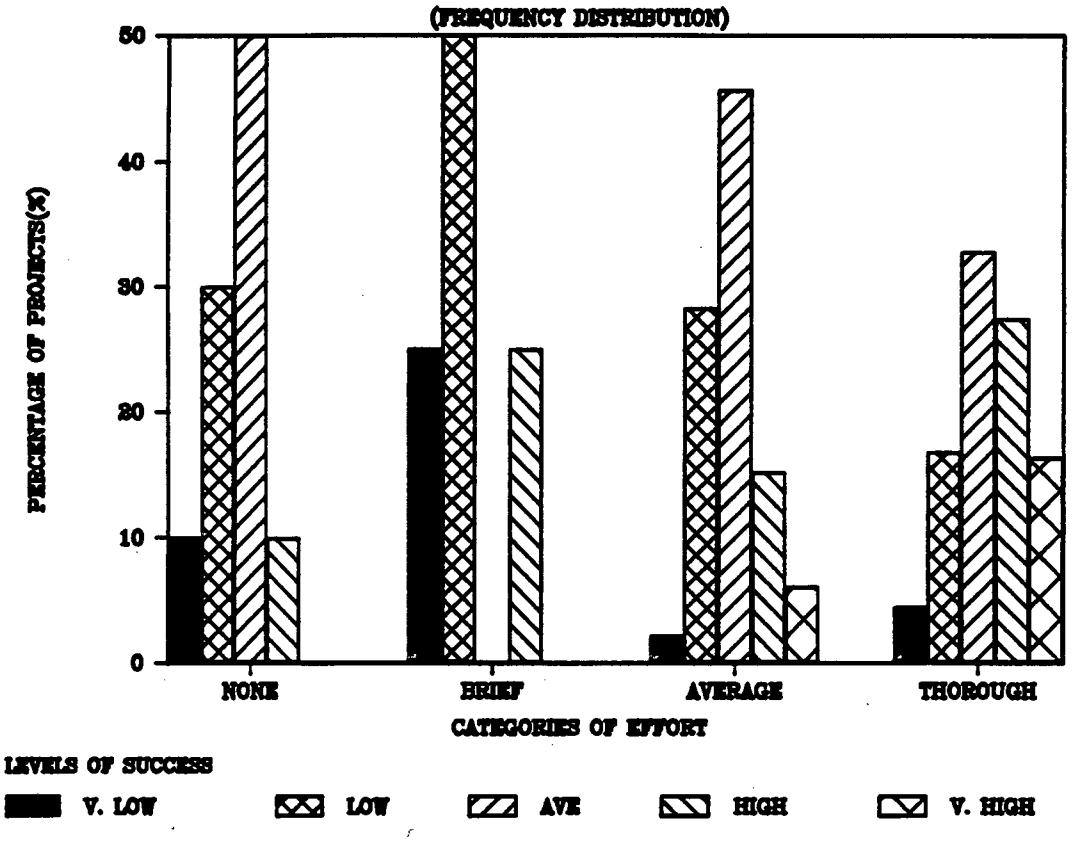
TECHNICAL SUCCESS VS EFFORT ON TECHNICAL STUDIES



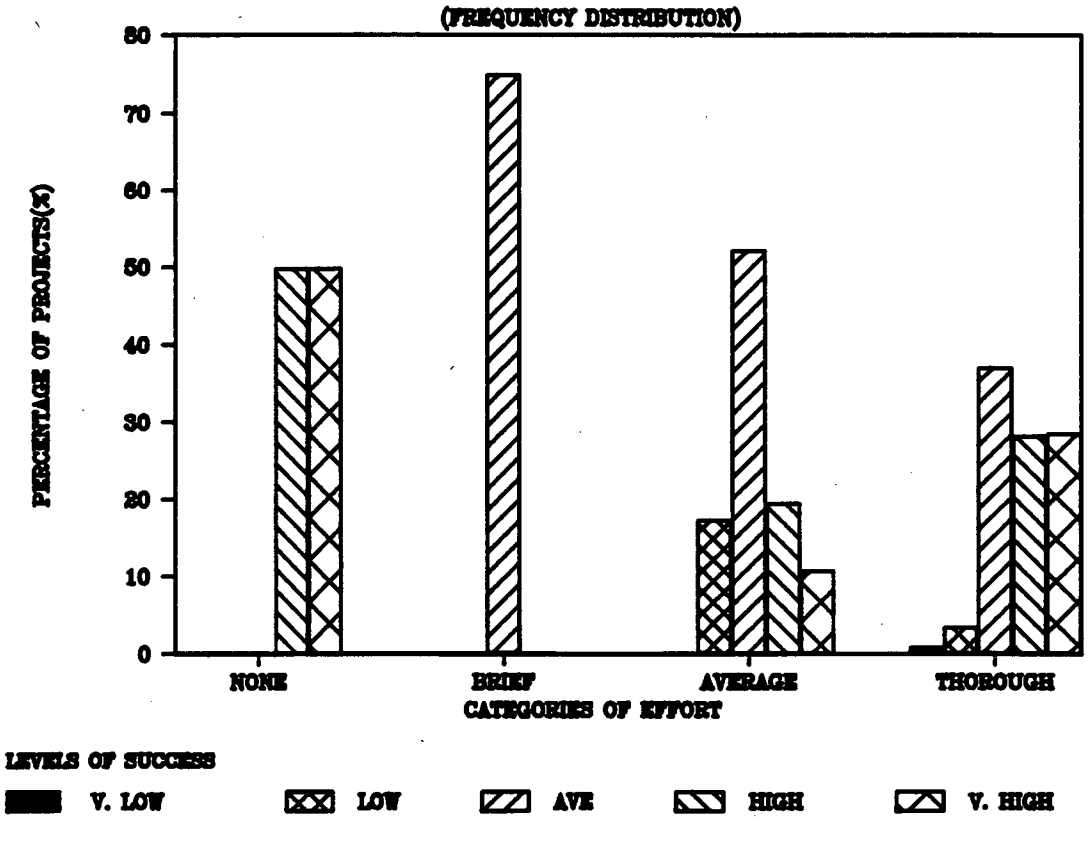
BUDGET SUCCESS VS EFFORT ON OPERATIONAL STUDIES



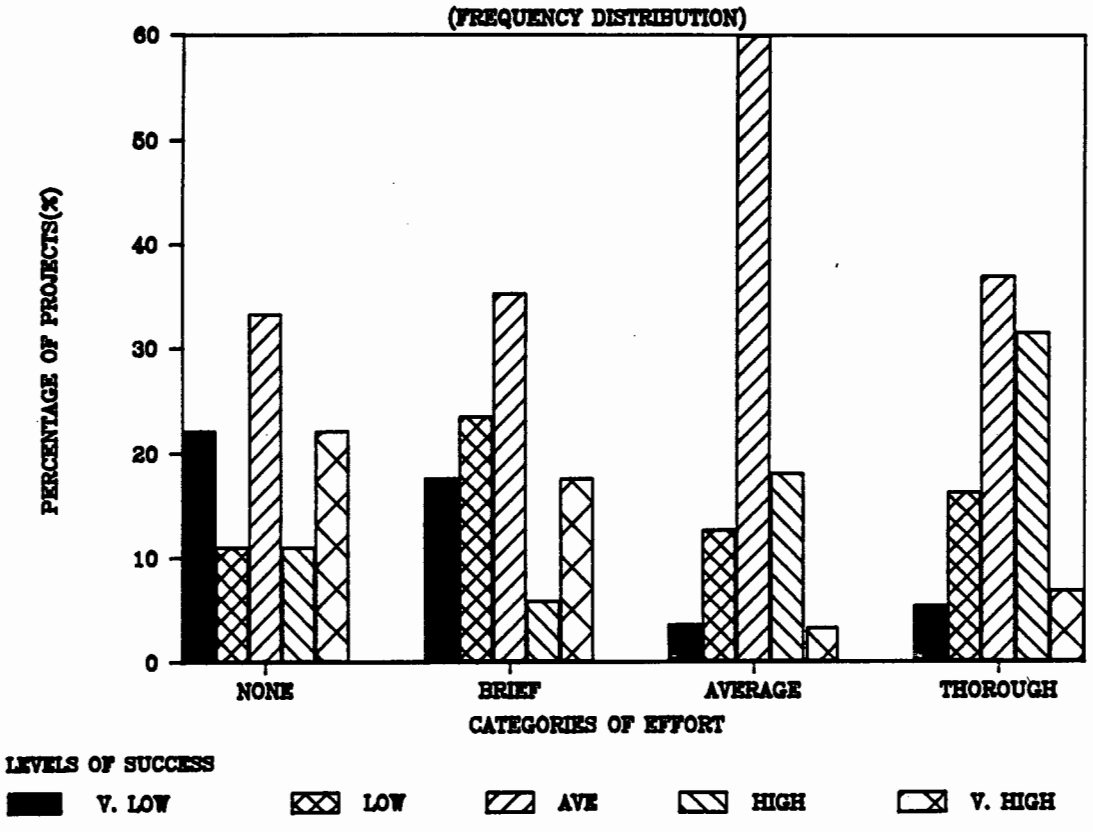
SCHEDULE SUCCESS VS EFFORT ON OPERATIONAL STUDIES



