

**University of Cape Town
Cape Town**

**The impact of Information Technology (IT)
on the financial performance of organizations in a developing country**

Thesis

submitted to the

Department of Information Systems

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in

INFORMATION SYSTEMS

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Additional points of clarification

1. **Paragraph 2.4.2:** For a better structuring and a specification of business risk for the purpose of this research consult paragraph 3.3.1.
2. **Page 34:** A full definition of IT could be found in the questionnaire (Appendix B).
3. **Figure 5.5.1:** Of those managers who are affected negatively, 70% would invest if the effect is not large. Of those affected positively, 66% would invest if the effect is large.
4. **The last sentence of the first paragraph on p 79:** Additionally it can also be conjectured by this study that when technology fits the organizational situation, significant savings in operating costs are possible, thereby supporting Harris and Katz's (1991) study.

ABSTRACT

The effect of IT investment on the risk and risk profile of managers were studied in the IT-using industry in Namibia. IT investment uses certain of an organization's resources. The following models (computerization index (CI), IT expense ratio (ITEX), IT costs efficiency ratio (ITCE), operating cost efficiency ratio (OPEX), operating leverage, cost-benefit ratio, return on IT assets ratio and profitability performance measurements in terms of six strategic ratios; profit/total assets, profit/turnover, turnover/total assets, gross margin/turnover, profit growth rate and sales growth rate) were used. The study also established the importance of perceived risk in any organization's and managers' daily activities. The study further investigated the close link between calculated organizational risk and IT investment decisions.

The results displayed a positive association between the CI and turnover growth. A link was shown between ITEX and OPEX and OPEX and the monetary value of IT, allowing the study to accept these two hypotheses. It was thus concluded that CI and ITEX could be used as a possible measurement of computerization. On the other hand, managerial perceived and calculated organizational risk were not found to be the deciding factors while an IT investment was being made.

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(S I Lubbe)

Chapter 1

Introduction

1.1 Introduction

This chapter will present an overview of the research. It includes a short introduction and explains the contents of the chapters that follow.

1.2 Overview

Harris and Katz (1988, 1991) posit that technology is changing the way organizations compete. They conjecture that some organizations in the first world could set an example of the extent of information technology (IT) investments the best. This created incentive for this study to examine the relationship (if any) between financial performance and the level of IT investment amongst organizations in Namibia as possibly representative of a developing country.

Weill and Olson (1989) conducted case studies on managing IT investment. They note that it is important for organizations to understand the impact of IT usage on operating results and profitability. They further conjecture that it would be possible to develop strategies for IT investments that would help an organization to gain or maintain its competitive advantage.

Because of the difficulty of measuring benefits, researchers such as Shoal and Lugasi (1988) and Ahituv and Neumann (1990) assessed different approaches in measuring the impact of IT investment on an organization. Such authors include Kwong and Mohamed (1985) and Harris and Katz (1988, 1991). Kwong and Mohamed designed their computerization index (CI) instrument that can be compared with performance ratios to evaluate quantitatively the impact of computerization on profitability. Harris and Katz used what they termed the information technology expense ratio (ITEX) and the operating cost efficiency ratio (OPEX) to find a relationship between profitability and IT expenses in the short term. Shoal and Lugasi (1988) examined the use of a utility model that can aid in deciding between different IT investments.

1.3 Statement of the Problem

From the above discussion, it is evident that IT investment uses certain organizational resources. The approach noted by Weill and Olson(1989) that IT expenditure should be measured and tracked over time against a convenient base, therefore deserves research attention. Also that every IT investment should be treated as a portfolio investment with different aims and associated levels of risk. Authors such as Ahituv and Neumann (1990), Shoal and Lugasi (1988) and Ward (1987) conjecture that organizational resources, based on the above, could be subjected to risk. They further suggest that this approach could help with the measurement and tracking of IT expenditure over time.

King (1988) supports a similar idea. He notes that among the criteria for IT investment that may be used is the assessment of the risk involved in various IT alternatives. Shoval and Lugasi (1988) support research in a new direction by noting that the cost-benefit ratio alone is not sufficient. They suggest that it is important to consider the decision maker's attitude to risk and uncertainty.

1.4 Brief statement of the Hypotheses

The first series of hypotheses could be summarized as: the CI of an organization will display positive association with different measures of profitability (that is: profit growth, turnover growth, pretax profit/turnover, market value of IT and OPEX). Similarly, the second series of hypotheses could be summarized as: ITEX will display positive association with profitability measures (that is: OPEX, ITCE and the monetary market value of IT).

According to Copeland and Weston (1980) and Tinic and West (1979), it is necessary to examine historical situations to test previous market efficiency for an investment. This can be done by calculating the risk (*risk can be defined as the probability of the occurrence of unfavourable outcomes [Weston and Brigham: 1981]*) of an organization (and/or industry) for historic situations. Lastly, the third series of hypotheses could be summarized as: *there is an association between the CI and ITEX models and risk related measures* (risk was incorporated in the following models: the probability of affecting organizational risk when making the IT investment, return on IT assets, operating leverage, cost-benefit analysis and organizational risk).

1.5 Research Methodology

Section 2.4 lists a number of models that were used: computerization index [CI], operating leverage [OPEL], return on IT assets [R_a], organizational risk factor, turnover growth (revenue stability), stochastic process simulation [SPS], information technology expense ratio [ITEX], operating cost efficiency ratio [OPEX], information technology costs efficiency ratio [ITCE], cost-benefit analysis ratio [CBA] and profitability measurement ratios. These are discussed in Appendix A. The population includes the entire Namibian and Namibian-related IT-using organizations (see Section 4.2). The final sample was reduced to organizations that indicated their willingness to participate in the study (see Section 4.2). A questionnaire (see Appendix B) was posted to these organizations, and these data were reworked and summarised (see Appendix C).

1.6 Contribution to Knowledge

This study examines the impact of IT on the financial performance of an organization (including the influence of risk) when investing resources in IT. According to Weill and Olson (1989), personal perceptions and the possibility of business failure may negate sound decisions to invest in IT.

The present study also demonstrated a close link between risk and investment decisions. These results are expected to be of help to managers because they provide guidelines whether to invest

resources in IT or not. Also IT managers are provided with a means of estimating the effect on risk of investment and financing decisions.

1.7 Assumed knowledge of the reader

Certain assumptions regarding the reader's knowledge have been made in the presentation of this thesis. For instance, background knowledge of information systems and management accounting is required to understand the terms and definitions given in section 2.2: particularly the use of financial performance measurements. A knowledge of investment and risk analysis is also required.

Beyond this, a basic understanding of the mathematical and statistical procedures used to analyze the data is assumed. These procedures includes using Kendall rank correlation tests, risk calculations and the use of decision trees and generalized financial models.

1.8 Outline of the Thesis

Chapter 1 (Introduction) presents a brief outline of the study.

Chapter 2 (Summary of Past Research) A summary of relevant research, discovered in available literature, are presented. A critical review of key studies is given at the end of this chapter.

Chapter 3 (Research Questions and the Hypotheses) A comprehensive account of the research problem is given together with hypotheses which were tested. A definition of risk is formulated, based on the literature consulted.

Chapter 4 (Research Methodology) describes methodology used to test the different hypotheses. Special attention is paid to the sample, measuring instruments and statistical analysis. It also describes empirical techniques that were used and precautions taken.

Chapter 5 (The Results) describes and interprets the results obtained in this research. The representativeness of the research sample is discussed. Finally, the study addresses the outcome of the research.

Chapter 6 (The Conclusions) This chapter summarises the investigations and the findings. Recommendations for further research are made.

Having presented a summary of this study, the literature survey follows in Chapter 2.

Chapter 2

Summary of prior research

2.1 Introduction

Previous authors' attempts to track information technology (IT) expenditure, that were found in studies of relevant literature, are dealt with. This provides the background to the problem of investing resources in IT, profitability and the associated levels of *cost-benefit analysis (CBA)* and *risk* involved.

The need to define information systems (IS) and the value of information is addressed in Section 2.2. This is necessary for purposes of IT costs classification and the measurement of the value of information. Earlier attempts to assess the value of the intangible benefits of IT such as those by Ahituv and Neumann (1990) include the effect of expenditure, such as research and development. These are included because they can affect performance and certain benefits, which the organization receives, in the long run. Chargeback systems will be discussed (Hufnagel and Birnberg: 1989; Bergeron: 1986) because it could be deemed as the first attempt to assign value to information.

The appropriateness of using models which can establish IT investment measures, and keep the concepts of CBA and risk in mind, are discussed briefly. The decision to keep both these aspects

in mind, while investing resources in IT, was taken to retain the emphasis on risk as recommended by certain authors such as Weill and Olson (see Section 2.3). Key studies were identified on account of their contribution and because they endeavoured to identify new directions in IT investment measures. These studies are critically reviewed.

2.2 **Definitions of Information System and the value of information**

Since the study focuses on investment in IT, it is clear that information systems and their value require consideration. Thus the terms *information systems* and the *value of information* have been defined and described, using literature consulted.

2.2.1 **Definition of Information System**

Murdick and Ross (1977), in a literature study of management information systems (MIS), define a *system* as a group of elements that are interrelated in order to accomplish a specific purpose. The definition of Schoderbeck *et al* (1990), in a literature study of conceptual considerations of management systems, is that a system is a *set* of objects together with *relationships* between the objects and between their attributes, and to their *environment* to form a *whole*.

Brabb (1976), in a literature study of computers and information systems (IS) in business, defines *information* as one of several resources found in an organization. Ward (1987), in a literature study on the integration of IS into business strategies, records that information is an increasingly

important business asset. This should be used effectively to maximise the contribution thereof before it depreciates.

Ives *et al* (1980), in studying past research frameworks, observe IS as a collection of subsystems defined by functional or organizational boundaries. Davis (1985), in an empirical study on user acceptance of IT, defines MIS as an integrated, user-machine system for providing information to support operations, management, and decision-making functions in an organization.

Since Ahituv and Neumann's (1990) definition is in agreement with those definitions of other authors discussed above, their definition was accepted for this study. That is, a computer-based information processing system is a mechanism designed to support operations, managers and decision functions within an organization.

2.2.2 The definition of the value of information

The only detailed definition that was discovered in the literature was the one by Ahituv and Neumann (1990). The approach to the value of information, as conjectured by Ahituv and Neumann (a literature study: 1990), is related to who uses it, when it is used, and in what situation it is used. They postulate that information does not have an absolute universal value because any attempt to assess the value of information should be closely tied to the decision supported by the information.

2.3 Previous attempts to quantify benefits received of Information Technology investment

2.3.1 *The tracking of Information Technology investments*

This section describes efforts at tracking IT investments found in the literature, and discusses problems encountered. Only three in-depth studies could be located: one by Weill and Olson (1989) and two by Harris and Katz (1988, 1991).

Weill and Olson (1989) used case studies to investigate how IT is "defined" by IS/IT practitioners for the purposes of determining the level of IT investment, how IT investments are measured and tracked and managed, and what factors influence IT investment decisions. They record that the Product Portfolio and Profit Impact of Marketing Strategy (PIMS) established average IT expenditure at 2% of revenue. Turner (1985) notes in agreement that measurement of IT performance does not capture all factors that contribute to high organizational performance. He further found no relationship between organizational performance and the portion of resources allocated to IT.

Weill and Olson confirmed that the link between IT and corporate strategy varies. Claims which emerge from their study include the suggestion that managers need to adopt a broad definition of IT so that they know what that investment is, and that IT expenditure should be measured and tracked over time against a convenient base. This base can include revenues, total expenses or

management controlled costs. This suggests that the amount of every IT investment could be treated as a portfolio investment with different aims and associated levels of risk.

According to them, matters for consideration are IT investment and return on IT investment. Weill and Olson (1989) postulate that IT investment does not lend itself to return on investment (ROI) approaches because it is difficult to determine the income stream and therefore the calculation of a meaningful ROI is thus not possible. Additionally investment in IT tends to be spread throughout the organization. The outcome of these investments, they continue, are likely to be the result of interactions among a number of different project investments in IT (namely database, hardware, etc.).

Shoval and Lugasi (1988) conducted a literature study on a graphical cost-benefit approach to computer systems selection. They focus on methods for comparing the costs and benefits of proposed options. During evaluation and selection, comparison of choices should relate predicted benefits and costs. Shoval and Lugasi assume, however, that the benefits aspect (unlike cost) is difficult to measure in monetary or other quantitative terms.

Harris and Katz (1988 [initial study], 1991 [completed study]) studied the relationship between profitability and IT expenditures in forty insurance companies. They tracked IT investment against non-interest operating expenses. The results suggest that what they termed the "most profitable firms (top performers)" are more likely to spend a significantly higher proportion of their non-

interest operating expense on IT. Harris and Katz note that the "least profitable" firms are more likely to spend a significantly smaller proportion of their non-interest operating expense on IT. They note, however, that each business situation should be evaluated on its own merits (see Section 2.4 and Appendix A) and thus could not provide an instrument guaranteed as universally reliable.

As is evident, the literature covered above suggests the need to calculate the total investment in IT and benefits received. No general method of determining such benefits, however, could be found in the literature surveyed. Shoval and Lugasi (1988) note in agreement that the decision-maker will, with this knowledge, have to weigh various investment alternatives against each other to make the final investment decision.

2.3.2 Previous attempts to classify costs in assessing the value of information

Ahituv and Neumann (1990), in a literature study of management information systems, postulate that any attempt to assess the value of information should be linked to a decision supported by the information provided. They emphasise the need to employ economic criteria in IS planning and development and recorded difficulties involved in assessing costs and benefits of information.

Ahituv and Neumann (1990) further posit that the selection of criteria to be used in comparative analysis, and the performance of numerical calculations, is the easier part in cost-benefit analysis (CBA). The difficult part, they claim, is to identify all the elements that form part of costs and benefits, and to determine how to measure (or estimate) all these elements. They thus classify

costs into the following categories: tangible monetary costs; tangible non-monetary costs; and intangible costs. The last category they sub-divided into costs transformable into monetary terms, and those that cannot be transferred into monetary terms.

Keen (1981) proposes the use of an evaluation technique of benefits received, from making an IT investment, which he calls value analysis. This technique differs from CBA in that the emphasis falls on benefits. The evaluation technique is based on the assumption that benefits are of primary interest to decision makers and that computing the CBA is redundant if benefits meet some threshold. This also applies, he claims, where the costs are within some acceptable limits. This method attempts to reduce risk by insisting on prototyping as part of the evaluation process. A drawback of this proposal, Keen notes, is the limited form of evaluation that may include relevant measures.

Ahituv and Igbaria (1988) address the problem of establishing a financial policy for managing computer systems. They propose a model incorporating facets such as: determining the cost rates of hardware resources and evaluating the impact of pricing policy and budget planning. These authors conjecture that managing a computing centre involves some major activities: namely the costing of computer activities; pricing of computer services; and budgeting for the future acquisition of resources and operations. Additionally, they claim, the common method for allocating direct and indirect cost consists of identifying measurable computing activities, allocating direct costs, overhead costs and determining standard rates for each unit of resource being used.

Ahituv *et al* (1989) conducted a literature survey on the relationship between various organizational attributes and the deployment of hardware resources. As a basis for their hypothesis, they searched for previous evidence of a link between economic sector and hardware distribution in IS literature, finding none. Additionally, no significant relationship was found after completion of the statistical analysis. This was controlled by focusing on the omittance or aggregation of certain categories. It was also determined that there was no further indication of a significant relationship between the various organizational attributes and the deployment of hardware resources.

It was observed by Ahituv *et al* (1989) that information on sectoral organization cannot assist in predicting the level of hardware distribution. It is difficult, they assert, to price computer services because of the existence of intangible benefits. Keen notes, however, that it is possible to reduce the risk involved in doing value analysis of benefits by using prototyping as part of the evaluation process. In other words, an approximate measure is preferable to no measurement at all.

2.3.3 Attempts to measure the effectiveness of the usage of information technology and benefits that it imparts to the organization

Various approaches were used by researchers such as Kwong and Mohamed (1985) and Ward (1987) to measure the benefits that an organization receives. Ward (1987) claims that contrary to common policy, expense such as research should be included as part of the total IT investment cost.

Kwong and Mohamed (1985) suggest the use of a *computerization index* (CI) in their empirical study on the quantitative evaluation of the impact of computerisation on profitability. CI, they claim, measures the extent and sophistication of computerisation. It incorporates factors such as the number of computers, application software, staff, number of shifts and the years of computer usage. Also the size of the Central Processing Unit (CPU), hardware costs, organizational location, level of management activity, and project-investment analysis (see Appendix A).