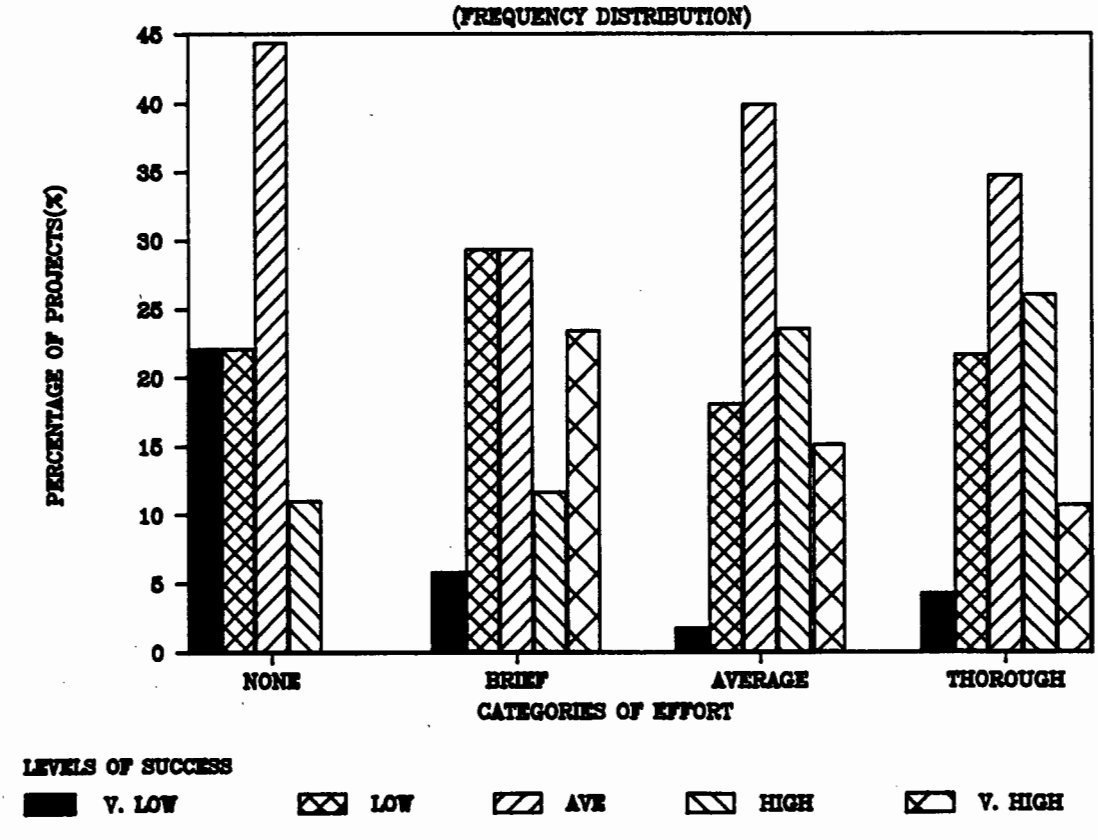
TECHNICAL SUCCESS VS EFFORT ON OPERATIONAL STUDIES



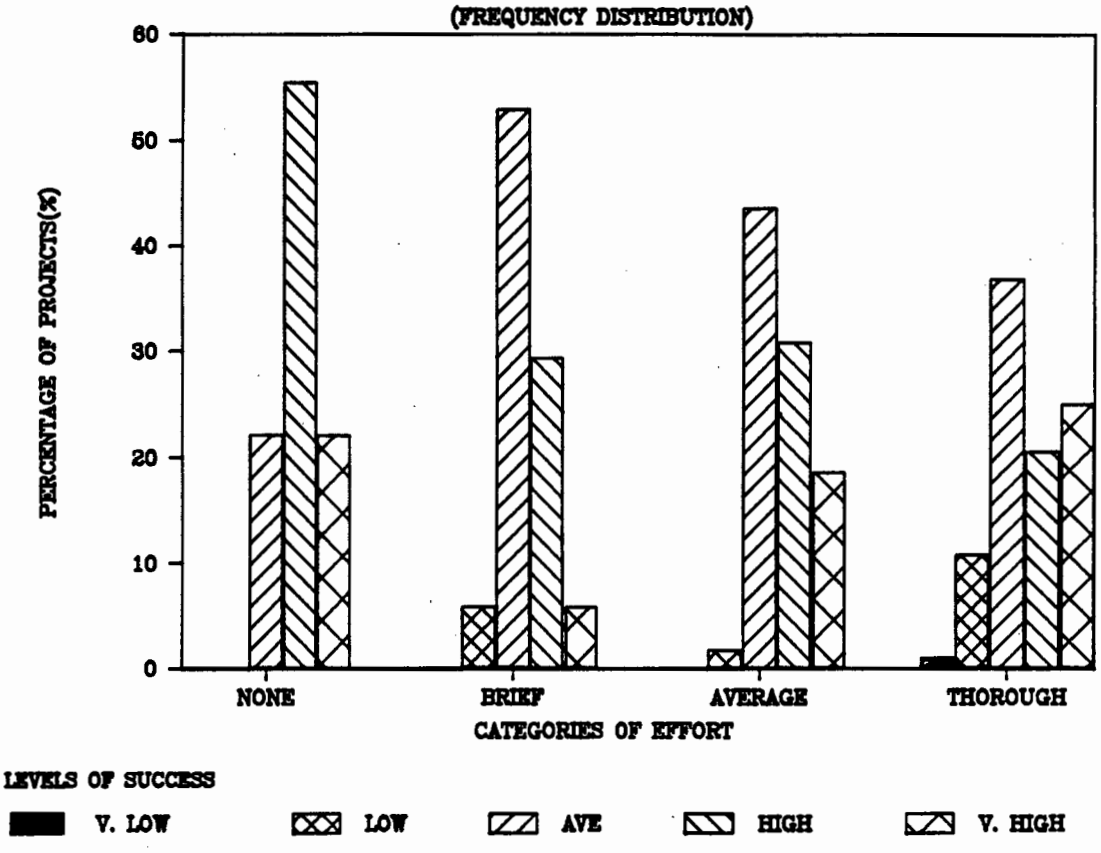
BUDGET SUCCESS VS EFFORT ON FINANCIAL STUDIES