Kwong and Mohamed (1985) compare the methods of Product Portfolio and Profit Impact of Marketing Strategy (PIMS), and the Boston Consulting Group Method as measurements of financial performance. In contrast with Harris and Katz (1988) the conclusion is that return on investment (ROI) is a suitable measure of financial performance in spite of its deficiencies in dealing with the timing, duration and risk differences among returns. Consequently their decision was to use multiple measures of financial performance (for example *Gross Margin: Gross profit/Total sales*).

Kwong and Mohamed observe that the organizations examined showed an "increasing degree" of computerisation. They note that this "generally" relates to an increasing profitability margin as indicated by the positive correlation between the CI and the ratio of pre-tax profit to revenue. Their conclusion was that computerisation is positively associated with improved performance, in both the short and long term.

Ward (1987) in a literature study of the integration of IS into business strategies, conjectures that there are trends of a decrease in the costs of IT and increase in capabilities in IT. This trend would boost the use of technology in both the economic and technical fields. He claims that central planning enables a better understanding of competitive opportunities and requirements.

Ward conjectures further that research and development expenditure may include wasted investments because of "trial and error": that is, discarding recently acquired IT when it proves to be inappropriate. This implies that IT investments can be expensive and wasteful, and requires competent managers to convert original ideas into effective applications. According to him, IS applications are the end product of IT development, and like an investment, must provide at least an approximate return. He notes that managers must keep in mind that the potential advantage to be gained from IT will rise and fall according to the profitability of the organization at large, as is the case with any other risk investment.

King (1988) describes, in a literature study on the effectiveness of IS planning, a comprehensive evaluation of an organization's process for IS strategic planning. He notes that resource inputs have to be used to describe and evaluate the overall impact of IS strategic planning on an organization. King studied the effectiveness of IS planning, describing this as the "evaluative dimension". He uses this term to describe a set of measurements that can be made to address the issue of how well the IS planning system has met its goals. Hence, he claims, it is possible to record the relative worth of the IS planning system.

2.3.4 *The use of chargeback systems where the IT department is seen as a profit centre*

A chargeback system, as defined by Bergeron (1986), is a mechanism that helps users allocate financial resources among projects. It does not ensure the organization of an adequate return on investment for its IS expenses but it should help sustain organizational profitability. Possible solutions where the IT department is seen as a *profit centre* are considered by authors such as Hufnagel and Birnberg (1989) and Bergeron (1986) as the solution to attempts in quantifying IT. This occurs where chargeback systems (Olson and Ives: 1982) try to evaluate information provided by the IT department.

Hufnagel and Birnberg (1989), in a case study of perceived chargeback system fairness in decentralised organizations, suggest that difficulties can arise in decentralised organizations when usage-based chargeback systems are implemented to control computing resources. They note that most chargeback systems are designed directly or indirectly to affect organizational decision making as far as the use and/or management of IT is concerned.

Surveys conducted by Drury (1980) and Choudhury *et al* (1986) in chargeback and non-chargeback environments provide evidence that MIS managers generally are in favour of using chargeback to control the utilisation of scarce information resources. MIS managers, they conjecture, use chargeback systems to control user and management involvement in MIS activities. A study of IS Controls by Mautz *et al* (1983) determined that chargeback systems provide benefits: an

assertion supporting the benefits noted by Drury and Choudhury *et al.* Mautz *et al* describe these chargeback systems as "difficult to operate" on an equitable basis.

In a field survey, Bergeron (1986) investigated the factors involved in the use of IS chargeback in organizations. He found that it was possible to assess the relative competitive efficiency and capability of the IS department and to provide information on the costs of adding or removing computer applications. Another finding, however, is that chargeback systems do not ensure the organization of an adequate ROI for its IS expenses but may help sustain the organizational profitability.

Solomon and Tsay (1985), in a study on current chargeback practices, identify primary purposes for internal pricing schemes. First, transfer pricing (a form of chargeback pricing) is designed to motivate profit centre managers to make sound economic decisions. Second, transfer pricing provides a basis for rating the performance of each profit centre in terms of its separate contribution to corporate goals. Ronen and McKinney (1970) support these principles. They add another constraint, namely, that transfer pricing system must motivate managers to increase their operating efficiency without a loss in the autonomy of divisions as profit centres.

Hufnagel and Birnberg (1989) conjecture that dual chargeback pricing indicates that cost-based prices are preferable when the selling unit is a cost centre. They posit some benefits of a dual chargeback pricing system as: (i) it serves as a means to compensate divisional managers for the

loss of autonomy resulting from a policy of mandated internal sourcing; (ii) as divisions could buy computing services at competitive rates, divisional concerns about fairness should vanish; and (iii) a strategy of dual pricing on internal sales should eliminate the inevitable conflict that will occur if divisions found that external clients were charged less. Dual pricing is not recommended by them as a long-term solution, for this could create organizational slack owing to the favourable price each unit receives. The dual pricing system approach consists of charging buyers full-cost for products/services purchased internally, while crediting sellers with market price on the sale. Despite the chosen method they claim, market price usually exceeds full cost.

McKinnon and Kallman (1987) developed a model, mapping chargeback systems to organizational environments in their study. They postulate that a critical problem facing MIS is to decide what kind of chargeback system to install and whether it will be applicable in the future. A complete chargeback accounting service, they claim, should record usage in such detail that it identifies all consumed resources and it should identify the individual performing the work and the department receiving the benefit. They postulate that organizations have to analyze all computing costs to provide a basis for selecting a pricing strategy. Howard (1981) suggests that organizations should cost each IS processing resource category individually and then charge this out. This will allow user managers to associate charges with the value of services delivered.

Allen (1987) in a literature study on methods to make IS pay its way, suggests that companies can use IT as a key to competitive advantage. This can be effected by running IS as a business within

a business. It must be remembered, notes Allen, that a profit centre department differs from other departments because budgets are variable and the centre sells services at a price. He further indicates that charge-out is a matter of costing, not pricing.

Allen explains that in the past hardware had been the big cost item. Today costs have shifted towards software. He conjectures that economies of scale in processing no longer exist, but IS overhead is still a cost borne by users. Allen summarises these ideas by noting that IS costs are not really fixed but can be made to vary with volume or demand over time. He reports that one advantage of viewing the IS department as a profit centre is that the organization benefits from this. It encourages the use of information processing when the total value of using the service exceeds the cost of the service and when the price received by IS for the service exceeds its cost.

As can be seen from the above, the chargeback systems method is one technique used to quantify the benefits which an organization receives from IT (Hufnagel and Birnberg). Mautz *et al* observes that these chargeback systems are complex to operate. Allen, however, postulates that a competitive advantage can be gained from them.

2.4 Models for IT investment decision making

To test statements made by authors such as Weill and Olson, and Harris and Katz in the literature studied, and to justify decision making on IT investments, suitable models were required. Eleven

such models for IT investment decision-making were found in the literature. These are: Computerization index (CI), operating leverage (OPEL), return on IT assets (R_a), organizational factor, revenue stability, stochastic process simulation (SPS), IT expense ratio (ITEX), operating cost efficiency ratio (OPEX), IT cost efficiency ratio (ITCE), the probability of making an IT investment when organizational risk is affected positively/negatively when making an IT investment, and cost-benefit analysis ratio (CBA). Detailed descriptions of the mathematical calculations supporting each model may be found in Appendix A. A brief description of each follows.

2.4.1 *Computerization Index (CI)*

Kwong and Mohamed (1985) quantitatively evaluated the impact of computerization on profitability by developing a computerization index (CI) in full. The CI is claimed to measure the extent and sophistication of computerization. Ten variables (for example years using computers, management activity level, etc.) were selected to collectively represent the computerization process (see Appendix A).

2.4.2 *Risk and risk related measures*

According to Weston and Brigham (1981), business risk is measured by the variability of the operating income over a minimum period of two years (earnings before interest and taxes: EBIT). An influence on the degree of variability in EBIT is the extent to which the organization has fixed operating expenses (operating leverage) such as depreciation on fixed assets (see Appendix A).

Business risk is the inherent uncertainty or variability of expected pre-tax returns on the organization's portfolio of assets, according to them. Gitman (1991) defines business risk as the risk to the firm of being unable to cover its operating costs. He conjectures that revenue stability affects business risk.

Weston and Brigham define operating leverage as the percentage change in earnings before interest and taxes (EBIT) divided by the percentage change in turnover (EBIT will be equated with operating profit for the purpose of this study). Operating leverage affects EBIT, while financial leverage affects earnings after interest and taxes (earnings available to the owners).

2.4.3 *Stochastic Process Simulation (SPS)*

Post and Diltz (1986) describe the stochastic process simulation (SPS) approach as consisting of two fundamental changes to the expected value approach to risk analysis. This was in a case study on the use of the SPS approach to risk analysis of computer systems. The primary objective is to compare the costs associated with various options. SPS analysis evaluates the entire distribution of IT investments. Only the basic interpretation of SPS is presented (see Appendix A for a detailed discussion). SPS considers any project as a whole and takes uncertainty (risk as defined above) into consideration when any investment is reviewed (Wilson: 1969). Ziemba and Vickson (1974), in a study of stochastic models in finance, suggest that the investor will normally have some investment options available from which they can freely choose. They conjecture that the investor's goal is to maximize the expected utility of terminal wealth.

The first step, it can be conjectured, in this approach is to assume that the initial IT investment must be replaced or enlarged. The next step would be to analyze the effects of the assumed IT investment at various points in time. According to Post and Diltz, the analyst should examine all the areas of the system that are to be replaced or enlarged. While comparing alternatives, the decision maker has to realise that he/she is faced with a set of risky alternatives.

Gottfried (1984), in his literature study on elements of stochastic process simulation, notes that the objective of SPS in risk analysis is to assess the desirability of the proposed investment. This he bases upon some financial decision criterion such as present worth. He posits that comparisons can be made based on an acceptable level of risk. Post and Diltz conjecture that the primary advantage of SPS methodology is that it is designed to answer the specific question of what type of investment should be made. The point of this analysis, they note, is in helping managers selecting between alternative IT investments.

2.4.4 *IT related ratios*

Harris and Katz (1988, 1991) (see Appendix A), in a study of the relationship between profitability and IT expenditures, set forth a theory that the most profitable firms are more likely to spend a significantly higher proportion of their non-interest operating expense on IT. In other words, they consider the organization to be IT capital intensive. They note that the least profitable organizations are more likely to spend a significantly smaller proportion of their non-interest operating expense on IT.

The ratios described by Harris and Katz reflect IT expenditures of organizations. The model calculates two ratios, one being the *operating cost efficiency ratio* (OPEX)(non-interest operating expense to premium income) and the other being the *IT expense ratio* (ITEX)(IT expenses to non-interest operating expenses). These ratios are used for comparison and to plot graphs for visual presentation in the actual research.

2.4.5 Cost-Benefit analysis

Shoval and Lugasi (1988) in a literature study on a graphical cost-benefit approach to computer systems selection, postulate that a cost-benefit graph can be used by the decision maker to select among alternative computer systems while not only considering the best cost-benefit ratio, but also the relative importance of the benefit and cost factors in a given situation. They note however, that the cost-benefit ratio needs to be supported by some form of a graphical tool to show the absolute values of the parameters, their relative importance to the decision maker, and his attitude to risk and uncertainty (see Appendix A); a utility theory based on von Neuman's principle.

2.5 Critical review of key studies

2.5.1 Weill and Olson (1989)

Weill and Olson (1989) emphasize the difficulties of measuring both costs and benefits of IT investments. Alternative aggregate measures of performance, such as return on assets or growth rates can be used, but these all face conceptual and practical difficulties, according to them.

The authors claim that the only spending guide available for managers is that of competing organizations. They overlook the fact, however, that it is difficult for competing organizations to acquire each other's information on levels of IT expenditure.

While noting that IT investment does not lend itself to ROI approaches they claim that certain IT investments can give a negative return. This was in contrast with the conclusion by Kwong and Mohamed (1985) that PIMS base their method on ROI as a suitable measure of performance. Weill and Olson (1989) record a variety of definitions and methods of tracking of IT in the reported case studies. This makes it difficult to come to a conclusion in the empirical sense. They postulate that it is almost impossible to identify all costs connected with resources because some hidden costs will arise from operational expenses. This, it will be noted, conflicts with the findings of McKinnon and Kallman (1987).

2.5.2 *Kwong and Mohamed (1985)*

The variables used by Kwong and Mohamed for their CI do not consider the organization (system) as a unit, as defined by Schoderbeck *et al* (1990) in their literature study, nor did they research the objectives of complete systems. They did not focus on the processes that link the parts of a system together. This is in conflict consequently with the definition of the system that was accepted for use in this study, by which relationships between objects and their attributes are clearly defined. This is relevant because the boundary of their study is consequently not clear.

The analysis by Kwong and Mohamed reveals that there is a positive correlation between performance and the degree of computerisation. Weill and Olson (1989) recount cases where a relationship between IT investment and performance were indeed established. They note, however, that the results could not be generalised beyond that particular industry. Kwong and Mohamed note that large CI's associate with an increase in ROI. Weill and Olson, however contradict that by noting that IT investment does not lend itself to ROI approaches because of the problem to determine the income stream, and because of the spread of IT throughout the organization.

2.5.3 *Bergeron (1986)*

Hufnagel and Birnberg (1989) criticise the study of Bergeron (1986) for being interpretively too broad for application. Contingency theorists in management accounting (Otley: 1980) point out that there may not be a single control system that is universally appropriate in all organizations under all circumstances. King (1988) notes that allocation problems for costs in centralised organizations are different from the ones in decentralised organizations. Bergeron did not considered this. Hufnagel and Birnberg further note that it is not surprising for billing information to be used by managers who are charged in ratio to their use of computing resources, rather than by managers who receive a simple overhead allocation. Hufnagel and Birnberg claim that one should be aware that report usage alone does not ensure effectiveness.

McKinnon and Kallman (1987) note that the Bergeron study reports the benefits and weaknesses of the structure of chargeback-systems. It ignores the question of how an organization should select the chargeback-system that provides the information useful to an organization.

2.5.4 *McKinnon and Kallman (1987)*

A point of criticism against the model defined by McKinnon and Kallman (1987) is that they mapped the chargeback system to the organizational environment. This is in conflict with Schoderbeck *et al* (1990) who claim that problem-solving necessitates a broad consideration of a system rather than an overly obsessive scrutiny of the particular problem in question. The system's environment is only one of five basic considerations concerning system thinking identified by them.

A statement made by McKinnon and Kallman, is that a chargeback system is an accounting process for maintaining resources. A pricing process for linking with users needs to be clarified. Hufnagel and Birnberg (1988) note, for example that one of the drawbacks of a chargeback system is the assumption that dual pricing will phase itself out in time if there is sufficient demand for the system's services.

2.5.5 *Allen (1987)*

Allen's (1987) view, that IS should be turned into a profit centre, could be criticised based on the findings of Weill and Olson (1989). The latter authors conjecture that the cost involved in IT is

generally embedded within the operating budget of a department, which makes this cost difficult to distinguish from other costs. The profit of the organization could eventually be influenced.

Mautz *et al* (1983) reason that chargeback systems provided benefits, but claim that the systems are difficult to operate on an equitable basis. Allen claims that chargeback is a matter of costing not pricing. McKinnon and Kallman (1987), however, note in contradiction that chargeback system is an accounting process for monitoring resources and a pricing process to interface with users.

It must be remembered that when IS is run as a cost centre, managers control the funding for computing and are responsible for monitoring the efficiency of the IS department (Hufnagel: 1989). Allen claims this to be a task which most managers find difficult.

2.5.6 *Harris and Katz (1988, 1991)*

Harris and Katz (1988) acknowledge that evaluating whether a firm's level of investment in IT is sufficient (or insufficient), or represents a competitive edge, has been a problem historically for top managers. This is owed to the lack of competitive information on a sufficient number of firms. Part of this problem can be described as the lack of agreement between business firms and academics on the appropriate measures to study IT effects. Weill and Olson support this statement by noting that it is difficult to establish a relationship between the benefits an organization receives from IT and the actual IT investment.

Kwong and Mohamed support the study by Harris and Katz in establishing that the higher the computerization, the higher the profitability of an organization. Harris and Katz posit that the potential risks, as well as the potential rewards associated with investments in IT may be accelerating. This is supported partly by Weill and Olson who note that there is a possibility of treating the amount of every IT investment as a portfolio investment with different aims and associated levels of risk. Harris and Katz's study establishes an amount of causality (although they did not establish which direction), while Ahituv and Igbaria (1988) and Weill and Olson (1989) did not establish any link between IT investment and the profitability of an organization. Weill and Olson support the use of a measurement of IT expenditure against a convenient base as used by Harris and Katz.

2.6 Conclusion

This chapter refers to attempts by researchers (Weill and Olson, Shoval and Lugasi, Hufnagel and Birnberg, Harris and Katz and McKinnon and Kallman) to quantify benefits received from IT investment. All these authors conjecture that no concrete calculation of the total impact of IT has been made. However, no study was found in recent IS literature that kept the concept of the change in risk in mind while investing resources in IT. Authors like Weill and Olson, Harris and Katz and Ahituv and Igbaria (1988) recorded the importance of risk when making an IT investment. Weill and Olson posit that every IT investment (portfolio investment) does have an associated level of risk. This provided one motivation for this study: to compare the models that

measure changes when resources are being invested in IT, in any organization, while accommodating the reality of risk.

Over the last few years some authors (Weill and Olson: 1989 and Ahituv *et al.*: 1989) examined the possibility of quantifying IT expenditure. Weill and Olson suggest that most surveys underestimate the total investment in IT. Almost all the authors (Weill and Olson: 1989; Kwong and Mohamed: 1985; McNurlin and Sprague: 1989; Hufnagel and Birnberg: 1989 and Harris and Katz: 1988) note that the link between IT and performance vary. The problem they foresee is the measurement of the intangible benefits of IT. They all agree, however, that the value of information should be closely linked to the decision supported by the information available. Ahituv and Neumann (1986) claims that all the components of IT should be considered if the right pricing method for the chargeback of IS is to be selected.

Some authors (Kwong and Mohamed: 1985 and Harris and Katz: 1988) established a definite link between IT investment and an increasing profitability margin. They note that an increase in the profitability margin could be found in similar organizations in the same industry. All the studies researched agree that investing in IT could make a contribution towards the benefit which the organization receives.

As can be seen from the above little definitive work has been carried out in the field of measuring the impact of IT investment on profitability and risk of an organization. From the contradictory

views expressed by credited experts, much of this research is in any case open to question. Based on these uncertainties, hypotheses could be formulated which are discussed in Chapter 3.

Chapter 3

Research Questions and the Hypotheses

3.1 Overview of the chapter

This chapter outlines the research questions and the hypotheses for this study, based on the literature discussed in Chapter 2.

3.2 Research Questions

It was noted in the conclusion to Chapter 2 that certain areas remain open to discussion. Attempts were made, for example, to quantify benefits received from IT investment, but no definite conclusion could be drawn (see Section 2.6). As noted, Weill and Olson; and Ahituv and Igarria conjectured that no concrete calculation of the total impact of IT had ever been made; the former in fact suggest that most surveys underestimate the total IT investment. No definite study was found that included the measurement of risk prior to an IT investment. However authors such as Weill and Olson; Ahituv and Igarria; and Harris and Katz suggest that IT investment does have an associated level of risk.

This claim gave rise to the fundamental objectives of this study, which were to evaluate the effect of IT investment on the business's profitability, cost-benefit analysis ratio and the risk of an organization. Subsequently the following research questions were identified: (i) What is the impact

of IT investment on the profitability of an organization? (ii) Will the initial IT investment target be changed if managers can assess the changes in an organization's risk? and (iii) What is the impact of IT investments on the organizational risk, cost-benefit analysis (CBA), operating leverage (OPEL) and return on IT assets (R_a).

3.3 Risk

3.3.1 *Definition of Risk*

As noted above, this research is based partly on the concept of *risk*. Risk is defined histographically by Weston and Brigham (1981), in a study of financial theory, as the probability of the occurrence of unfavourable outcomes. Kast and Rozenzweig (1972) posit that certainty involves complete knowledge, and at the other end of the spectrum is uncertainty or a complete lack of knowledge. They postulate that the continuum between certainty and complete uncertainty could be called risk. Gitman (1991) defined business risk as the risk to the firm of being unable to cover its operating costs. Copeland and Weston (1983), in a literature study of financial theory and corporate policy, define risk in a similar manner. This, it will be noted, also agrees with Weston and Brigham's definition. With this consensus in the literature, Weston and Brigham's definition of risk was assumed for the present study; that is, as the probability of the occurrence of unfavourable outcomes.

3.3.2 *The Measurement of Risk*

Risk was dealt with in this study in relation to the models of significance found in the literature. These were CI, operating leverage, return on IT assets, revenue stability, IT related ratios, SPS and CBA (see Section 2.4). Stochastic decision trees and scatter diagrams were used to apply SPS for simulation purposes. SPS considers any project as a whole and takes uncertainty (risk as defined above) into consideration when any IT investment is reviewed (Wilson: see Section 2.4.3). Leverage (see Section 2.4.2) considers both financial and business risk when an organization is under investigation because, Brigham and Capenski (1988) argue, an organization's total risk depends on both. Gitman (1991) conjectures that operating leverage and revenue stability (or profit growth) are "important" factors affecting business risk.

3.3.3 *IT Investment*

IT investment, in the context of this study was taken to mean the amount spent by an organization on all IT equipment and related overheads during the financial year under investigation. Harris and Katz (see Section 2.4) denote this as *IT capital intensity*. The research sample had thus to be limited to those organizations that were prepared to disclose these costs.

3.4 **Development of the Hypotheses**

3.4.1 *The relationship between IT investment (CI) and profitability*

Hypotheses were required to investigate the impact and extent of the sophistication of IT investment (CI) on the profitability of an organization. Kwong and Mohamed (see Section 2.3.3),

suggest that IT investment reduces the disparity between the industry's profitability and that of the organization of which the industry is part. Weill and Olson (see Section 2.3.1), claimed that every IT investment should be treated as a portfolio investment with different aims and associated levels of risk. Shoval and Lugasi (see Section 2.3.1) postulate that the more the decision maker seeks risk, the narrower the alternatives of selection between computer systems selection; the more risk-averse, the wider is the range for the alternative. Keen (see Section 2.3.2), suggests that organizations should use an evaluation technique of benefits received, after making an IT investment, which he calls value analysis. Ward (see Section 2.3.3) concludes that IS applications are the product of development, and like an investment, must provide almost a return on that investment. Hence, after noting the conjectured relationships between profitability and computerization, Kwong and Mohamed's claim could be rephrased as follows:

H1_a: *There is a positive association between IT investment (CI) and profitability of an organization.*

H1_b: *There is a positive association between IT investment (CI) and the growth of the organization's turnover.*

H1_c: *There is a positive association between IT investment (CI) and profitability of an organization (OPEX).*

H1_d: *There is a positive association between IT investment (CI) and the value of IT expressed in monetary terms.*

3.4.2 *Measuring the impact of IT investment (ITEX) on the profitability of an organization*

To enable the present study to compare the studies by Kwong and Mohamed with that of Harris and Katz, it was deemed necessary to compare the profitability measure used by Harris and Katz to the profit growth measurement as used by Kwong and Mohamed. Hence the following hypothesis was conjectured:

H_{2a}: *OPEX and profit growth ratios as profitability measures are negatively associated.*

Harris and Katz (1991) note that Bender (1986) established the potential of linking the firm's performance to IT expense measures. Hence:

H_{2b}: *A negative association exists between profitability measures and computerization (ITEX).*

Harris and Katz (see Section 2.3.1), note that technology is altering the way companies compete and that there is an increased incentive to examine closely the link between the business strategy of the firm and the IT strategy. They evaluate, in their research on organizational performance and IT, the extent to which IT is a critical activity in the home office operations of systems technology leaders. Hence the following hypotheses were conjectured to test the cost efficiency of IT, computerization, and profitability:

H_{2c}: *There is a positive association between cost efficiency of computerization (ITCE) and computerization (ITEX)*

H_{2d}: *A negative association exists between cost efficiency of computerization (ITCE) and profitability (OPEX).*

Harris and Katz (see Section 2.3.1) conjecture that to state that the level of IT investment is sufficient has been a problem historically for top management. They furthermore state that each business situation should be evaluated on its own merit. Hence the following hypotheses were conjectured:

H_{2e}: *There will be a negative association between the value of IT expressed in monetary terms and profitability (OPEX).*

H_{2f}: *There will be a positive association between the value of IT expressed in monetary terms and computerization (ITEX).*

H_{2g}: *There will be a positive association between the value of IT expressed in monetary terms and ITCE.*

3.4.3 *Measuring IT investments against risk and risk related measures*

Hypotheses were formulated to investigate the following research questions: Will the initial IT investment be changed if managers can assess the changes in an organizations' risk?; and What is the impact of IT investment on risk, CBA, OPEL and R_a? Post and Diltz (see Section 2.4.3), claim that stochastic dominance methodology can assist managers to choose between alternative IT investments (see Appendix A). In short, the following hypotheses were suggested to test this:

H_{3a}: *There will be a positive association between the organizational risk factor and the probability of making an IT investment if organizational risk is affected.*

H_{3b}: *A positive association exists between the organizational risk factor and computerization (ITEX).*

H_{3c}: *There is a positive association between IT investments (CI) and the organizational risk factor of an organization.*

Ziembra and Vickson (see Section 2.4.3) suggest that the investor will normally have some investment options available from which they can freely choose. Shoval and Lugasi (see Appendix A; Section 3.3) posit that the absolute values of the parameters must be considered, as must their relative importance to the decision maker, and his attitude towards risk and uncertainty.

H_{3d}: *There will be an association (positive/negative) between computerization (ITEX) and the probability of making an IT investment if organizational risk is affected.*

Post and Diltz (see Section 2.4.3) note that stochastic dominance methodology can be applied to less extensive investments as well as by considering individual components separately and adjusting the time frame as necessary. Gottfried (see Section 2.4.3) recorded that the objective of stochastic dominance in risk analysis is to assess the desirability of the proposed investment. He suggests that comparisons can be made based on an acceptable level of risk. What one can conclude therefore, assuming Post and Diltz are correct, is that stochastic dominance can also be applied to IT investments and can assist managers to choose between alternative IT investments by generating a cumulative distribution for the decision criteria. Hence the following hypotheses were posited to test these statements:

H_{3e}: *There is a positive association between IT investment (CI) and cost-benefit analysis (CBA) as assessed by the IT/IS/Financial managers.*

H_{3f}: *There is a positive association between IT investment (ITEX) and CBA as assessed by the IT/IS/Financial managers.*

H_{3g}: *The risk profile of managers in developing countries differs from the risk profile of managers in first-world countries.*

In the next chapter, a detailed discussion of the research methodology used to test all the hypotheses recorded above is given.

Chapter 4

The Research Methodology

4.1 Overview of the Chapter

The research methodology involved organization sample selection, the models to be used and the rationale for each model. Additionally the instrument questionnaire and its development is discussed. Finally the precautions used are outlined.

4.2 Organization sample selection

For the purposes of this study Namibia is defined as the geographic region consisting of the original South West Africa (under colonial SA rule) together with Walvis Bay. Walvis Bay is included because of its dependency on Namibia and (at the commencement of this study) its proposed inclusion into Namibia. Namibia was selected as an example of a developing country because of certain economic characteristics discussed below.

Organizations in Namibia are "typically small" as defined by the Namibian Information Piece (issued by the Namibian Government: 1990). Such organizations, according to this body, are operated as owner-controlled companies with close relatives sometimes employed in key positions and are not controlled by formal structures but by obligation networks.

The complete listing of organizations using IT in Namibia was available from a strategic planning list produced by a major computer organization (see Section 4.4.1 and Appendix N). A random sample of 120 organizations was selected from this list, and questionnaires were sent to each. Of the 50 questionnaires that were received back, two were discarded because they were incorrect. This gave an effective response rate of 40%. The resultant sample of 48 was assumed to be representative of the Namibian IT-using population since no arguable relationship could be established between the parameters measured and the tendency of an organization to return the questionnaire. There could also be no relationship argued between the sensitivity of the data and the tendency to return the questionnaire, since respondents were encouraged to divide all their financial responses by a common factor known only to themselves (see Section 4.4.1).

4.3 The Models used

All eleven models (see Section 2.4) were tested simultaneously by virtue of one questionnaire (see Appendix B). Because of the diversity of the models found in the literature (see Section 2.4) (CI, operating leverage, return on IT assets, revenue stability, IT related ratios, SD, and CBA) it was felt that the research would benefit by using each model and comparing results obtained. Conclusions on the appropriateness of using each model are discussed in Chapter 5.

It was necessary to modify some of the models to include decision criteria related to risk, using stochastic process simulation. These additional requirements could be partly met by using the decision tree approach. Decision trees (Hespos and Straussman: 1965: see Figure 5.5.2) allow for

an overall picture to be presented of both the problem and outcome associated with the various alternatives. The measurement of risk could be included by expressing various outcomes in the tree, in terms of probabilities. The appropriateness of this modelling approach was assumed since, according to Hespos and Strassman, it enables managers to associate probabilities with specific outcomes.

4.4 **Collection of Data**

4.4.1 *Introduction*

The financial data were gathered either from financial statements or from the instrument or from a computer organization in Namibia which had accumulated such data over 25 years. Where such data was incomplete, the data collection process was supplemented by an interview and/or audited working papers for the period under investigation (where available). The period under investigation was taken as 1990 -1992 inclusive, since political changes in Namibia had been finalised by that stage. This period could supply sufficient information to perform the necessary calculations, despite the obvious advantage of collected over a longer period.

To preserve the confidentiality, the respondents were given the option verbally of rendering their figures as they were, or divided by a common factor known only to themselves. The questionnaire (see Appendix B) was sub-divided into sections covering details of the organization, type of IT investment, financing of this investment, keeping track of the IT investment, and financial figures that were needed to complete and calculate the necessary models. The questionnaire was piloted

with IS practitioners and academics (see Section 4.4.2 below) and refined to the final version. Where possible the data were collected from reliable, audited accounting records and then used as a validator when replies were received. All the data were entered into a spreadsheet and analyzed.

4.4.2 *Pilot study*

A pilot study was carried out on academics at Rhodes University and 8 life insurance organizations to test for clarity. Alterations were made to remove ambiguities and reflect a clear and concise research instrument.

4.4.3 *Questionnaire design*

To gather data needed to complete the *Computerization Index*, and the *IT related ratios* for the organizations under investigation, a structured questionnaire was constructed (see Section 4.4.2 and Appendix B). The questionnaire included the one described above, but was extended by additional aspects such as the probabilities of making an IT investment, benefit received and classification. These extents were necessary to measure hypotheses 3(a)-(v), and included items which had been used by Shoal and Lugasi (1987/1988). The probabilities associated with risk were evaluated by the von Neuman technique (see Appendix A).

4.4.4 *Completion of the Questionnaire*

Phase 1 was based on the confidential strategic planning list of the same computer companies mentioned above. As discussed in Section 4.2 a list of IT-intensive companies in Namibia was prepared, by randomly selecting a sample of 120 organizations. The second phase consisted of

interviewing (either face-to-face or by telephone) IT/IS/Financial managers in each organization. The third phase was to mail a questionnaire to the target manager identified in the initial investigation. They, or some other executive designated by them, then completed the questionnaire.

4.4.5 *Limitations*

It was assumed that the organizational financial and other figures, as rendered, were accurate and complete where they could not be verified with audit/working papers. Additionally, it was assumed that the respondents completing the questionnaire did so accurately. However, a possible source of error lies in the respondents' interpretation of the terminology used in the questionnaire, although it was pre-tested (see Section 4.4.2).

Furthermore, some data given by the respondents in the questionnaire could not be verified fully, owing to its sensitivity. Also, it was not possible to check on the method of accounting and it is acknowledged that this could have influenced some financial ratios. Given these limitations, it was still possible to use the models to test the hypotheses in order to analyze some of the statements made by the authors (Harris and Katz, Weill and Olson) since these sources of error did not differ from those evident in their studies. It was also possible to interpret the results based on the data obtained as no statistical technique could show them to be unreliable (see Section 5.2).

4.5 Statistical procedure

The questionnaire was analyzed by entering the data into a spreadsheet and preparing frequency and other tables (see Chapter 5). Organizations were classified into installation matrices, based on the matrix used by Harrison and Katz. All calculations (including systematic risk calculations) were done on Quattro Pro Version 4.0 (spreadsheet package) and Statgraphics version 6 (statistical package).

4.6 Analysis of the series of hypotheses

4.6.1 *The relationship between IT investment (CI) and profitability*

Composite CI as defined by Kwong and Mohamed was determined using the data gathered from items 3 - 12 and sections E and F on the questionnaire (see Appendices B, C, D and E). The results were tabulated and ranked in ascending order according to their CI. To detect any relation between the CI and the ratio of pre-tax profit to revenue, the paired data were plotted on a scatter-diagram.

4.6.2 *Measuring the impact of IT investment (ITEX) on the profitability of an organization*

The data needed for these hypotheses are presented in appendices C - M and were collected from item 2 and sections E and F. The operating expense ratio and the IT expense ratio were calculated for the organizations over the three year period, using the data in Appendices C - M. The ratios were averaged over three years. This allowed for the partial elimination of any outside effects that

were not part of the original risk or other influences. Organizations were ranked according to the operating expense ratio and grouped into percentiles to highlight trends.