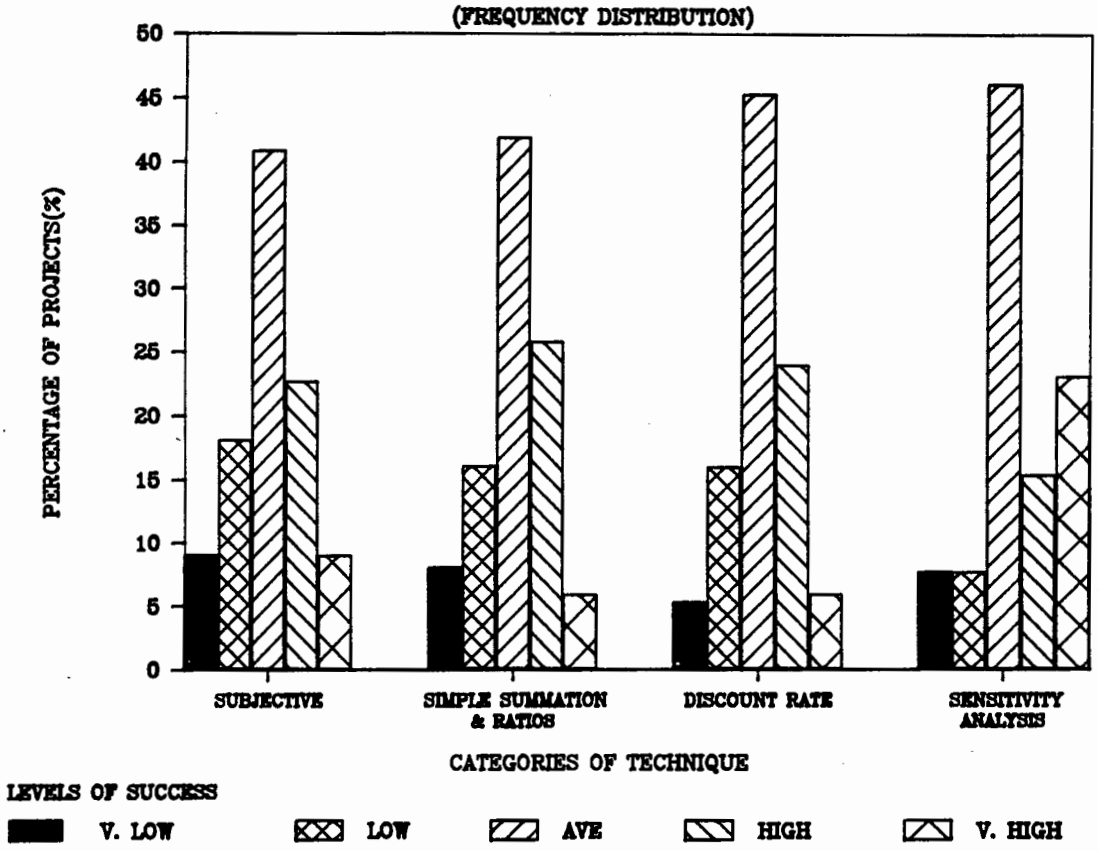
SCHEDULE SUCCESS VS EFFORT ON FINANCIAL STUDIES



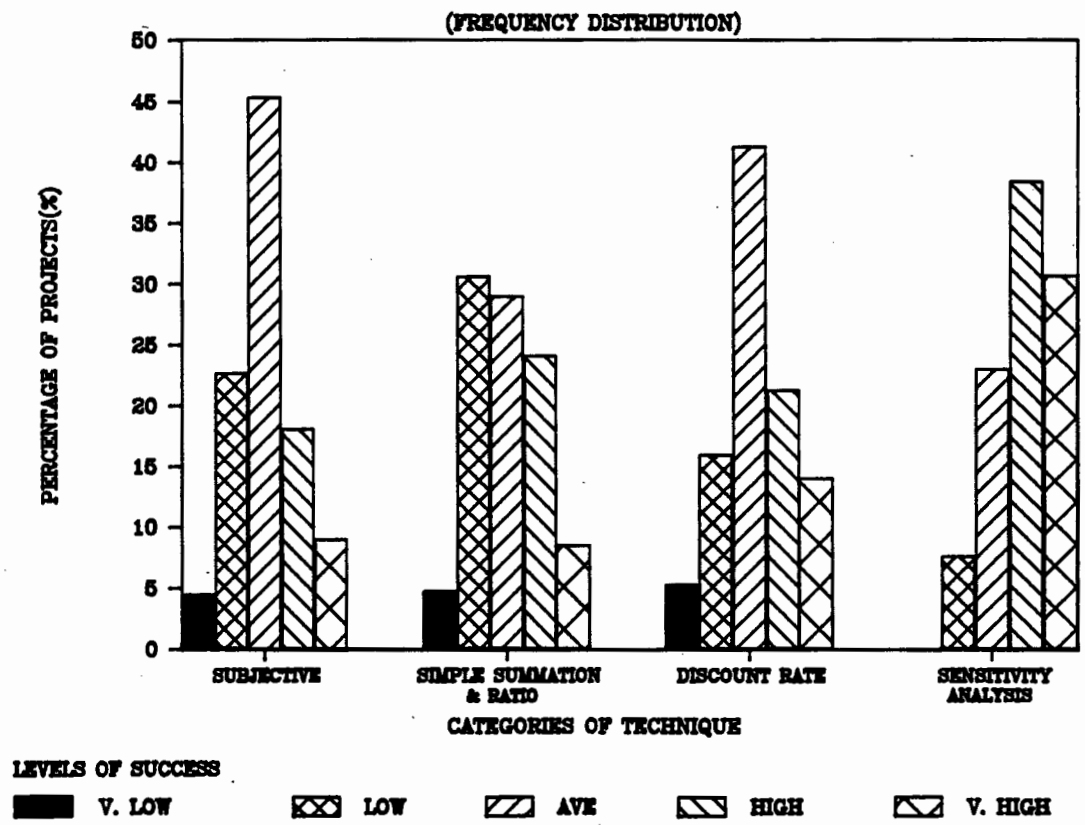
TECHNICAL SUCCESS VS EFFORT ON FINANCIAL STUDIES



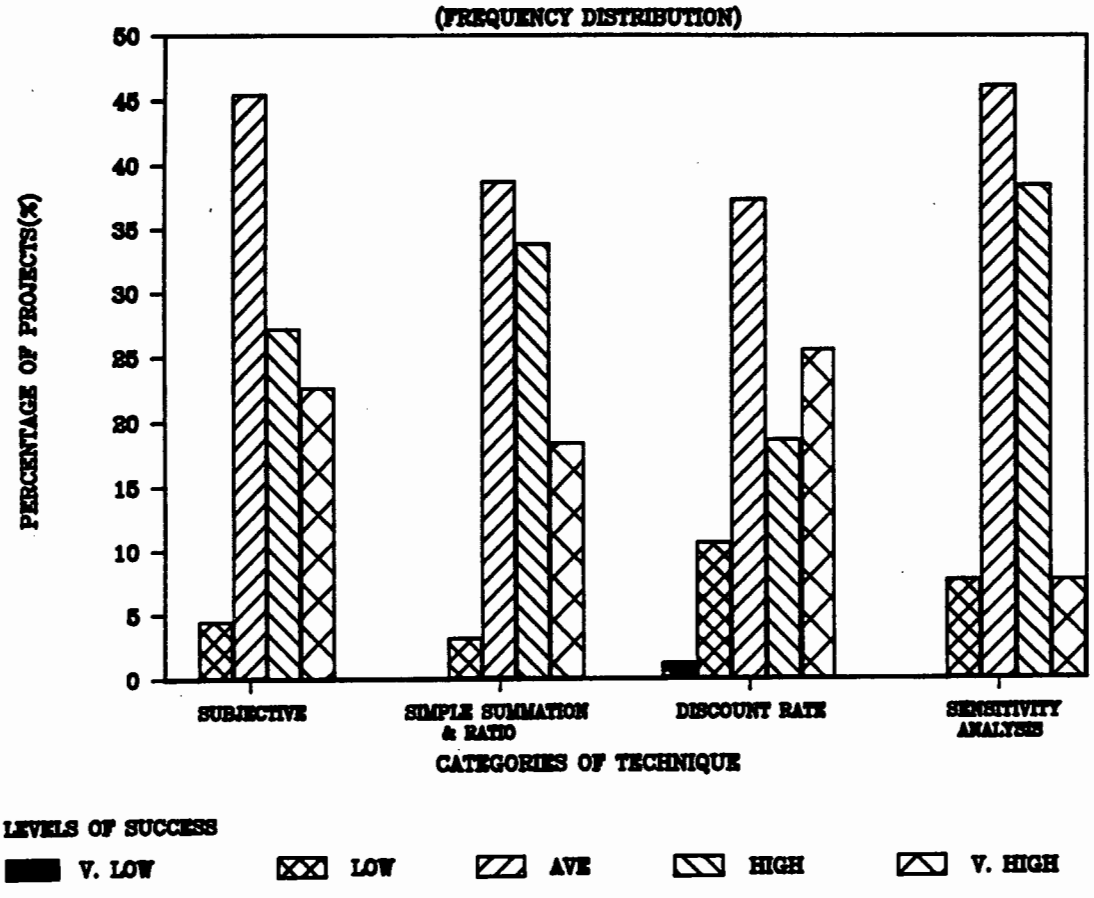
THE BUDGET SUCCESS OF FINANCIAL TECHNIQUES