4.6.3 *Measuring IT investment against risk and risk related measures*

As noted in Appendix A, stochastic simulation can never yield the outcome that a given parameter is exactly x . Risk and risk related measures were calculated using Sections G and H on the questionnaire. In order to use data that are as realistic as industry and organizations can describe them, the data in Appendix B were used. Based on the research questions (see Section 3.2) the desirability of the proposed IT investment was simulated using a graph and stochastic decision trees. Risk conditions were applied using the von Neuman technique enabling the decision maker to form a utility function. This utility function was applied to the cost transformation problem.

This simulation, it was conjectured, could help managers select the IT investment that best fit the risk profile of the organization. The requirement of this phase, as noted in 4.4, was for the inclusion of some decision criteria related to risk. This was because the decision tree approach lends itself to a graphical portrayal of the decision criteria (Hespos and Strassman: 1965). The measurement of risk was included by expressing various outcomes in the tree, in terms of probabilities. This modelling approach was assumed to be appropriate because managers were able to associate probabilities to specific outcomes.

4.6.4 *Variables correlated/used***Table 4.6.1: Variable correlated/used**

Return on turnover (see Appendix A)

	Turnover growth
Profit growth (revenue stability)	Computerization index (CI)
Operating cost efficiency ratio (OPEX)	The value of IT expressed in monetary terms
IT expense ratio (ITEX)	IT cost efficiency ratio (ITCE)
Organizational risk factor	Return on IT assets
Operating leverage (OPEL)	Revenue stability
Cost-benefit analysis (CBA)	Probability of affecting the organization's risk while making an IT investment

All associations, as named above, were measured using Kendall's rank correlation co-efficient. It will be noted from the statements of the hypotheses in Sections 3.4.1, 3.4.2 and, 3.4.3 that specific positive or negative directions are posited. This implied one-tail significance testing in each case.

Having described the research methodology, the results are presented and discussed in Chapter 5.

Chapter 5

The Results

5.1 Overview of the Chapter

Presentation of the data and their analysis will be covered in this chapter. A description of the sample of the organizations that rendered a completed questionnaire is given. Following this are tests of each hypothesis developed in chapter 3. Finally the findings are discussed and assessed.

5.2 Summary statistics from the research sample

This research set out to establish phenomena in IT investment in the population of Namibian organizations. From this deductions were possible with implications for IS research in developing countries in general. As a first step, therefore, the sample was examined to establish the degree to which it represents the Namibian population. Table 5.2.1 presents a summary of the responses to the questionnaires (Appendix B) on the type of IT sophistication (item 2 on the questionnaire); that is according to Harris and Katz (1988; 1991: see Section 2.4.4). Graphically the summarized classification of these organizations was portrayed in Figure 5.2.1 below.

As noted in Section 4.2, the low organizational density and comparatively sparse population of Namibia would suggest a low degree of IT sophistication. Hence the high number of type I organizations in the sample was considered to be representative of the Namibian population.

Table 5.2.1: Classification of Organizations in Harris and Katz's IT sophistication matrix

	TYPE I	TYPE II	TYPE III	TYPE IV	TYPE V	TYPE VI
Frequency	33	1	4	4	4	2
Type I	Single hardware locations; fewer than 25 IT/IS staff.					
Type II	Multiple hardware locations; between 25 - 50 IT/IS staff.					
Type III	Multiple hardware locations; between 50 - 100 IT/IS staff.					
Type IV	Emphasis on batch processing; between 100 - 200 IT/IS staff.					
Type V	Multiple location hardware; between 200 - 400 IT/IS staff.					
Type VI	Multiple location hardware; 400+ IT/IS staff.					

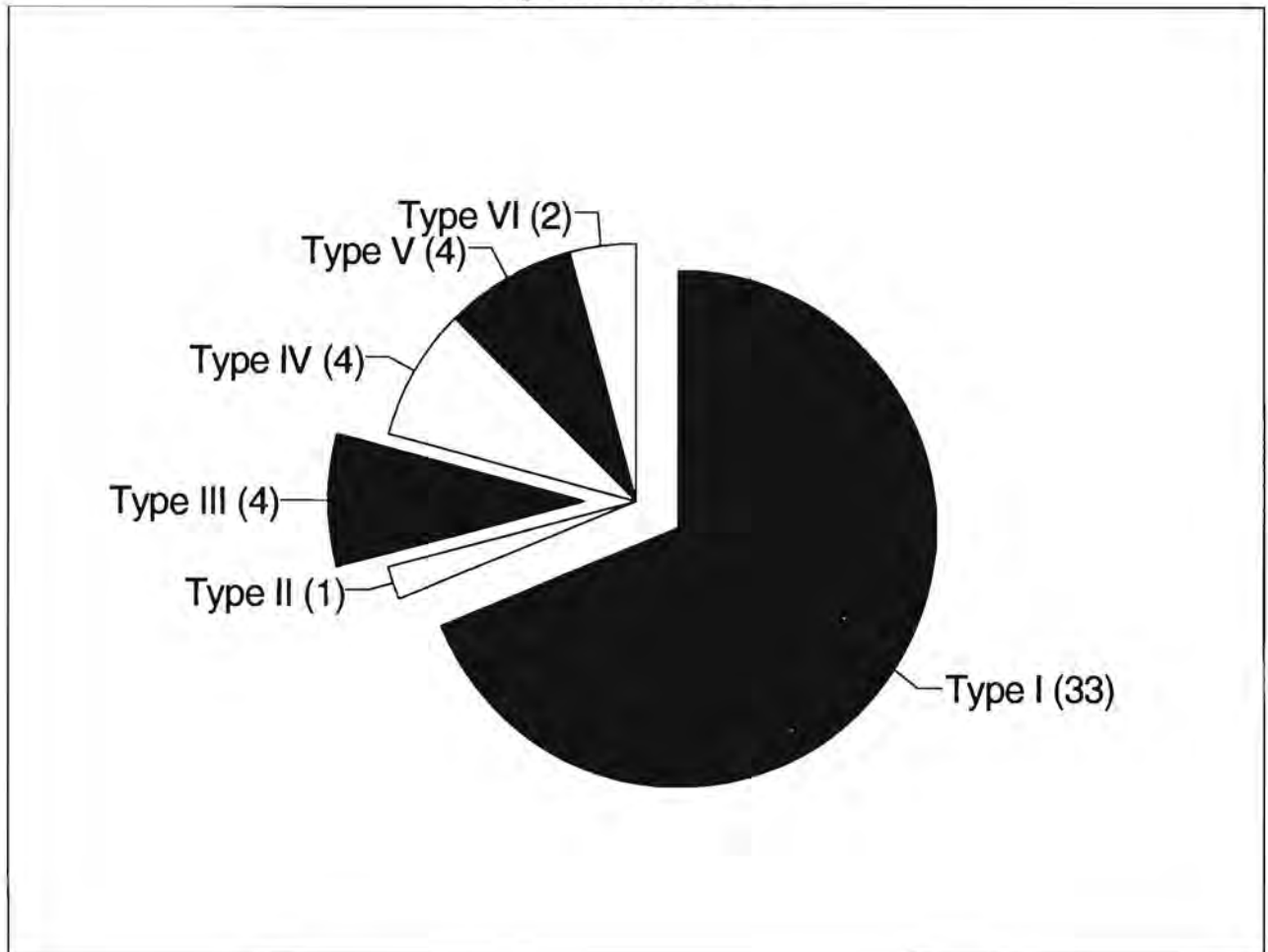
Figure 5.2.1: Classification of organizations in Harris and Katz's systems technology sophistication matrix

Table 5.2.2 contains the probabilities of IT investment as assessed by the respondent managers (Section G on the questionnaire).

Table 5.2.2: Probabilities of making an IT investment as assessed by IS/IT and Financial Managers

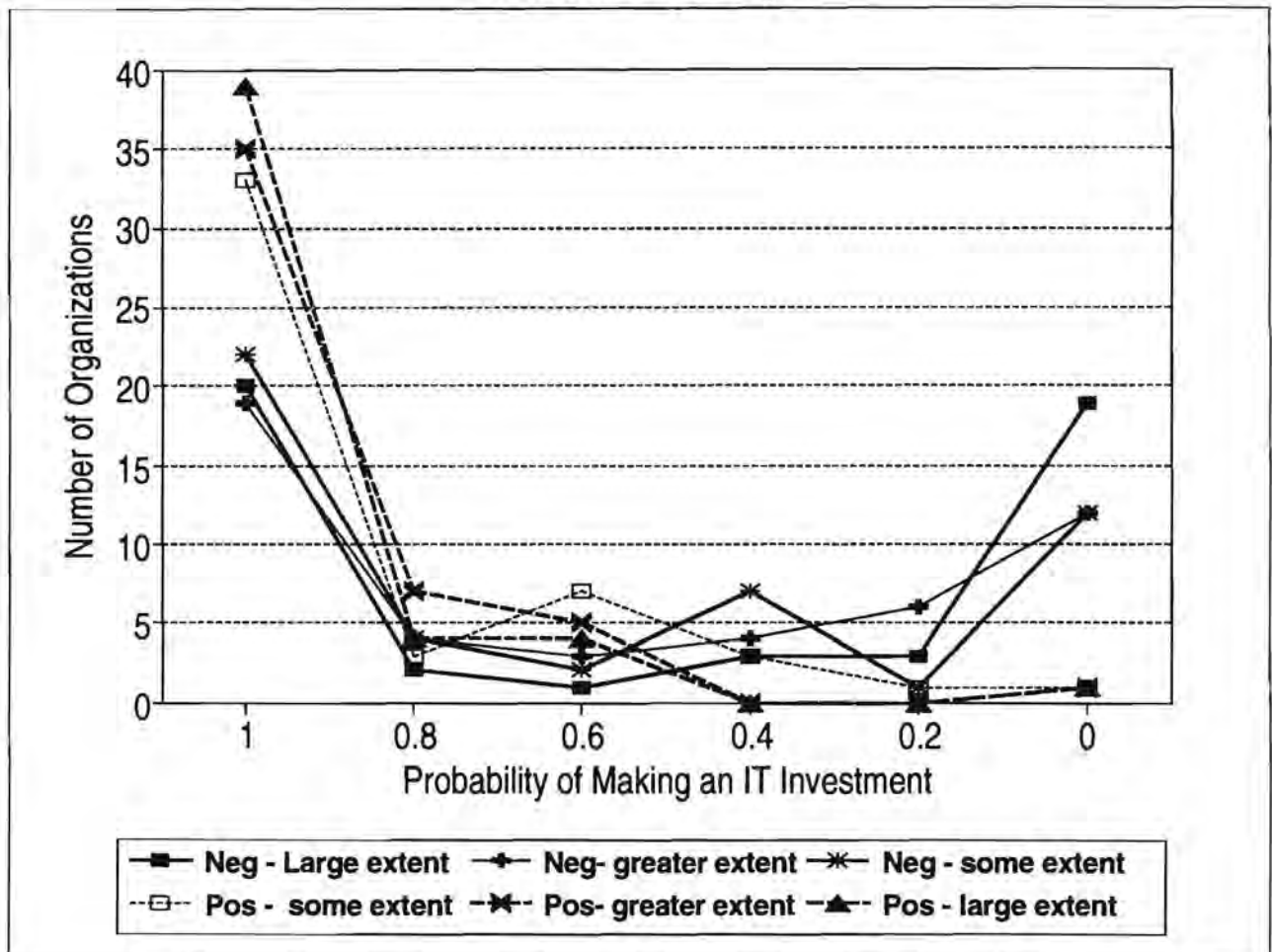
Probability of making an IT Investment if the organization is affected:	1	0,8	0,6	0,4	0,2	0
Negatively - to a large extent	20	2	1	3	3	19
- to a greater extent	19	4	3	4	6	12
- to some extent	22	4	2	7	1	12
Positively - to some extent	33	3	7	3	1	1
- to a greater extent	35	7	5	0	0	1
- to a large extent	39	4	4	0	0	1

It will be noted that 53.47% of these managers indicated that they would invest in IT if the probability exceeded 0.60 that their organization would be affected negatively by making an IT investment. This implies that perceived risk plays a part in IT investment in over half of the sample organizations. It can therefore be conjectured, that over half the managers of sample organizations are risk takers.

It was observed by the respondents that most organizations relied solely on their IT/IS/Financial managers' discretion when acquiring IT. None of the managers targeted could provide any scientific basis for their decisions in this regard, commenting in some of the personal/telephonic interviews, that they made their estimates by "gut feel", or words to that effect. Accordingly on the positive side, 95.14% of the respondents indicated a probability exceeding 0.60 that they would

invest in IT when they believe that the risk would be positively affected. Only 4.86% claimed a probability of <math> < 0.4 </math> (less than 50%) that their organization would invest in IT despite its believed positive impact on risk.

Figure 5.2.2: Probability of Making an IT Investment as assessed by IS/IT/Financial Managers



It is evident from Table 5.2.2 that 74.3% of the sample would follow their initial IT investment plan. Of these, 36% conjectured (probability >50%) negative short-term impact because of the perceived importance of risk. Figure 5.2.2 displays a non-symmetric u-shape curve that represents a negatively-skewed distribution of organizational frequency versus IT investment probability.

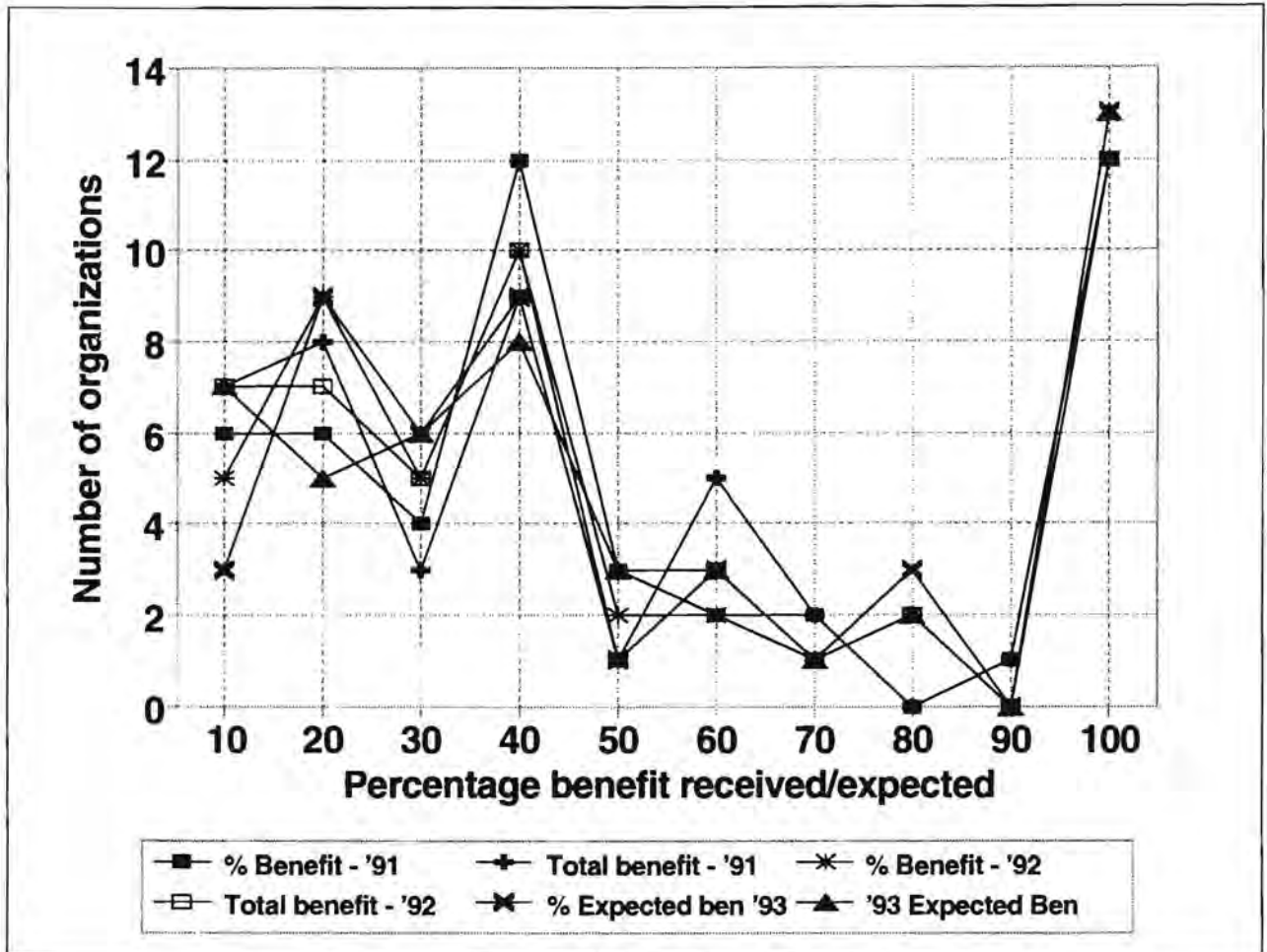
About 29.86% of the organizations indicated that they would not invest in IT if their organizational risk would be affected negatively. An anomalously high proportion (70.14% ; see Figure 5.2.2) of organizations indicated that they would invest in IT even if they believed that their organizational risk would be affected negatively. In short, this study finds that most Namibian managers believe in the longer-term benefits of IT.

Table 5.2.3: Cost-Benefit received as perceived by IS/IT/Financial Managers

	10	20	30	40	50	60	70	80	90	100
% Benefit received of total IT investment in 1991	6	6	4	12	3	2	2	0	1	12
% Benefit received of IT investment in 1991	7	8	3	9	1	5	2	0	1	12
% Benefit received of total IT investment in 1992	5	9	5	10	2	2	1	2	0	12
% Benefit received of IT investment in 1992	7	7	5	10	1	3	1	2	0	12
% Benefit expected of total IT investment in 1993	3	9	6	9	1	3	1	3	0	13
% Benefit expected of IT investment in 1993	7	5	6	8	3	3	1	2	0	13

Table 5.2.3 is based on the personal perception of the respondents, that is a rating on a 10 point scale (where 1 point = 10%) as to what benefit they received from their IT investment for a specific year. Also what benefit they received from their total investment in IT (including previous years). More than 60% of the organizations indicated that they received less than 50% benefit of their IT investment for the specific year. Twenty five percent of the respondents perceived that they received 100% benefit from their IT investments in all the years. Once again, these results indicate a general belief in the long-term benefits of IT, despite shorter term set-backs.

Figure 5.2.3: Perceived cost-benefit details



The previous arguments partly explain why most organizations can still be classified on Harris and Katz's matrix as Type I data installations (see Section 5.2). Figure 5.2.3 shows the frequency of the respondent managers classified in the benefit they perceived to have received from their IT investments. All the lines in the graph follow the same pattern and supports previous discussions that most respondents can be grouped in the 0 - 50% bracket. There is a drop in the graph from the 40% level and it rises again from the 90% level. This supports the statement that a clear majority of the respondents perceived they did not receive the full value of their IT investment;

an expected result in a representative sample of IT users. The expected benefit for 1993 exhibits the same tendency.

Table 5.2.4: Classification of software applications based on Anthony's framework

Software Applications	1990	1991	1992
Strategic management applications	28	34	42
Operation control applications	299	349	386
Management control applications	288	336	357
Transaction processing applications	414	433	459

Table 5.2.5 (items 9 - 12 on the questionnaire) represent the response of the respondents on the use of software applications over the period under investigation in order to portray a complete picture of the sample used.

Table 5.2.5: Software Application per Organization

	Mean	Highest	Lowest
Strategic management applications	0.88	9	0
Operations control applications	8.04	47	0
Management control applications	7.44	30	0
Transaction processing applications	9.56	50	0
Years of use	13.81	35	3
Number of installations	3.38	25	1

More than half (52.08%) of the organizations had a separate IT department. More than 80% of the organizations used project investment analysis for making their IT investment when deciding to invest in IT.

Table 5.2.6: Location and Project Investment Analysis

	Yes	No
Location analysis	56.25%	43.75%
PI analysis	81.25%	18.75%

None of the above measures, it was conjectured by the present study, in any way indicated a departure from expected tendencies amongst Namibian organizations. In summary, the sample was assumed to be representative of the population of IT-using organizations in Namibia.

5.3 The relationship between IT investment (CI) and profitability

The data needed to test this were gathered partly from financial statements supplied by the respondents and the rest of the data needed from the questionnaires (Items 3 -12 and Sections E and F). The raw data used for the CI and profitability ratios may be found in Appendices E and G. The CI frequencies are shown in Table 5.3.1. The CI were calculated as outlined in Appendix A (see Section A.1.5).

To calculate the CI, an interval value of 6 was allocated to the largest CPU size and to the smallest an interval value of 1. This was in accordance with the study by Kwong and Mohamed (1985) (see Appendix A, section 1.5(ii)). The CPU's were ranked by two IT experts: an IT consultant with 25 years experience of IT installations; and an IT manager with 15 years experience in a large multinational banking group with assets exceeding R 80 billion. Mainframe CPUs were ranked highest, followed in decreasing order by mini computers, 80486, 80386, 80286 and lastly PC's

which are not IBM-compatible. Mainframes were allocated an interval value of 6, mini computers an interval value of 5, and so on.

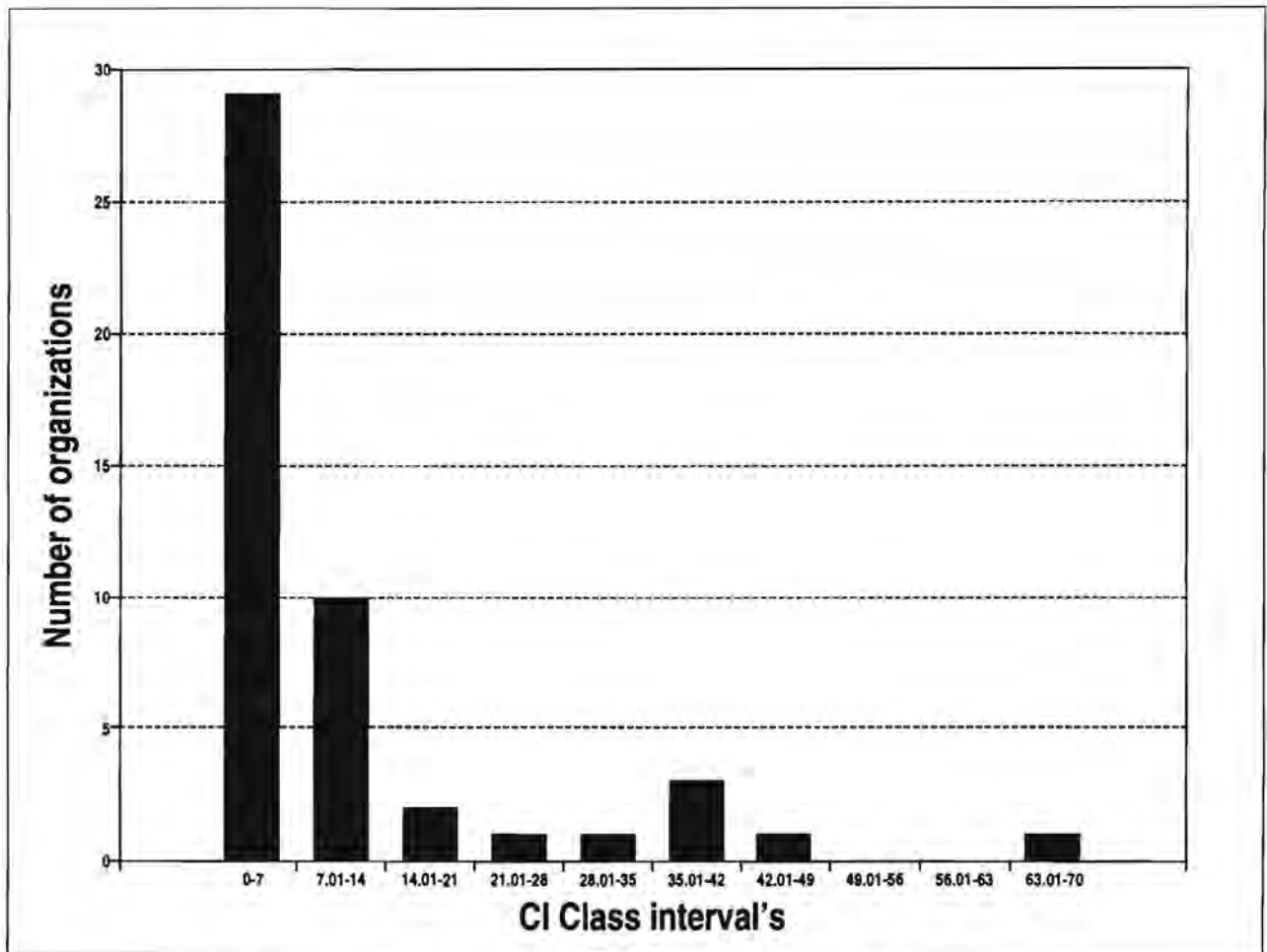
Hardware costs were ranked as well into 5 categories, as suggested by Kwong and Mohamed's study where the largest hardware cost was allocated an interval value of 5 and the smallest, 1. The hardware costs were entered on a spreadsheet and ranked in ascending order. Because of the nature of the spread of the hardware costs, it was not possible to use Sturge's rule (Williams: 1990) to establish classes. After consultation with a statistical expert (see acknowledgments), the top of each interval in Rand, was established as follows: 100 000, 800 000, 5 100 000, 160 000 000, and 400 000 000. Values were allocated accordingly and the results presented in Appendix D. The study by Kwong and Mohammed required the sorting of the CI into ascending or descending order. Appendix E presents the raw data, Appendix D the calculation of the CI and Appendix C, a summary of the ratios calculated. Figure and Table 5.3.1 present a summary of the CI frequencies calculated from these appenda.

Table 5.3.1: Computerization Index summarized

Interval Ranking	Number of organizations
0 - 7.0	29
7.01 - 14.0	10
14.01 - 21.0	2
21.01 - 28.0	1
28.01 - 35.0	1
35.01 - 42.0	3
42.01 - 49.0	1
49.01 - 56.0	0
56.01 - 63.0	0
63.01 - 70.0	1

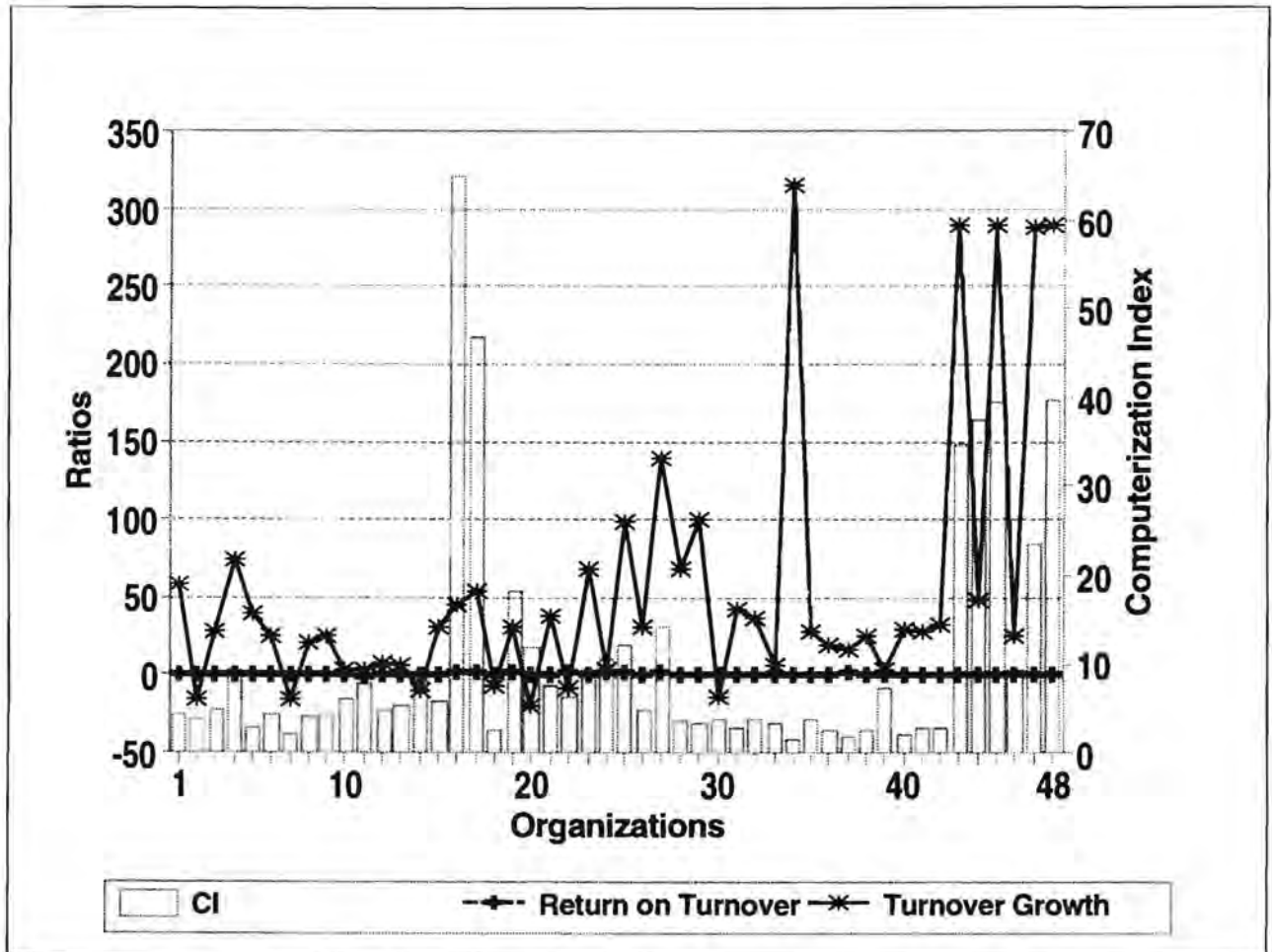
It is evident from Figure 5.3.1 that some 60% of the respondents have a CI of 7 or less. One might conjecture that these low CI's stem partly from the 15.97% of sample organizations not prepared to invest resources in IT. Another possibility is that more than 60% of respondents perceived a 50% or less return (benefit) of their IT investments for 1991 and 1992. Further, only 56.25% of IT managers had direct control over the IT investments.

Figure 5.3.1: Computerization Index Profile of the respondents



It remained to be seen how their other selected measures of profitability could predict the claimed outcome. Hypothesis 1(a) posits a positive association between IT investment (CI) and return on turnover. Hypothesis 1(b) posits a positive association between CI, the turnover growth rate and the profit growth rate. These data were gathered for the same period of three years. The raw data used to calculate these ratios can be found in Appendices G and H and a summary of the ratios in Appendix C. Figure 5.3.2 shows some of the lines of the measures used.

Figure 5.3.2: CI vs. Return on Turnover and Turnover Growth



As may be noted from Figure 5.3.2, most companies displays a CI of 30 and lower. Kendall rank statistical analysis shows that the association between the CI and the return on turnover is only 55% concordance (not significant at $p = 5\%$). However, the association between the CI and profit growth was calculated as 61% concordance (significant at $p = 4\%$) while the concordance between the CI and turnover growth was found to be 60% (significant at $p = 5\%$). As can be seen from these figures, little association between the rate of profit measure (return of turnover) and the CI could be found.

Table 5.3.2: Hypotheses 1(a) to 1(d) summarized

No	Hypothesis	Posited Association	t (Kendall)	Significance	Accepted
H _{1a}	CI and return on turnover	Positive	0.1092	p = 0.2742	No
H _{1b1}	CI and turnover growth	Positive	0.1952	p = 0.0505	Yes
H _{1b2}	CI and profit growth	Positive	0.2102	p = 0.0352	Yes
H _{1c}	CI and OPEX	Positive	-0.1206	p = 0.2267	No
H _{1d}	CI and the value of IT (expressed in monetary terms)	Positive	0.4736	p = 0.00001	Yes

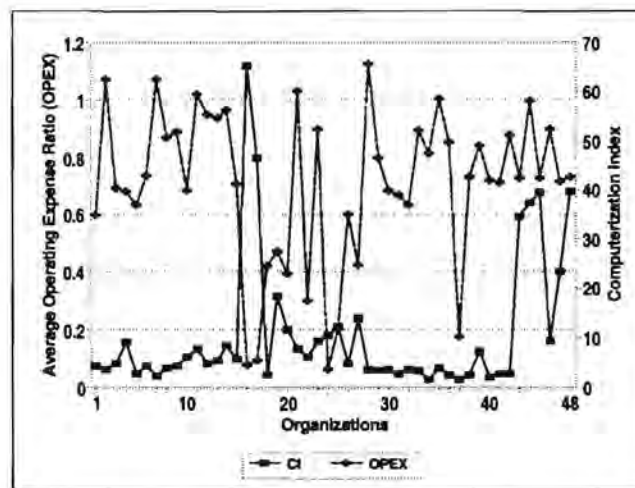
This study thus rejects Hypothesis 1(a); finding that there is no significant association between IT investment and the return on turnover. This, it will be noted, contradicts the Kwong and Mohamed study partly. It can be argued that this contradiction is a property of Namibia as a developing country economy suggesting that Kwong and Mohamed's study does not hold for such economies. However, it finds a significant positive association (see above) between IT investment (CI) and turnover growth and CI and the profit growth rate. Thus, this study accepts Hypothesis 1(b1) and hypothesis 1(b2).