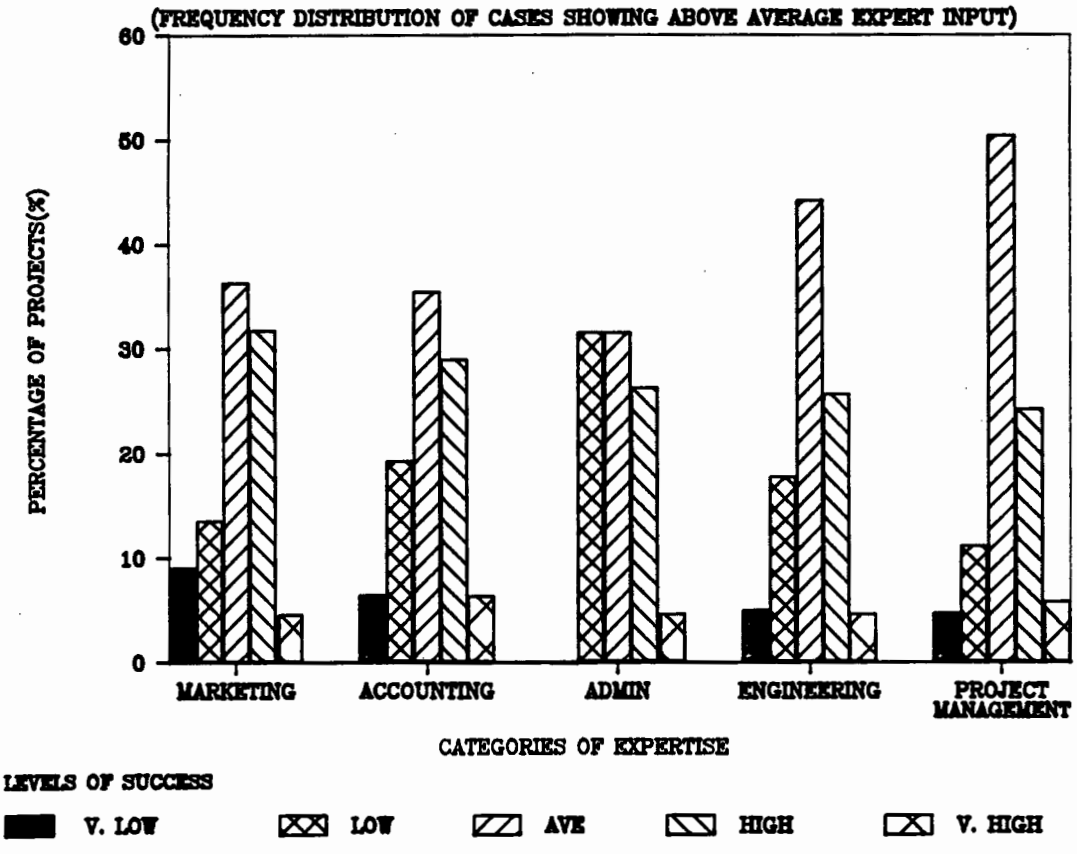
THE SCHEDULE SUCCESS OF FINANCIAL TECHNIQUES



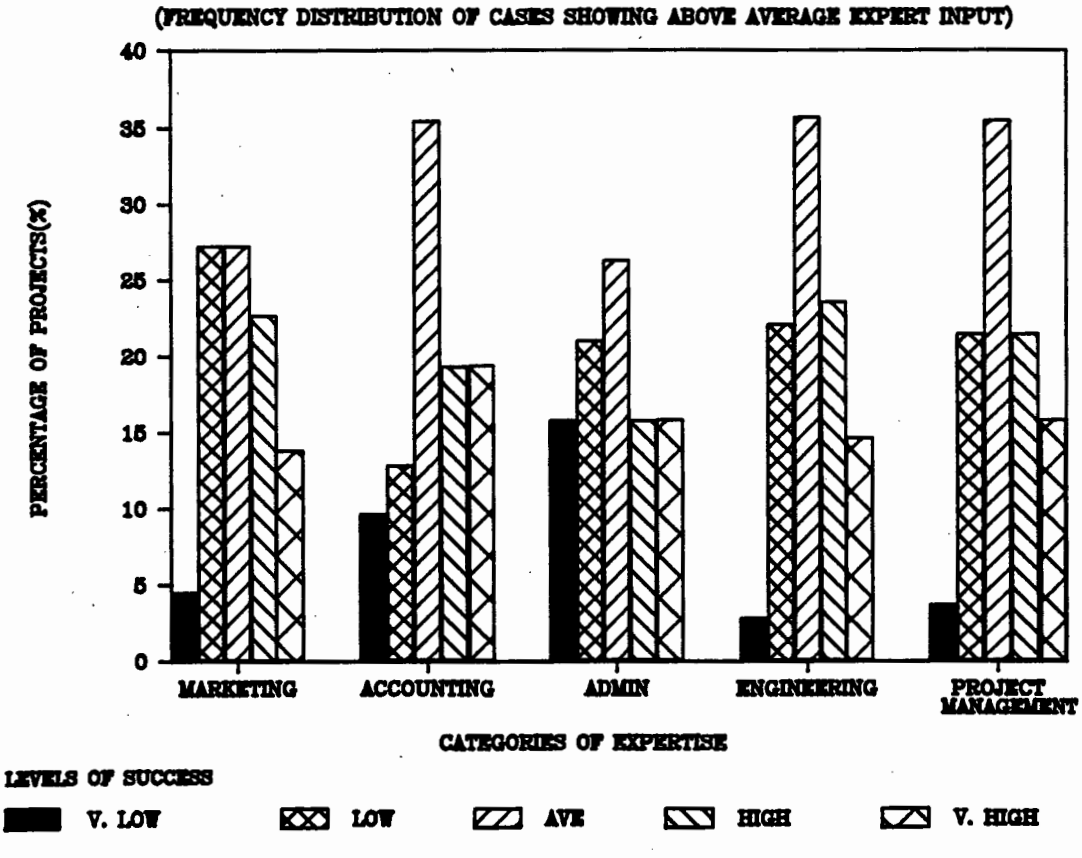
THE TECHNICAL SUCCESS OF FINANCIAL TECHNIQUES



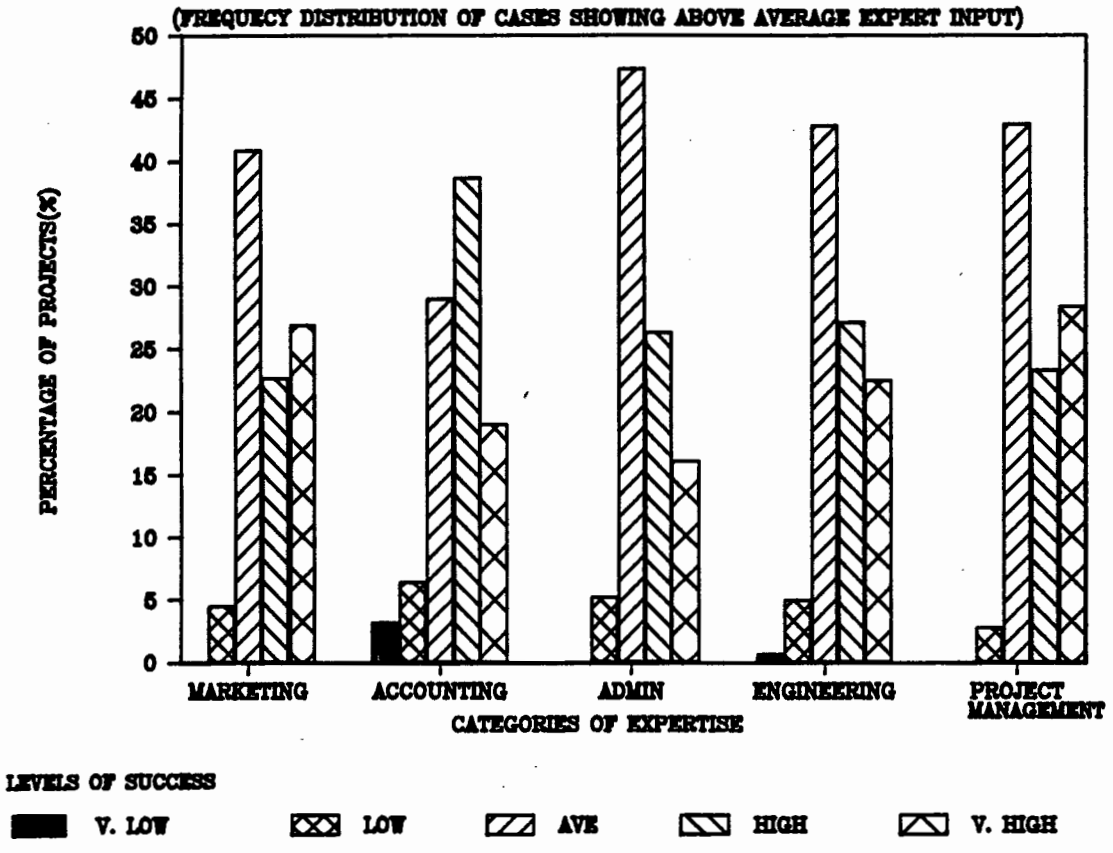
EFFECT OF VARIOUS EXPERTISE ON BUDGET SUCCESS



EFFECT OF VARIOUS EXPERTISE ON SCHEDULE SUCCESS



EFFECT OF VARIOUS EXPERTISE ON TECHNICAL SUCCESS



APPENDIX D

RESULTS OF ANALYSIS OF VARIANCE

APPENDIX D: RESULTS FROM ANALYSIS OF VARIANCE.

D.1 "Significant" Results established through single factor ANOVA.

NOTE : This significance is referenced to the 5% probability that the "null" hypothesis is true.

TABLE 1: The Effect of Project Characteristic on Success.

	SUCCESS		
CHARACTERISTIC	Budget	Schedule	Technical
Age	-	0,010	-
Type	-	0,002	0,020
Value	-	-	0,004
Duration	0,000	-	-

TABLE 2: The Effect of Appraisal Philosophy on Success.

	SUCCESS		
PHILOSOPHY	Budget	Schedule	Technical
Appraisal Thoroughness			
Technical	-	0,014	0,003
Operational	-	0,010	0,000
Financial	-	-	-
Chronological Position			
Technical	-	-	0,050
Operational	-	-	0,023
Financial	-	-	-
Formal Techniques			
Technical/Operational	-	0,019	0,015
Financial Techniques			
Subjective	0,029	-	0,002
Simple summation	-	-	-
Simple ratios	-	-	-
Discounted summation	-	0,027	-
Discounted ratios	-	-	-
Sensitivity analysis	-	0,009	-
Overall	-	0,046	-
Expert Input			
Marketing	-	0,008	-
Accounting	-	-	-
Admin	-	-	0,038
Engineering	-	-	0,011
Project Management	-	-	0,006

TABLE 3: The Effect of project characteristics on Appraisal Philsophy

	CHARACTERISTIC			
PHILOSOPHY	Age	Type	Value	Duration
Appraisal Thoroughness				
Technical	0,000	0,000	-	0,014
Operational	0,001	0,001	-	-
Financial	0,040	-	-	-
Chronological Position				
Technical	-	0,000	-	0,008
Operational	-	-	-	-
Financial	-	0,000	0,011	-
Formal Techniques				
tech/operational	0,018	0,004	0,023	0,010
Financial Techniques				
Subjective	-	-	-	0,005
Simple summation	-	-	-	-
Simple ratios	-	-	-	-
Discount summation	-	-	-	0,001
Discounted ratios	-	0,009	0,011	-
Sensitivity anal.	-	-	0,010	0,002
Overall	-	0,045	-	-
Expert Input				
Marketing	-	-	-	-
Accounting	-	-	-	-
Admin	-	0,006	-	-
Engineering	-	0,004	-	-
Project Management	-	0,029	-	-

D.2 The Results of Two Factor ANOVA.

TABLE 4: The Combined Effect of Project Age and Appraisal Philosophy on Success.

	SUCCESS		
PHILOSOPHY	Budget	Schedule	Technical
Appraisal Thoroughness			
Technical	-	0,001	0,036
Operational	-	0,000	0,004
Financial	-	0,010	-
Chronological position			
Technical	-	-	-
Operational	-	-	-
Financial	-	-	-
Formal Techniques			
Technical/Operational	0,012	0,002	-
Financial Techniques			
Subjective	0,024	0,015	-
Simple summation	-	0,022	-
Simple ratios	-	0,019	-
Discounted summation	-	0,004	-
Discounted ratios	-	0,013	-
Sensitivity analysis	-	0,003	-
Overall	-	0,009	-
Expert Input			
Marketing	-	0,002	-
Accounting	-	-	-
Admin	-	-	-
Engineering	0,038	0,028	-
Project Management	-	-	-

TABLE 5: The Combined Effect of Project Type and Appraisal Philosophy on Success.

	SUCCESS		
PHILOSOPHY	Budget	Schedule	Technical
Appraisal Thoroughness			
Technical	-	0,001	0,001
Operational	-	0,001	0,000
Financial	-	0,002	0,019
Chronological Position			
Technical	-	0,006	0,008
Operational	0,018	0,001	0,006
Financial	-	0,005	-
Formal Techniques			
Technical/Operational	0,040	0,001	0,004
Financial Techniques			
Subjective	0,020	0,003	0,001
Simple summation	-	0,003	0,039
Simple ratios	-	0,004	0,025
Discounted summation	-	0,000	0,037
Discounted ratios	-	0,003	0,036
Sensitivity analysis	-	0,000	0,021
Overall	-	0,001	-
Expert Input			
Marketing	0,033	0,000	0,045
Accounting	-	0,006	0,009
Admin	-	0,012	0,004
Engineering	0,020	0,009	0,002
Project Management	-	0,022	0,004

TABLE 6: The Combined Effect of Project Cost and Appraisal Philosophy on Success.

	SUCCESS		
PHILOSOPHY	Budget	Schedule	Technical
Appraisal Thoroughness			
Technical	-	0,034	0,000
Operational	-	0,043	0,000
Financial	-	-	0,011
Chronological Position			
Technical	-	-	0,001
Operational	-	-	0,001
Financial	-	-	0,016
Formal Techniques			
Technical/Operational	-	-	0,003
Financial Techniques			
Subjective	-	-	0,000
Simple summation	-	-	0,010
Simple ratios	-	-	0,010
Discounted summation	-	-	0,006
Discounted ratios	-	-	0,007
Sensitivity analysis	-	-	0,006
Overall	-	-	0,020
Expert Input			
Marketing	-	0,031	0,007
Accounting	-	-	0,006
Admin	-	-	0,001
Engineering	-	-	0,001
Project Management	-	-	0,000

TABLE 7: The Combined Effect of Project Length and Appraisal Philosophy on Success.