To compare the CI with the short-term measurement of profitability, as used by Harris and Katz (1991), it was decided to employ the operating expense ratio (OPEX) (see Chapter 3; Hypothesis 1(c)). Hypothesis 1(c) posits a positive association between IT investment (CI) and operating expense ratio (OPEX). The OPEX was calculated, using data in financial statements and the questionnaire (see Section F) and recorded the calculated OPEX ratio in the summary (see Appendix C). The organization with the largest OPEX ratio represents the least profitable

organization and the organization with the smallest, the most profitable. The organization with the largest CI was assumed the most computerized (see above).

The Kendall rank association coefficient between CI and OPEX was found to be -0.1206 (not significant at $p = 5\%$). Hypothesis 1(c) is thus rejected by this study.

Figure 5.3.3: CI vs. Operating Expense Ratio



Hypothesis 1(d) conjectures a positive association between the value of IT (expressed in monetary terms) and CI. By using Kendall rank coefficient calculations, an association of 74% concordance (significant at $p = 0.00001$) was found. The study thus accepts hypothesis 1(d), claiming there is a significant association between the monetary market value of IT investment and the CI ratio.

Of these 4 hypotheses, hypotheses 1(b) and 1(d) (associations between IT investment (CI) and turnover growth and IT investment (CI) and the monetary market value of IT) was accepted. This supports the conclusion that there is no link between profitability and IT investment in Namibia. Turnover growth, and not organizational profit, could have been responsible for a growth in IT

investment. As noted above, one might conjecture that the findings by Kwong and Mohammed based on positive association between the CI and profitability, are not valid in organizations in Namibia. The CI, however, is a possible measurement of computerization if used cautiously.

5.4 Measuring the impact of computerization (ITEX) on the profitability of an organization

Hypotheses 2(a) to 2(g) were developed to investigate the relationships between IT investment (ITEX) and various measures of profitability. The data on which these hypotheses are based can be found summarised in Appendix C. In order to test the hypotheses for this section, data was analyzed as supplied by the respondents (Sections E - F). The ratios, as described in Appendix A, were summarized in Appendix C. These ratios were the operating cost efficiency ratio (OPEX), Information Technology expense ratio (ITEX) and the Information Technology cost efficiency ratio (ITCE). The results of the hypotheses are summarised in Table 5.4.1.

Table 5.4.1: Summary of Hypotheses 2(a) to 2(g)

No	Hypothesis	Posited Association	t (Kendall)	Significance	Accepted
H _{2a}	OPEX versus Profit Growth	Positive	-0.0949	p = 35%	No
H _{2b}	ITEX versus OPEX	Negative	-0.2447	p = 2%	Yes
H _{2c}	ITEX versus ITCE	Positive	0.7926	p = 0.0001	Yes
H _{2d}	ITCE versus OPEX	Negative	-0.0372	p = 70%	No
H _{2e}	Monetary value of IT vs OPEX	Negative	-0.1946	p = 5%	Yes
H _{2f}	Monetary value of IT vs ITEX	Positive	0.0595	p = 60%	No
H _{2g}	Monetary value of IT vs ITCE	Positive	-0.0844	p = 40%	No

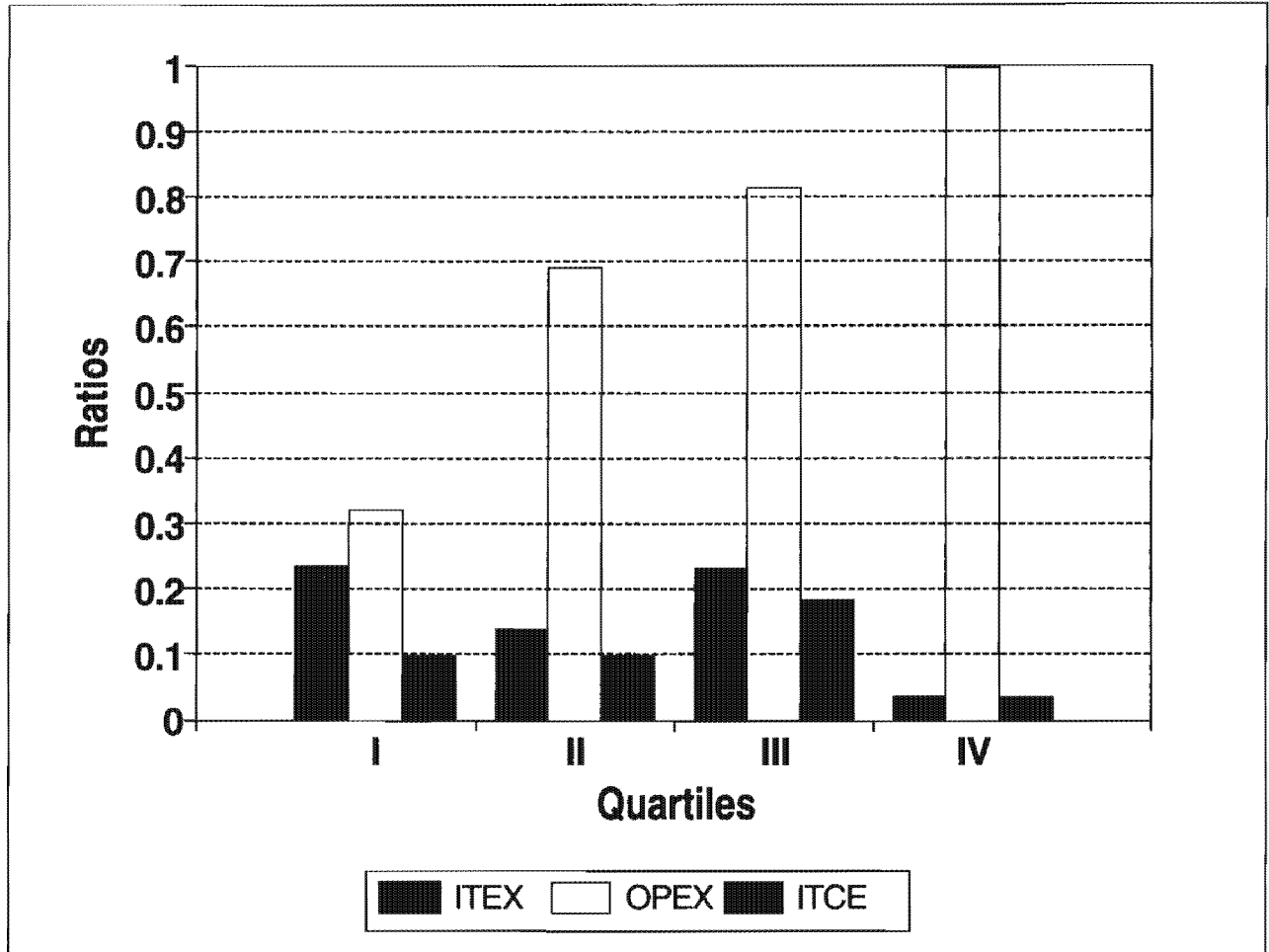
The OPEX ratio was compared with profit growth because it enabled this study to draw conclusions based on an analysis of these two ratios (H_{2a}). There was a link between ITEX as measure of the degree of operating dependency on computerization and OPEX (H_{2b}). No link was found between the monetary market value of IT and profitability (OPEX)(H_{2e}). No link was discovered between the monetary value of IT and ITCE. This study supports the finding by Harris and Katz that there is a link between computerization and profitability. However, no link were discovered between the IT cost efficiency ratio and profitability. The present study therefore conjectures that there is no link in computerization costs efficiency and profitability in organizations in Namibia and possibly other developing countries. Table 5.4.2 displays ITEX, OPEX and ITCE in quartiles. The ratios were calculated, sorted in ascending order using OPEX as the primary key, each group of ratios were averaged into quartiles (that is in 4 groups of 12). As is evident, Group I organizations were the most profitable quartile and group IV the least. Group I organizations invested the most in IT per rand operating expenses.

Table 5.4.2: ITEX, OPEX and ITCE in quartiles

Quartiles	ITEX	OPEX	ITCE
I	0.235	0.318	0.095
II	0.138	0.688	0.095
III	0.232	0.813	0.182
IV	0.036	0.995	0.035

It will be noted that the table represents the ITEX, OPEX and ITCE ratios averaged over the three years under investigation (1990 - 1992). The OPEX for the most profitable organizations (because their average ratio is the smallest - group I) were 0.318 versus 0.995 in the least profitable organizations (their OPEX being the largest - group IV). In addition, group I organizations exhibited the higher average levels of IT capital intensity over three years (0.235) while group IV organizations invested significantly less (0.036). Group III organizations invested slightly less than group I organizations (0.232). The first quartile displays the highest ITEX ratio and the lower ITCE ratio was found to be group IV organizations. In other words, group IV organizations were the most cost efficient in terms of their computerization.

Figure 5.4.1: Quartiles comparison between ITEX, OPEX and ITCE



5.5 Measuring IT investments against risk and risk related measures

The data needed to test the relevant hypotheses were gathered from the questionnaire (Items 3 - 12 and Sections E - H) and returns supplied by respondents.

The raw data used for the figures, are summarized as ratios, in Appendix C. The organizational risk factors were calculated, using the coefficient of variance of the organization's EBIT (operating

narrow series of critical values in selecting the alternative computer system and the more risk averse, the wider is the range for the alternative system. The assumption could be made that the decision-maker wants to form a utility function. A utility function model can similarly be applied to the cost transformation model as designed by Shoval and Lugasi (1988). Shoval and Lugasi define the cost value C_i^* for which the utility $U(C_i^*) = 1$, and a cost value C_i^0 for which $U(C_i^0) = 0$. The rest of this argument was explained in Appendix A. The decision makers can select their choice if an organization was affected negatively or positively when investing resources in IT (Section G on the questionnaire). Shoval and Lugasi used hypothetical examples and for the same reason it was decided to do the same. The most expensive quotation was hypothetically set at R 7 000 and the cheapest quotation for a similar system R 4 000. An alternative system could have been bought for R 6 739. This determined that $A(7\ 000) = 0$ and for the second alternative, $B(4\ 000) = 1$. The utility of the third alternative could then be calculated.

The question (as noted by Shoval and Lugasi) was based on the fact that the investor has two choices, that is; what their choice would be were they presented with two options; namely:

Option 1: the cost of alternative i is C_i^* , and they are sure of obtaining this alternative.

Option 2: the cost of alternative i is given on a lottery card, in which there is probability q that the cost is C_i^* and probability $(1-q)$ that the cost of the alternative is C_i^0 . Remaining attributes are the same at the fixed level. The value of q was then the level at which they would be indifferent to the choice between the two options.

Table 5.5.2 presents the data that were used in the arguments below. These were based on the research data (see Appendices C - M). The organizational risk factor (see Appendix L and M) and the CBA were ranked in ascending order, using organizational risk as the primary key. These data points were divided into 3 equal sets. The table below presents the results of the calculations. In order to calculate 'probability' of the risk profiles, the 3 averages were added together, and then every value divided by the total. This gave a value which is smaller than 1 and could be substituted into the arguments used by Shoval and Lugasi.

Table 5.5.3: Summary of risk profiles and CBA

	Risk avg		CBA
Risk averter	0.867		0.660
Risk indifferent	0.087		0.312
Risk Seeker	0.046		0.571

Respondents were asked at which levels they would be indifferent in investing resources in IT. An average was obtained for risk-indifferent and risk-seeking respondents. The first scenario, based on Shoval and Lugasi's arguments, was where they were indifferent to risk. The calculated average on this level was 0.087. Therefore:

$$U(6\ 739) = q.U(4\ 000) + (1-q).U(7\ 000) = 0.087 \times 1 + (1-0.087) \times 0 = 0.087$$

The expected cost of option 2 with $q = 0.087$ yields:

$$0.087 \times 4\ 000 + (1 - 0.087) \times 7\ 000 = 6\ 739$$

Hence, the expected cost of option 2 equals the cost of option 1 (see above).

The second scenario was where the investors were averse to risk. The probability of the risk averters were calculated as 0.867. The presentation could be taken as $U(6\ 739) = 0.867$. The interpretation, based on the assumptions of Shoal and Lugasi, is that the condition for the decision maker to select option 2 is a higher probability ($0.867 > 0.087$) for obtaining the less costly system. The expected cost for this option is less than the cost of the alternative which the decision maker is sure to obtain:

$$0.867 \times 4\ 000 + (1 - 0.867) \times 7\ 000 = 4\ 399 < 6\ 739$$

The third scenario was where the investors were risk seekers. The probability of the risk seekers were calculated as 0.046. The meaning of risk seeking is that the decision maker will select the uncertain option (2) for a lower probability ($0.046 < 0.087$) of obtaining the less costly system. The expected cost is now more than the cost of the sure option:

$$0.046 \times 4\ 000 + (1 - [0.046]) \times 7\ 000 = 6\ 862 > 6\ 739$$

A cost-benefit graph of the three cases could display alternatives 1 and 2 as normalised cost values (in all cases) are 0 and 1, respectively. For alternative C, three different normalised cost values could be marked for the corresponding decision-making styles, and therefore three different lines were drawn for this alternative: line C_1 (for $q = 0.087$), line C_2 (for $q = 0.867$) and line C_3 (for $q = 0.046$). For each case a unique set of intersection points between pairs of alternatives was obtained (see Appendix M).

The calculated intersection points between pair of alternative p-values, on the weighted (x) axis (see Appendix M), are:

1. for the case of the user, indifferent to risk:
 $0.49 \leq p \leq 0.78$
2. for the case of the user, averse to risk:
 $0.34 \leq p \leq 0.91$
3. for the case of the user, risk seeker:
 $0.34 \leq p \leq 0.79$

Shoval and Lugasi mention that a cost transformation, based on Keeney's utility model, was in their opinion preferable to other methods. This is because Shoval and Lugasi based it on a normative model, including axioms that reflect behavioral rules of the decision maker in determining preference, considering the important factors of risk and uncertainty. This argument supports previous findings in this chapter that risk, or perceived risk plays an important part in the decision to invest in IT or not.

This study accepts hypothesis 3(g). This is because of the following decisions in this section: the more the decision maker is averse to risk, the wider is the range of p to prefer the third alternative; the more the decision-maker seeks risk, the greater the probability that he/she will end up with the second widest range to select the alternative (third) investment. This contradicts the findings by Shoval and Lugasi. They claimed that the risk seekers will have a narrow series of values. The behaviour of a person who is risk averse is more similar to the behaviour of a manager who takes

the pure cost-benefit approach Shoval and Lugasi claim, accordingly to which the third alternative was preferred at any rate. These findings also failed to support Shoval and Lugasi's study, which claims that a risk-seeker often prefers the "certain" third alternative less. The present study finds that the probability exceeds 50% that the third alternative *will* be considered by risk-seeking managers, rather than the managers who are risk-indifferent. It could be conjectured that the risk profiles of managers in developing countries differ from their counterparts in first-world countries.

In accordance with Hespos and Strassman (1965), the decision tree method can be applied to investments characterized by high uncertainty and requiring a series of related decisions to be made over a period. Figure 5.5.1 displays the possibility of investing resources in IT in the form of a stochastic decision tree. This series of arguments will address research question (ii)(see Section 3.2), namely will the IT investment target be changed if managers can assess changes in an organization's risk.

The probability of investing resources in IT could have a positive or negative effect on the risk. Figure 5.5.1 displays a 30% probability that a manager will invest resources in IT if his/her organization was affected negatively to a large extent. On the other hand, only a 34% probability was found that resources will be invested by an organization if the organization was affected positively to a large extent in the past.