	SUCCESS		
PHILOSOPHY	Budget	Schedule	Technical
Appraisal Thoroughness			
Technical	0,000	0,050	0,009
Operational	0,000	0,039	0,000
Financial	0,001	-	-
Chronological Position			
Technical	0,000	-	0,032
Operational	0,001	-	0,014
Financial	0,004	-	-
Formal Techniques			
Technical/operational	0,000	-	0,025
Financial Techniques			
Subjective	0,000	-	0,015
Simple summation	0,000	-	-
Simple ratios	0,000	-	-
Discounted summation	0,000	-	-
Discounted ratios	0,000	-	-
Sensitivity analysis	0,000	-	-
Overall	0,000	-	-
Expert Input			
Marketing	0,000	0,044	-
Accounting	0,001	-	0,018
Admin	0,001	-	0,013
Engineering	0,000	-	0,014
Project Management	0,001	-	0,010

APPENDIX E

RESULTS OF CONTINGENCY ANALYSIS

APPENDIX E: RESULTS OF THE CONTINGENCY ANALYSIS.

E.1 Application to the Uncompressed Database.

NOTE: 1. Although the success variables have undergone some compression, the overall database compression is at a minimum for meaningful results. It is, therefore, referenced as the uncompressed state.

2. After the title of each variable in this appendix, a numerical value will be displayed in brackets. The intention is to indicate the number of levels within the variable. In this way, one can tell whether or not the variable has been compressed. A key at the end of the appendix describes compressed levels more completely. Uncompressed variables are described by the questionnaire.

3. Results with an asterisk have produced an uncertainty warning during calculation.

4. Results in brackets are not quite significant, but are deemed suitable for consideration.

TABLE 1: The Effect of Project Characteristic on Success.

	SUCCESS		
CHARACTERISTIC	Budget(3)	Time(3)	Tech(3)
Age(5)	-	0,002	-
Type(6)	-	0,030 *	0,002 *
Cost(5)	-	-	0,016 *
Duration(5)	0,002	-	-

TABLE 2: The Effect of Appraisal Philosophy on Success.

	SUCCESS		
PHILOSOPHY	Budget(3)	Time(3)	Tech(3)
Appraisal Thoroughness			
Technical(4)	-	-	0,038 *
Operational(4)	-	0,014 *	0,000 *
Financial(4)	-	-	-
Chronological Position			
Technical(3)	-	-	0,019
Operational(3)	(0,076)	0,014	0,033
Financial(3)	-	-	-
Formal Techniques			
Tech/Operational(2)	-	-	(0,080)
Financial Techniques			
Subjective(2)	(0,063)	-	0,007
Simple summation(2)	-	-	-
Simple ratios(2)	-	-	-
Discount summation(2)	-	0,048	0,027
Discounted ratios(2)	-	-	-
Sensitivity anal(2)	-	0,036 *	-
Overall(4)	-	-	-
Expert Input			
marketing(5)	-	0,019 *	-
accounting(5)	-	-	-
admin(5)	-	-	-
engineering(5)	-	-	0,000 *
project management(5)	-	-	0,008 *

TABLE 3: The Effect of project characteristics on Appraisal Philsophy

	CHARACTERISTIC			
PHILOSOPHY	Age(5)	Type(6)	Cost(5)	Dur(5)
Appraisal Thoroughness				
Technical(4)	0,019 *	0,001 *	-	0,030 *
Operational(4)	0,030 *	0,031 *	0,004 *	0,015 *
Financial(4)	0,022 *	0,020 *	-	-
Chronological Position				
Technical(3)	-	0,000 *	-	0,030
Operational(3)	-	0,014 *	-	-
Financial(3)	-	0,000 *	-	-
Formal Techniques				
Tech/Operational(2)	0,019	0,005 *	0,024 *	0,011
Financial Techniques				
Subjective(2)	-	-	-	0,006
Simple summation(2)	-	-	-	-
Simple ratios(2)	-	-	-	-
Disc summation(2)	-	-	-	0,002
Discount ratios(2)	-	0,010 *	0,012 *	-
Sensitivity anal(2)	-	-	0,011 *	0,002 *
Overall(4)	-	-	-	0,008 *
Expert Input				
Marketing(5)	-	-	0,049 *	-
Accounting(5)	-	0,001 *	0,016 *	0,041 *
Admin(5)	-	0,002 *	0,000 *	-
Engineering(5)	-	0,003 *	-	-
Project Mngmnt(5)	-	0,000 *	-	-

E.2 Applications to Tables of Compressed Variables.

NOTE: There are various stages of compression that can be achieved. The only ones displayed here, however, are those yielding meaningful results. This is not to say that other stages have not been investigated. They are just not displayed.

TABLE 4: The Effect of Compressed Project Characteristics on Appraisal Philsophy

	CHARACTERISTIC			
PHILOSOPHY	Age(3)	Type(5)	Cost(3)	Dur(3)
Appraisal Thoroughness				
Technical(4)	-	0,016 *	-	-
Operational(4)	-	0,013 *	0,002 *	0,036 *
Financial(4)	0,042 *	0,014 *	-	-
Chronological Position				
Technical(3)	0,040	0,000 *	-	-
Operational(3)	-	0,022 *	-	-
Financial(3)	-	0,000 *	(0,063)	-
Formal Techniques				
Tech/Operational(2)	-	0,002	(0,067)	-
Financial Techniques				
Subjective(2)	-	-	-	-
Simple summation(2)	-	-	0,050	-
Simple ratios(2)	-	-	-	-
Disc summation(2)	-	-	-	-
Discount ratios(2)	-	0,010 *	-	-
Sensitivity anal(2)	-	0,048 *	0,002 *	0,016 *
Overall(4)	-	-	0,012 *	0,023 *
Expert Input				
Marketing(5)	-	-	0,030 *	-
Accounting(5)	-	0,001 *	0,020 *	0,006 *
Admin(5)	-	0,001 *	0,000 *	-
Engineering(5)	-	0,002 *	-	-
Project Mngmnt(5)	-	0,007 *	-	-

TABLE 5: The Effect of Compressed Project Characteristic on Success.

	SUCCESS		
CHARACTERISTIC	Budget(3)	Time(3)	Tech(3)
Age(3)	0,019	-	-
Type(5)	-	0,044	0,006 *
Cost(3)	-	-	-
Duration(3)	-	-	-

TABLE 6: The Effect of Compressed Appraisal Philosophy on Success.

	SUCCESS		
PHILOSOPHY	Budget(3)	Time(3)	Tech(3)
Appraisal Thoroughness			
Technical(2)	-	0,031	-
Operational(2)	-	(0,072)	-
Financial(2)	-	-	-
Expert Input			
Marketing(3)	-	-	-
Accounting(3)	-	-	-
Admin(3)	-	-	-
Engineering(3)	-	-	0,004 *
Project Management(3)	0,038	-	0,003 *

TABLE 7: The Effect of Compressed Project Characteristics on Compressed Appraisal Philsophy

	CHARACTERISTIC			
PHILOSOPHY	Age(3)	Type(5)	Cost(3)	Dur(3)
Appraisal Thoroughness				
Technical(2)	-	0,009 *	-	-
Operational(2)	-	0,005 *	-	-
Financial(2)	-	-	-	-
Expert Input				
Marketing(3)	-	-	-	-
Accounting(3)	-	0,005 *	-	-
Admin(3)	-	0,001 *	(0,083)	-
Engineering(3)	-	0,007 *	-	-
Project Mngmnt(3)	-	0,029 *	-	-

E.3 Special Case of Compression concerning Project Type.

NOTE: 1. The variable of project type produced a number of significant probabilities that are subject to a warning in sub-section E.2. It is, therefore, undertaken in this sub-section to compress the variable further in the hope of salvaging some meaningful results.

2. Relationships in the table that are marked with an "x" are those that already have been processed and have been found to not show a warning.

TABLE 8: The Effect on Appraisal Technique of Compressing Type in Successive Stages.

	SUCCESS		
PHILOSOPHY	type(4)	type(3)	type(2)
Appraisal Thoroughness			
Technical(2)	0,016 *	0,017	-
Operational(2)	0,006 *	0,011 *	0,007
Financial(2)	-	-	-
Chronological Position			
Technical(3)	0,000	x	x
Operational(3)	0,050	x	x
Financial(3)	0,002	x	x
Financial Techniques			
Subjective(2)	-	x	x
Simple summation(2)	-	x	x
Simple ratios(2)	0,049	x	x
Discount summation(2)	-	x	x
Discounted ratios(2)	0,043	x	x
Sensitivity anal.(2)	0,054 *	0,020 *	0,021 *
Overall(2)	-	x	x
Expert Input			
Marketing(3)	-	-	-
Accounting(3)	0,002 *	0,009 *	0,003
Admin(3)	-	0,005 *	0,009
Engineering(3)	0,012 *	0,040 *	0,007 *
Project Management(3)	0,020 *	0,009	-

KEY: DESCRIPTION OF COMPRESSED VARIABLES

variable name	description of variable levels
Success	
Budget(3)	exceeded expectation; met expectation; did not meet expectation.
Time(3)	exceeded expectation; met expectation; did not meet expectation.
Tech(3)	exceeded expectation; met expectation; did not meet expectation.
Characteristic	
Age(3)	0 - 3 Years; 3 Years - 5 Years; >5 Years.
Type(5)	research; development; construction; implementation; general engineering
Type(4)	development; construction; implementation; general engineering.
Type(3)	development; construction; general engineering.
Type(2)	development; construction.
Cost(3)	0 - R100 000; R100 000 - R1 Million; >R1 Million
Length(3)	0 - 1 Year; 1 Year - 3 Years; >5 Years.
Appraisal Thoroughness	
Technical(2)	none/brief; average/thorough.
Operational(2)	none/brief; average/thorough.
Financial(2)	none/brief; average/thorough.
Expert Input	
Marketing(3)	below average; average; above average.
Accounting(3)	below average; average; above average.
Admin(3)	below average; average; above average.
Engineering(3)	below average; average; above average.
Project Management(3)	below average; average; above average.

APPENDIX F

RESULTS OF LOG-LINEAR ANALYSIS

APPENDIX F: RESULTS OF LOG-LINEAR ANALYSIS.

F.1 The Effect of Project Characteristics on Project Success.

NOTE: In this appendix the only relations that will be considered are those that have been highlighted as significant in Appendix E.

TABLE 1: The Effect of Duration(5) on Budget(3) Success.

duration	success: high		low
short	+0,7	+0,4	-1,5
	+0,8	+0,2	-0,7
	+0,6	+0,3	-1,2
	-1,6	-0,7	+2,9
long	-1,7	-0,2	+2,2

Short duration projects appear to be associated with high budget success, while long duration projects appear to be associated with low budget success.

TABLE 2: The Effect of Age(5) on Schedule(3) Success.

age	success: high		low
young	-0,4	+1,2	-1,0
	+0,4	-1,0	+0,7
	-1,2	-0,6	+2,1
	-0,7	+2,2	-1,8
old	+1,8	-1,2	-0,7

No particular trend is visible. It is quite possible that a strong relationship could have resulted due to a chance distribution.

TABLE 3: The Effect of Type(5) on Schedule(3) Success.

type	success: high		low
research	+0,8	+0,3	-1,3
development	-0,5	+0,2	+0,4
construction	-1,6	+0,4	+1,4
implementing	+2,2	-1,5	-0,9
general	0,0	+0,2	-0,3

Strong associations to schedule success are visible from research, construction and implementation projects. Research and implementation projects appear to be associated with high success, while construction projects appear to be associated with low success.

TABLE 4: The Effect of Age(3) on Budget(3) Success.

age	success: high		low
young	-0,8	+0,7	-1,9
	-0,5	-1,0	+1,9
old	-0,7	-0,1	+1,0

A condensed variable of age appears to relate to budget success in as far as young projects are associated to high success, while old ones are associated to low success.

TABLE 5: The Effect of Cost(3) on Schedule(3) Success.

cost	success: high		low
low	+0,2	+0,7	-1,1
	-1,2	-0,5	+2,0
high	+0,8	-0,4	+0,5

Low value and high value projects appear to be associated with high schedule success, while average value projects appear to be associated with low success.

F.2 The Effect of Appraisal Technique on Project Success.

TABLE 6: The Effect of an Operational(3) Study's Chronological Position on Budget(3) Success.

position	success: high		low
1st	-0,7	-0,8	+2,0
2nd	+0,2	+0,7	-1,2
3rd	+0,7	0,0	-0,9

The budget success of a project appears to improve when operational studies are conducted later in the appraisal.

TABLE 7: The Effect of using Subjective(2) Financial Analysis on Budget(3) Success.

usage	success: high		low
used	-0,8	-0,3	+1,4
not used	+0,8	+0,3	-1,4

The use of Subjective Financial Analysis Techniques appears to have a negative effect on budget success.

TABLE 8: The Effect of using Project Management(3) as Expert Input on Budget(3) Success.

usage	success: high		low
low	+0,1	-0,1	+0,1
ave	-0,1	-1,5	+2,2
high	0,0	1,0	-1,4

Project Management Input appears to be positively associated with Budget Success. This appears, however, to be a weak association.

TABLE 9: The Effect of Operational(3) study Order on Schedule(3) Success.

order	success: high		low
1st	-1,2	+1,0	+0,3
2nd	-0,1	+0,5	-0,5
3rd	+1,9	-2,3	+0,4

Although the relation appears to be confused, there is a strong association between high schedule success and conducting Operational Studies last in the appraisal.

TABLE 10: The Effect of using Discounted Summation(2) Financial Analysis Techniques on Schedule(3) Success.

usage	success: high		low
used	+0,9	+0,5	-1,6
not used	-0,8	-0,4	+1,4

The use of Discounted Summation Financial Analysis Techniques appear to have a strong positive effect on schedule success.

TABLE 11: The Effect of Technical(2) Appraisal Thoroughness on Schedule(3) Success.

thoroughness	success: high		low
none/brief	-1,9	+1,0	+1,0
ave/thorough	+0,8	-0,4	-0,4

Increased thoroughness in technical appraisal appears to be positively related to schedule success.

TABLE 12: The Effect of Operational(2) Appraisal Thoroughness on Schedule(3) Success.

thoroughness	success: high		low
none/brief	-1,4	-0,1	+1,7
ave/thorough	+0,4	+0,0	-0,5

Increased thoroughness in operational appraisal appears to be positively associated with schedule success.

TABLE 13: The Effect of a Technical(3) Study's Chronological Position on Technical(3) Success.

position	success: high		low
1st	+1,2	-0,8	-1,1
2nd	+0,2	-0,7	+1,1
3rd	-1,8	+2,0	0,0

The early conduct of technical studies within appraisal appears to be associated with high technical success of that project.

TABLE 14: The Effect of an Operational(3) Study's Chronological Position on Technical(3) Success.

position	success: high		low
1st	-0,8	+0,5	+0,8
2nd	-0,5	+0,4	+0,3
3rd	+2,0	-1,4	-1,6

The conduct of operational studies after technical and financial appears to be positively associated with high technical success for that project.

TABLE 15: The Effect of using Formal Technical/Operational Techniques(2) on Technical(3) Success.

usage	success: high		low
used	+1,1	-0,8	-1,0
not used	-1,0	+0,7	+0,9

The use of formal technical and operational study techniques appears to be positively associated with high technical success.

TABLE 16: The Effect of using Subjective(2) Financial Analysis Techniques on Technical(3) Success.

usage	success: high		low
used	-1,2	+0,6	+1,7
not used	+1,3	-0,6	-1,8

The use of subjective financial analysis techniques appears to be negatively associated with technical success.

TABLE 17: The Effect of using Discounted Summation(2) Financial Analysis Techniques on Technical(3) Success.

usage	success: high		low
used	-0,3	-0,5	+1,9
not used	+0,3	+0,5	-1,7

The use of discounted summation financial analysis techniques appears to be negatively associated with technical success.

F.3 The Effect of Project Characteristic on Appraisal Technique.

TABLE 18: The Effect of Project Age(5) on the use of Formal Technical/Operational Techniques(2).

usage	age: high				low
used	-2,0	-0,1	+1,1	+0,8	+0,7
not used	+1,9	+0,1	-1,0	-0,7	-0,6

Over the past approximately ten years there appears to have been a move towards the use of formal techniques for technical/operational appraisal.