Figure: 5.5.1: Stochastic decision tree displaying the choices the respondents selected

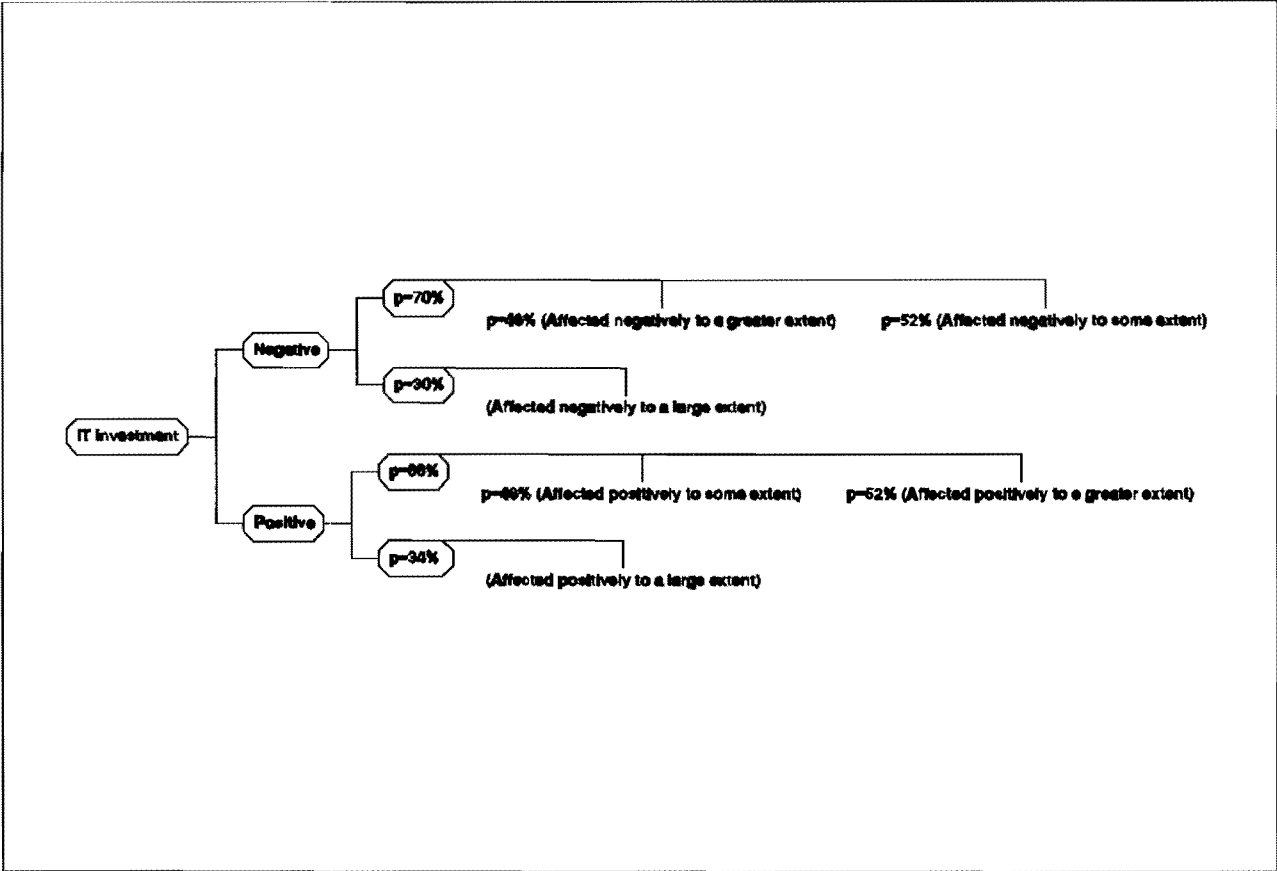
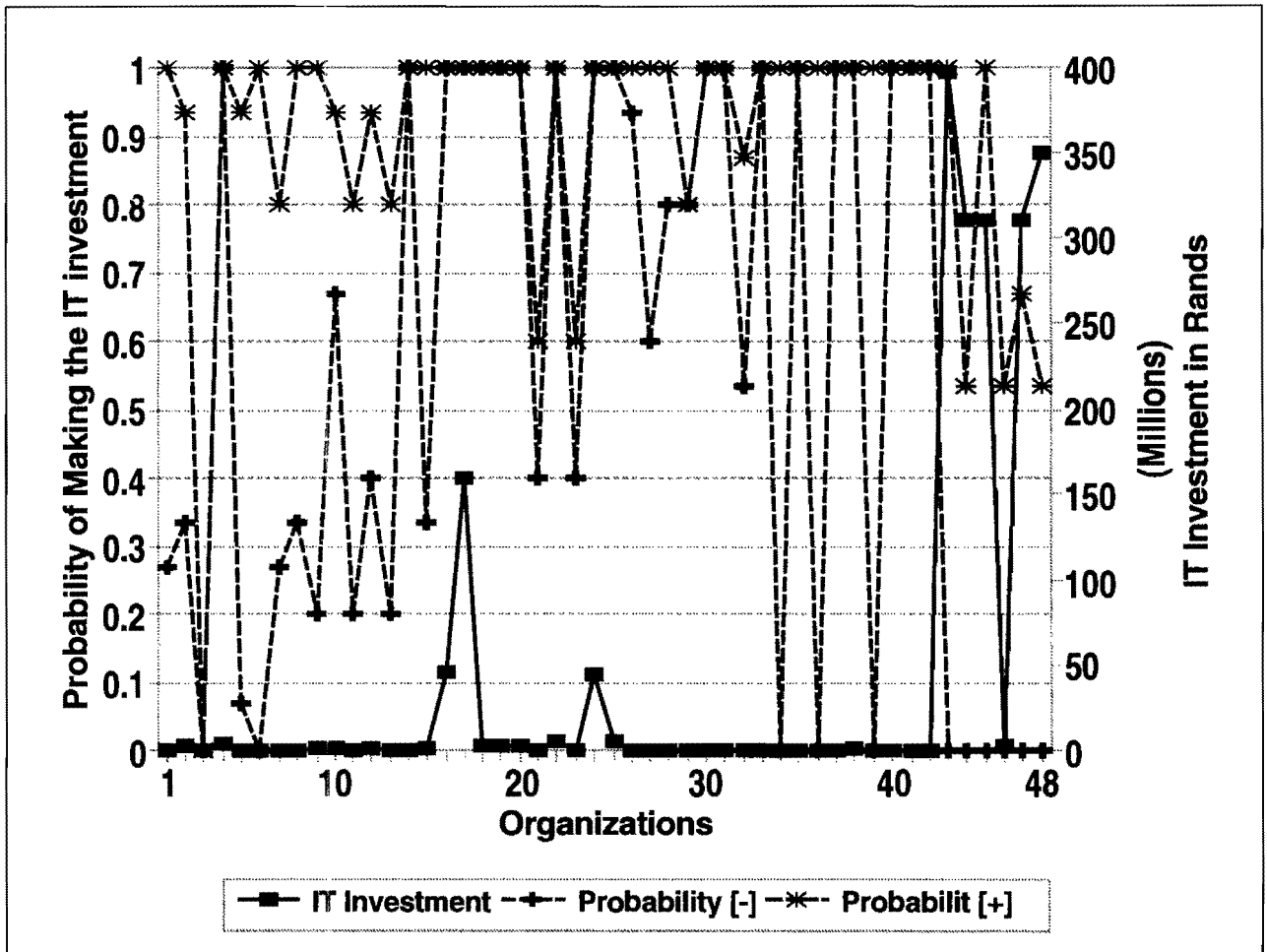


Figure 5.5.2 displays Stochastic process dominance (SPS)(see Appendix A). A manager (see Section 5.4 for discussion) would see the risk profile covered by the IT investment in organizations 41 - 47 (shaded area). This reflects SPS. For decision-makers faced with a set of risky alternatives, such as IT investments, decision theorists have developed an important principle called the domino principle (Hespos and Strassman: 1965). This can be interpreted as meaning that risk seeking managers will select an option that will fits in with the profile when the risk profile distribution line moves above the investment distribution.

Figure 5.5.2: Monetary value of IT investment versus the probability of making an IT investment which affects the risk of an organization



A concordance of -0.09 (not significant at $p = 5\%$) was discovered between IT investment in rands and the possibility of affecting the organization's risk positively when investing resources in IT. A concordance of -0.0528 (not significant at $p = 5\%$) was discovered between IT investment in rands and the possibility of affecting the organization's risk negatively when investing resources in IT. The result of the stochastic decision tree analysis is available in Figure 5.5.1. Alternative decisions can be compared with alternative uses for resources before making a final decision. It

is also not possible to forecast an optimum IT investment for any organization. This is because there are too many human factors interlinking with an organization to be able to state that this is the optimum investment. Risk profile can indicate whether managers should invest resources in IT or not. At the same time it answers research question (ii)(see Section 3.2), the IT investment target will be changed if managers can assess changes in an organization's risk.

5.6 Discussion

It is evident from the above that it is difficult to evaluate the relationship between investments in IT and organization performance (see H_{1a}) because of the need to consider several complex factors. These factors include industry structure (see Section 5.2); the extent of technological sophistication and change (see Section 5.3); the strategy of the organization (see Section 5.2); strategy implementation (see Section 5.2); and historical behaviour (Hypotheses 1(a), 1(b) and 2(b)). It can be conjectured that the new Namibian government with its policy of affirmative action might have changed the training direction of organizations in that resources had to be used to train previously disadvantaged workers. It is admitted that these factors could change over time. The CI is a possible measure of computerization but caution must be exercised when using it, since no links were found between profitability measures and the CI. It can be conjectured that profitability cannot be the only supportive measurement to be used when making an IT investment.

A link was found between ITEX as a measure of computerization and profitability, but caution must be exercised in using the ITEX. ITCE does not explain the link between profitability and

computerization. The answer to the first research question could be answered: IT investment does relate to profitability on the short term as calculated by the OPEX ratio. Hypotheses 2(a), which tested the link between computerization and profitability, it will be noted, confirm Harris and Katz's study. The ITEX and OPEX ratios in the present study's sample exhibited an association of -0.2447 concordance (significant at $p = 2\%$). This compares with the average correlation of -0.644 (significant at $p = 0.0009$) of the Harris and Katz study.

In the hypotheses 3(a) - 3(v), no links were discovered between the monetary value of IT investments and the organizational risk of an organization when making the IT investment, however utility theory was able to predict the best alternative IT investments that best suit the risk profile of an IS/IT/Financial manager in a developing country. One might conjecture from these results, for example, that risk averters in the sample would adopt the cheaper option, while the risk indifferent managers would take the middle option. Risk seekers would evidently select the more costly option. While comparing the CI with the von Neuman utility theory, it became evident that there might be more risk averters in Namibia, and in so far as Namibia represents developing countries, in a developing country.

5.7 Conclusion

Harris and Katz (1991) claimed that top performers are more aggressive and effective in integrating and coordinating their business processes through information technology than weak performance

firms. This was indicated in their study by some of the respondents with the lowest operating expense (the most profitable organizations).

Hypotheses 1(a), and 1(c) were rejected by this study. This contradicts the study by Kwong and Mohamed who hypothesized that a link exists between profitability and computerization. The link that was discovered (see H_{1b} and H_{1d}), was the link between turnover growth and computerization and CI and the market value of IT. Only hypotheses 2(b), 2(c) and 2(d) of the second series of hypotheses were accepted. This study supports Harris and Katz by claiming that an association exist between profitability and computerization. Hypotheses 3(a1), 3(b), 3(c), 3(d2), 3(e), 3(f), 3(h), 3(i), 3(j), 3(l), 3(m), 3(n), 3(o), 3(p), 3(q), 3(t), and 3(u) were rejected, thus no association was found between the organizational risk factor and computerization. Although it was not possible to calculate an optimum IT investment, SPS could be still be applicable despite this study's inability to do this calculation.

Chapter 6

Conclusion

6.1 Introduction

This chapter discusses the conclusions, based on the results of the previous chapter. Certain recommendations are also made and future research areas are identified.

6.2 Key Conclusions

Kwong and Mohamed (1985) constructed a composite measure of the various factors influencing the extent and degree of sophistication of computerization (see Section 2.3.3). The results for hypotheses 1(a) - 1(d) displayed association between the computerization index (CI) and turnover growth. It is clear from the results of hypothesis 1(c), that the degree of computerization (CI) when related to the operating expense cost ratio (OPEX), exhibited no correlation. The results for hypothesis 1(c) showed a general increase, suggesting that as turnover growth increases, the level of sophistication similarly increases (H_{1b}). It can be conjectured, based on the results of hypothesis 1(b), that the increase in computerization (computerization index [CI]) shows positive effect on turnover performance. This suggests that the level of computerization, measured by the CI, is not significantly associated with profitability performance in the short term.

It was shown that levels of information technology capital intensity (ITEX) were related to the organization's cost advantage/disadvantage from current operations (short-term profitability performance - OPEX)(H_{2b}). The findings suggested that low profitability companies (high operating expense ratio) are at greater risks with low levels of IT capital intensity than high profitability companies with high levels of IT capital intensity as suggested by Harris and Katz (1991). Additionally, it can be conjectured that when technology fits the organizational situation, significant savings in operating costs are possible as conjectured by Harris and Katz (1991).

There was no significant association between the organizational risk factor and the monetary value of IT (H_{3c}). This did not help in establishing any first and/or second degree of stochastic process simulation between the two factors (see Section 5.5). Organizational risk plays no significant part in the decision to invest resources in IT, especially the perceived importance of risk by managers. It was, however, established that utility theory (risk profiles of managers in developing countries) can be utilised by managers in deciding between different IT investments (H_{3v}).

From the results in the previous chapter (hypotheses 1(b1), 1(b2), 1(d), 2(b), 2(c), 2(e), 3(a2), 3(d1), 3(g), 3(k), 3(r) and 3(s)) it can be concluded that the ITEX, OPEX and CI ratios are applicable in a developing country. Although the direction of causality between the profitability (OPEX) and the ITEX was not established, relationships were established (H_{2b}). The general findings were that organizational risk was not affected when resources were invested in IT (H_{3b} and H_{3c}). It was noticeable that when the probability to affect the organization was positive when making an IT investment, the perceived risk by the managers plays a part (H_{3d1}).

It can be conjectured that courses in politics (that is affirmative action) are playing a major part in the re-allocation of resources that eventually will influence the decision to invest in IT. Political considerations, important in most organizations, impacts buying of IT equipment as suggested by Harris and Katz (1991). These political considerations sometime eclipse technical and economic considerations and were generally perceived as becoming important in the developing countries. Other findings suggest that organizational performance in the leading organizations in a developing country was linked to the level of IT investment intensity (H_{2b}).

The findings in hypothesis 2(b) support previous research (Lubbe et al (1992), Lubbe and Nel (1993) and Harris and Katz (1988, 1991)) that process integration was associated with reduced firm costs. Harris and Katz (1991) claimed that higher levels of process integration may nullify some negative aspects of environmental uncertainty. Organizations that are not leaders in the use of information technology are potentially more bureaucratic and less adaptable to meet the changes in the external environment, such as the changing of government, political pressures (affirmative action), etc (see Section 5.2).

The primary findings (hypotheses 1(b1), 1(b2), 2(b), 3(h) and 3(d1)) in this research were confirmed by examining the relative incremental changes in organizational performance (OPEX), information technology investment intensity, and other key operating indicators, such as cost-benefit analysis, return on IT assets, operating leverage and risk (H_{1a-d} , H_{2a-g} and H_{3a-v}).

Harris and Katz (1991) suggested that organizations with available additional resources may be the best positioned to respond to environmental uncertainty and increases in technical complexity, that can satisfy their internal coordination needs. Organizations exhibiting strongest growth in income, contrasts with the slow growing organizations which may not be as well positioned to address their internal coordination needs because of the reduced availability of scarce resources (especially the smaller organizations) as noted by them. An example of what may be happening in a developing country: Resources needed to address the organization's internal problems might not be available if decision makers' priorities in slow growing or declining organizations were diverted to manage threats in the external environment. This, it can be conjectured, can lead to the theoretical conclusion that in a developing country industries the potential gain associated with process integration may be conditional on both organization size and whether the organization is fast growing or declining.

It can further be conjectured that the paradox confronting slow growing or declining organizations is that they need the benefits of the technology, as much as, if not more than their faster growing competitors. However, according to Harris and Katz (1991), organizations may face greater overall risks (both internally and externally), because of organizational barriers (that is allocation of resources, cultural, environmental). Also the lack of adequate human and financial capital (a shortage in the new independent Republic of Namibia as suggested by the Namibian Information Piece [1990]) to realize potential payoffs.

While this research did not measure the size of the impact of information technology on an organization's performance, the findings in this research suggest that information technology management is a critical activity in the operations of systems technology leaders (H_{1b} , H_{2b} and H_{3r}).

Whereas the data and space available do not enable a final assessment on whether information technology is a cause or consequence of an organization's performance, preliminary analysis using associations suggests that both directions of causality may be significant (H_{1b} and H_{2b}). The competitive value of the information technology was complicated by the market structure of the organization, the rate of technological change in the organizations, the strategic dependence of the organization, the opportunities to redefine market structure through information technology related cost economies, linkage between product design and process changes, and synergies with marketing as supported by Harris and Katz (1991).

6.3 Future Research

The study also did not attempt to improve or expand on the model suggested by Kwong and Mohamed. Further research in this area may lead to a computerization index that represents the information technology sophistication of an organization, no matter which industry the organization was in. It could also be worthwhile to investigate the series of critical values in selecting the alternative computer system for a developing country. Some future research could review the influence of other factors on the buying of IT equipment.

Further research could lead to the discovery of an optimum level of computerization at which an organization reaps the full benefits of its IT investment. In addition, research could be undertaken along similar lines to establish whether the previously mentioned models are applicable in industries in South Africa and if they are going to experience the same type of trend as Namibia. The utility theory could be another area that can be investigated. This model can help managers decide between possible IT investments. The effect of downsizing and rightsizing as part of IT investment decisions could also be investigated.