TABLE 19: The Effect of Project Age(3) on Technical Study,s Chronological Position(3).

position	age(3) high		low
1st	-0,8	-0,5	+1,5
2nd	-0,3	+1,1	-0,5
3rd	+1,5	-0,9	-1,4

Over the past approximately ten years there appears to have been a move from conducting technical studies late in the appraisal phase to conducting them early.

TABLE 20: The Effect of Project Type(5) on the use of Formal Technical/Operational Techniques(2).

usage	type(5) research	develop	constr	implement	general
used	+1,1	-0,3	-2,3	-0,2	+1,6
not used	-1,0	+0,3	+2,0	+0,2	-1,5

It appears that, while research and general engineering projeects are using formal techniques more often, organisations involved in construction projects avoid their use. Development and implementation projects also appear to have preferences with regard to this question, but they are weakand therefore not worth considering.

TABLE 21: The Effect of Project Type(4) on a Technical Study,s Chronological Position(3).

position	type(4) develop	constr	implement	general
1st	+0,6	-1,2	-1,5	+1,3
2nd	-0,1	-1,8	+2,2	+0,1
3rd	-0,7	+3,9	-1,1	-1,9

The preferred chronological position, in which technical studies are conducted appears to vary with respect to the type of project under consideration. In the case of developmental projects this is first, for construction projects this is last, for general engineering it is again first.

TABLE 22: The Effect of Project Type(4) on an Operational Study,s Chronological Position(3).

position	type(4) develop	constr	implement	general
1st	+0,1	-1,6	+1,1	+0,4
2nd	+0,5	+1,7	-1,8	-0,5
3rd	-0,9	-0,3	+1,1	+0,1

The preferred chronological position, in which operational studies are conducted also appears to vary with respect to project type. For development projects this preferance is for second position, for construction it is also second, for implementation it can either be first or last, for general engineering it is first.

TABLE 23: The Effect of Project Type(4) on a Financial Study,s Chronological Position(3).

position	type(4) develop	constr	implement	general
1st	-1,1	+3,0	+0,3	-1,7
2nd	+0,4	+0,1	-0,6	0,0
3rd	+0,5	-2,2	+0,1	+1,2

The preferred chronological position, in which financial studies are conducted, once again appears to vary with respect to the type of project under consideration. For development projects it is last, for constructon projects it is first, for implemenmtation it is first and for general engineering it is last.

TABLE 24: The Effect of Project Type(4) on the use of Simple Ratio Financial Analysis(2).

usage	type(4) develop	constr	implement	general
used	-1,3	-0,1	+1,2	+0,2
not used	+1,6	+0,1	-1,4	-0,2

It appears that while development and construction show a tendency not to use Simple Ratio Financial analysis, implementation and general engineering projects do.

TABLE 25: The Effect of Project Type(4) on the use of Discounted Ratio Financial Analysis(2).

usage	type(4) develop	constr	implement	general
used	-1,4	-1,3	+1,0	+1,3
not used	+0,8	+0,7	-0,6	-0,7

It appears that while development and construction again show a tendency not to use Discounted Ratio Financial analysis, implementation and general engineering projects do.

TABLE 26: The Effect of Project Type(3) on the Thoroughness to which Technical(2) Studies are conducted.

thoroughness	type(3) develop	constr	general
none/brief	-0,2	+2,1	-1,6
ave/thorough	+0,1	-1,0	+0,7

It appears that while technical studies employed for evaluating development and general engineering projects tend to be more thorough, this definately not the case for construction.

TABLE 27: The Effect of Project Type(3) on the use of Project Management(3) as Expert Input.

usage	type(3) develop	constr	general
low	-0,3	+1,1	-0,8
ave	+2,1	+0,6	-1,6
high	-1,2	-0,9	+1,4

The input to development projects made by project managers appears to be average, while that of construction projects appears to be low and that of general engineering projecs appears to be high.

TABLE 28: The Effect of Project Type(2) on the Thoroughness to which Operational(2) Studies are conducted.

thoroughness	type(2) constr	general
none/brief	+2,2	-1,8
ave/thorough	-0,7	+0,6

The effort expended on Operational Studies appears to be low in the case of construction projects, but somewhat higher in the case of general engineering projects.

TABLE 29: The Effect of Project Type(2) on the use of Accounting(3) as Expert Input.

usage	type(2) constr	general
low	-1,5	+1,2
ave	+2,1	-1,7
high	+0,4	-0,3

The input to construction projects made by the accounting department of an organisation appears to be average to low, while the input to general engineering projects appears to be high.

TABLE 30: The Effect of Project Type(2) on the use of Administration(3) as Expert Input.

usage	type(2) constr	general
low	-1,0	+0,8
ave	+0,3	-0,3
high	+2,1	-1,7

The input to construction projects made by the administration department of an organisation appears to be high, while its input to general engineering projects appears to be low.

TABLE 31: The Effect of Project Type(2) on the Complexity(4) of the Financial Analysis Technique used.

complexity	type(2) constr	general
subjective	-1,0	+0,8
simple techs	+0,3	-0,3
discount rate	+2,1	-1,7
sensitivity	-2,0	+1,6

It appears that construction projects are mainly concerned with Discount Rate analysis, while general engineering projects show an affinity for sensitivity analysis together with a fair amount of subjectivity.

TABLE 32: The Effect of Project Value(3) on a Financial Study's Chronological Position(3).

position	value(3) low		high
1st	-1,7	+1,4	+0,7
2nd	-0,4	+0,3	+0,2
3rd	+1,3	-1,0	-0,6

High value projects appear to have the financial implications considered chronologically first, while low value projects tend to show finance as being considered last.

TABLE 33: The Effect of Project Value(3) on the use of Formal Technical/Operational Techniques(2).

usage	value(3) low		high
used	-1,1	-0,2	+1,3
not used	+1,0	+0,1	-1,2

It appears that the Formal techniques are more often used for high value projects.

TABLE 34: The Effect of Project Value(3) on the use of Simple Summation(2) Techniques.

usage	value(3) low		high
used	-1,0	+1,3	-0,1
not used	+1,0	-1,4	+0,1

It appears that the simple summation techniques are more often used in evaluating average value projects, than for evaluating high and low value projects.

TABLE 35: The Effect of Project Value(3) on the use of Administration(3) as Expert Input.

usage	value(3) low		high
low	+0,1	-0,5	+0,3
ave	+1,0	0,0	-1,2
high	-1,7	+1,3	+0,7

It appears as if the input of Administration increases with increase in the value of the project.

TABLE 36: The Effect of Project Duration(5) on a Technical Study's Chronological Position(3).

position	duration short				long
1st	-1,1	+0,9	-0,5	-0,4	+1,5
2nd	+0,9	-0,1	+0,7	+0,3	-0,4
3rd	+2,7	-1,1	-0,2	+0,1	-1,5

The trend for this relation is not fully clear. There is, however, an indication that for short projects, technical studies are conducted last and that as they get longer, technical studies move closer to the first position.

TABLE 37: The Effect of Project Duration(5) on the use of Formal Technical/Operational Techniques(2).

usage	duration short				long
used	-2,0	-0,4	+1,0	+1,4	+0,0
not used	+1,8	+0,4	-0,9	-1,2	-0,0

It appears that formal techniques are more often used for the larger projects.

TABLE 38: The Effect of Project Duration(5) on the use of Subjective(2) Financial Analysis Techniques.

usage	duration short				long
used	-0,1	-0,2	-1,2	+0,4	+2,2
not used	+0,1	+0,2	+1,3	-0,5	-2,4

It appears that subjective financial analysis is more often used for longer projects.

TABLE 39: The Effect of Project Duration(5) on the use of Discounted Summation(2) Financial Analysis Techniques.

usage	duration short				long
used	-2,5	+0,6	+0,8	-0,7	+1,3
not used	+2,2	-0,5	-0,7	+0,6	-1,2

The trend for this relation is unclear. It does, however, indicate high usage of discounted summation for long projects and low usage for short.