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Appendix A: A description and development of the models that were used to establish IT investment assessment measures:

A.1 Computerization Index (CI)

The objective of Kwong and Mohamed (1985), was to quantitatively evaluate the impact of computerization on profitability and, in the process, develop an indicator of the extent and sophistication of computerization. They proposed a Computerisation Index (CI) that measures the extent and sophistication of computerisation. This CI is constructed according to the following formula:

$$CI = V_1(W_1) + V_2(W_2) + \dots + V_n(W_n)$$

For a detailed description on the meanings and mathematics behind the formula see A.1.5.

Ten variables (V_1 to V_{10}) were chosen to collectively represent the computerisation process and their importance was indicated by awarding weights to each (for a description of the weight and the mathematics see A.1.5). These variables are: Management Activity Level; Years Using Computers; Number of Computers; Application Software; Hardware Cost; Staff; Number of Shifts; Organisational Location; Project Investment Analysis.

A.1.1 *Management Activity Level*

Computer applications in each of the four management activities were awarded a weight. For a detailed description of the weights and formulae that were applied see A.1.5. These applications were: Strategic management, management control, operational control and transaction processing.

A.1.2 *Other Variables*

The mathematics for taking variables such as: years using computers, number of installations, number of software applications, number of staff, number of shifts were explained in A.1.5.

A.1.3 *Measures of Financial Performance*

The measurement for financial performance will be described and explained in A.1.5.

A.1.4 *Classification of Computer Applications*

This was done according to the Robert Anthony Framework and presented below:

Transaction Processing	Operational Control	Management Control
Accounts Receivable	Inventory Control	Budgeting
Accounts Payable	Raw Material	Wage and Salary Analysis
General Ledger	Work In Progress	Sales Analysis
Delivery Report	Finished Goods	Sales Forecasting
Payroll	Sales Report	Financial Analysis
Processing Job Request	Sales Planning	Responsibility Accounting
Customer Billing and Invoicing	Personnel Status Report	Investment Analysis
Share Registration	Computer Utilization Report	Production/Job Costing
	Production Scheduling	Product Variance Analysis
	Computer Scheduling	Computer Budget
Strategic Management	Petroleum Production Systems	
Corporate Modelling	Plant/Factory Automation	
	Technical Systems	
	Material Requirements Planning	
	Purchase Requirements Planning	
	Linear Programming	
	Simulation	

A.1.5 *Presentation of the formulae used to do the calculations for the CI*

Kwong and Mohamed's (1985), Computerisation Index (CI) was constructed as follows:

$$CI = V_1(W_1) + V_2(W_2) + \dots + V_n(W_n)$$

where CI = Computerisation Index
 V_i = Variable affecting the degree of computerisation
 W_i = Weight applied to Variable V_i

Ten variables (V_1 up to V_{10}) were selected by Kwong and Mohamed collectively to represent the computerisation index. Their importance were indicated by different weights applied:

	VARIABLE	WEIGHT
V_1	Management Activity Level	0.40
V_2	Years Using Computers	0.10
V_3	Number Of Computers	0.10
V_4	Application Software	0.06
V_5	Size Of CPU	0.06
V_6	Hardware Cost	0.06
V_7	Staff	0.06
V_8	Number Of Shifts	0.06
V_9	Organisational Location	0.05
V_{10}	Project Investment Analysis	<u>0.05</u>
		<u>1.00</u>

(i) *Management Activity Level*

Computer applications in the four management activities were awarded a weight by Kwong and Mohamed: *Strategic Planning* [40%], *Management Control* [30%], *Operational Control* [20%] and *Transaction Processing* [10%]. Thus, the *management activity level* was calculated as follows:

Total score for *Management Activity Level* = (Number of Strategic Planning Applications x 0.4) + (Number of Management Control Applications x 0.3) + (Number of Operational Control Applications x 0.2) + (Number of Transaction Processing Applications x 0.1)

(ii) *Other Variables*

For the variables (years using computers, number of installations, number of application software, number of staff, number of shifts) the score is the numerical value multiplied by the weight.

A ranking procedure was used for the variables: size of CPU, hardware cost, organizational location and method of project investment analysis. The largest CPU size was given an interval ranking of 6 while the smallest was given a ranking of 1. Hardware cost values ranges from 5 for the highest to 1 for the lowest, reflecting its lesser importance compared to CPU size. For computing facilities located in the autonomous Computer/IT department the value is 5 and for any other department, the value is 2. Companies using the Discounted Cash Flow (DCF) method in evaluating hardware purchase were assigned a value of 5, and for non-DCF users a value of 2.

(iii) *Measures of Financial Performance*

Return on Investment (as used in the BCG and PIMS approaches) had been found to be deficient by Kwong and Mohamed. They suggested that the following multiple measures of financial performance be used:-

- 1) Pretax Return on Assets *(Pretax Profit / Total Asset)*
- 2) Pretax Return on Turnover *(Pretax Profit / Total Turnover)*
- 3) Asset Turnover Ratio *(Total Turnover / Total Assets)*
- 4) Gross Margin *(Gross Profit / Total Turnover)*
- 5) Three-Year Profit Growth Rate
- 6) Three-Year Turnover Growth Rate

Because of the sensitivity of the information and the competitiveness and to convince respondents to complete the questionnaire, it was decided to use only the second, fifth and sixth ratios.

A.2 **Leverage, return on assets and risk**

A.2.1 **Introduction**

Weston and Brigham (1981), in a literature study of managerial finance, conjecture that risk, return and value (see description below) are interrelated. They discuss different definitions of value, such as book value (the accounting value at which an asset is carried) and market value (the price at which the asset can be sold). Graham *et al* (1962) define fair value as that value that is justified by the facts; namely assets, earnings, dividends.

Weston and Brigham (1981), posit that although this idea was developed for security valuation, the idea is applicable to all business assets. They note that it involves estimating future net cash flows attributable to an asset, determining of an appropriate capitalization (or discount rate) and then finding the present value of the cash flows. Weston and Brigham posit business risk as measured by the variability of the operating income. The organization's risk, however, depends on both business and financial risk (Brigham and Capienski). Gitman (1991) defines business risk as the risk to the firm of being able to cover its operating costs.

Operating leverage affects the fixed cost of the organization. Fixed costs must, however, be recovered. Fixed assets are therefore being used in the hope that it will increase profits. Uncertainty (risk) on sales figures and cost of production can thus be increased by the operating

leverage. Weston and Brigham define business risk as the inherent uncertainty or variability of expected pre-tax returns on the organization's portfolio of assets.

Brigham and Capenski (1988) postulate that business risk is the single important determinant of a firm's capital structure. They note that business risk varies from industry to industry and can change over time. According to them, business risk depends on a number of factors such as: input cost variability, operating leverage, etc. Business risk depends partly on the extent on which a firm builds fixed costs into its operations. Brigham and Capenski note, however, that the higher the degree of operating leverage, the greater the business risk as measured by the standard deviation of expected EBIT.

Weston and Brigham defines operating leverage as the percentage change in operating profits associated in operating profits associated with a given percentage change in sales volume. Operating leverage affects earnings before interest and taxes (EBIT), while financial leverage affects earnings after interest and taxes (earnings available to the owners).

Van Horne (1980), conjectures that the traditional approach to leverage assumes that there is an optimal capital structure and that the organization can increase the total value of the organization through the judicious use of leverage. This position implies that the cost of capital is dependent on the capital structure of the organization and that there is an optimal capital structure. He conjectures that the cutoff rate for investment purposes is completely independent of the way in which an investment is financed (based on the Miller/Modigliani model). Van Horne, however, postulates that the perceived risks of personal and corporate leverage may differ. He posits that

managers need to look for capital market imperfections that impede the equilibrium of investments according to their expected returns and systematic risk. Given these circumstances, leverage may have an effect on the value of an organization and its cost of capital.

A.2.2 Preparation of the formulae used to do the calculations for risk for the organizations

The leverage models discussed in Chapter 2 and A.2.1 that were utilized are: *Operating Leverage* (which affects earnings before interest and taxes (EBIT)) and *Expected return on IT Assets and the percentage risk factor*.

The following equation were used to calculate *operating leverage* (Brealey and Myers: 1981):

$$\textbf{Operating Leverage:} = \% \text{ change in EBIT} \div \% \text{ change in turnover}$$

where:

EBIT = Earnings before interest and taxes.

The *expected return on assets model* selected in the research to measure the return on investment was:

$$r_A = \textbf{Expected operating income} \div \textbf{the market value of all securities}$$

Because of references to IT investment as the main area of research and the investment in IT used in the hypotheses (Chapter 3), it was suggested the terminology *securities* be replaced with *IT investment* as was noted in the hypotheses. Authors, (Weill and Olson (1989), Ahituv and Neumann (1986) and Turner (1985)) agreed that this was possible. Hence, the formula changed to:

$$\textbf{Return on IT Assets (} r_A \text{)} = \textbf{Expected operating income} \div \textbf{the market value of IT investments.}$$

To calculate business risk (referred to as organizational risk factor) the following formula was used, based on the statement by Weston and Brigham, Gitman and others as:

Organizational risk factor = Variance of the operating income for the organization ÷ The period under investigation

Risk was calculated as: operating income divided by the turnover of each organization for the 3 years under investigation. The coefficient of variance of these values was obtained and used as a representative value of the risk of an organization (expressed as a percentage). The smaller the value, the lower the risk of an organization. The higher the value, the riskier the organization.

A.3 Stochastic Process Simulation (SPS)

A.3.1 Introduction

Gottfried (1984), in his literature study on elements of stochastic process simulation (SPS), defines Stochastic Process Simulation (also known as Monte Carlo simulation) as simulation that refers to the use of mathematical models to study events that are characterized by the occurrence of discrete, random events.

One of the important tasks in running a business organization is the establishment of efficient operating policies according to Gottfried (1984). A manager could, for example, determine how many terminals must be in operation during a typical busy day in his organization. In this example, the choice of a particular operating policy can determine the difference between a profitable versus non-profitable operation.

Risk analysis is one of the most important and widely used applications of stochastic dominance (SD) simulation. The objective is to assess the desirability of a proposed investment, based upon some financial criterion such as either present worth, uniform annual series, rate of return, etc (Gottfried: 1984). Application of the SD method results in a cumulative distribution being generated for the decision criterion. By using this method, managers not only calculate the expected value of the decision criterion, but also the likelihood of realizing a much higher or much lower value.

Post and Diltz (1986), in a case study done on a SD approach to risk analysis of computer systems, posit that the methodology of SD consists of some fundamental changes to the expected value approach to risk analysis. One is that instead of emphasizing probability estimates for different types of proposals, the primary objective would be to compare the costs with various alternatives. The second one is that SD analysis evaluates the entire investment proposal instead of just the first one. The next step is to assign a probability that the component needs to be replaced, expanded or a new system bought to supplement the present system. The contingency plan needs to be made at this stage. This plan describes exactly what steps are to be taken when an investment is to be made. SD methodology can be applied to less extensive investments as well by considering individual components separately and adjusting the time frame as necessary. The primary objective is to evaluate IT investment plans.

To define first degree stochastic dominance (FSD), suppose that the decision-maker is choosing between *two risky alternatives*, f and g . Let F and G be the cumulative distribution functions of

outcomes corresponding to alternatives f and g , respectively. Then FSD, as defined by Post and Diltz, is:

$F^1 > G$ if and only if $G(x) > F(x)$ for all admissible x .

Post and Diltz note that to define second degree stochastic dominance (SSD) the decision-maker need to assume that decision-makers are risk averse. They claim that the decision-maker needs to define the two functions as:

$$F_2(x) = \int F(y) x \, dy, \text{ and } G_2(x) = \int G(y) x \, dy.$$

SSD was defined by them as: $F_2 > G$ if and only if $G_2(x) > F_2(x)$ for all admissible x .

Post and Diltz postulate that there are some useful properties of SD definitions: If $F >_1 G$ then $F >_2 G$. That is, if FSD holds, then SSD holds as well. The converse, they claim, however, is not necessarily true; and, both FSD and SSD support transitivity. That is, if $F_1 > G_1$ and $G_1 > H_1$ then $F_1 > H_1$.

They conjecture that one of the useful features about FSD is that it can be observed from plots of the cumulative distribution functions. The definition by Post and Diltz states that if the plot of F , on a graph, always lies above that of G , then G dominates F . The authors posit that if the x -axis is denominated as costs (if G dominates F) it means that there is a higher probability that alternative G would lead to higher costs. If the line crosses, FSD is indeterminate and SSD must be examined (unfortunately SSD is more difficult to determine visually but some generalisations usually holds true). If the cumulative distribution plots intersect once at low x values, SSD is usually indeterminant because it implies that one plan is better for small investments and another

for larger investments. If one line crosses another for a short interval and then returns, SSD will usually still hold. This, the dominance is calculated more precisely by the simulator as suggested by Post and Diltz.

Post and Diltz postulate that the main advantage of using SD for contingency planning, is that it examines the entire investment distribution, rather than the just the first moment. It also provides a way to display the distribution to allow the decision-maker can visually compare difficult investments. Such comparisons are facilitated with graphical presentations of the distributions.

A.3.2 Methodology for Stochastic Process Simulation

Stochastic simulation (pseudo-random number-based) has been widely used for performance evaluation (Warren *et al*: 1992) but is often presented without attention to the statistical nature of simulation output. An advantage of the SPS methodology is that it is designed to answer the specific question of what type of investment should be used if a decision is made to invest resources in IT. The whole point of the analysis is to help system managers choose between alternatives. This method focuses the attention on potential solutions. SPS methodology allows the MIS managers to analyze the MIS function and its relationship to the business. They suggest that SPS simulations needs to be calculated by computer.

The steps to be followed, they note, include the plotting of the present IT investments in a distribution graph against the percentage risk factor of the managers, the graph is examined for first and second degree dominance. Warren *et al* note that SPS can never yield the outcome that a given parameter of the simulated system is exactly x . The important simulation run parameters in

the replications method are the simulation duration, warm-up period, and the number of replications.

To run the simulation, stochastic decision trees and the distribution graphs were used. Tables were built that sketched a scenario, displaying the influence of risk on the organization when an investment in IT has to be placed. This table measured the effect on management decisions if the organization is affected negatively or positively to some extent. Using these data, a stochastic decision tree was designed, displaying all the options that could be exercised by a manager when he has to make a decision regarding an IT investment. A distribution plotting method was used, displaying the distribution of the respondents IT investment's monetary value against the risk profile of the respondents.

A.3.3 The von Neuman Utility Technique

From a given set of cost values, the utility function, termed as utility cost, will be evaluated (Shoval and Lugasi: 1988). In order to do so, define a cost value, C_i^* for which the utility $U(C_i^*) = 1$, and a cost value C_i^0 for which $U(C_i^0) = 0$. C_i^* is the least expensive alternative and C_i^0 us the most costly one. Thus, Shoval and Lugasi conjectures, the decision maker have two options; the one alternative i being C_i^* , which he is sure of obtaining or the alternative i being C_i^* is given on a lottery card, in which there is probability q that the cost is C_i^* and probability $(1-q)$ that the cost of the alternative is C_i^0 . At which level of q will the decision maker be indifferent to the choice between the two options? Shoval and Lugasi posit that when the decision maker is indifferent to both options 1, and 2, it can be conjectured that the utility of cost of the first option equals the expected cost of the second option. Mathematically it can be explained:

$$C_i^* = q \cdot U(C_i^*) + (1-q) \cdot U(C_i^0)$$

$$\Rightarrow C_i^* = q$$

A.4 IT related ratios

A.4.1 Introduction

Harris and Katz (1988) note that technology is altering the way companies compete. There is, they claim, therefore increased incentive to examine closely the link between the business strategy of the firm and the information strategy. Evaluating whether a firm's level of investment in information technology is sufficient, or represents a competitive edge, has been a problem *historically* for top management.

Systems technology sophistication is assessed, using a table of the types of data processing installations. These compilations, used by Harris and Katz, were formulated by an industry panel of senior information system executives. In this table, the columns correspond to five levels of systems technology sophistication.

Hardware	Multiple processors/Multiple locations directly connected or via switched networks
Operational	Database management system, TSO, CICS, remote and local batch
Systems Software	Multiple CPU's/multiple program execution multiple operational environments
Application Software	Modular programs/structured techniques high level language
Management	Multiple locations/dissimilar operations remote control

The rows are used to characterize the levels on five dimensions: (i) hardware environment, (ii) operations, (iii) systems software, (iv) applications software, and (v) management. Each firm self-types their data processing installation based on the definitions that are supplied with the survey instrument. A typical table could look like the previous example used by Harris and Katz (1988): This they call *Systems Technology Sophistication*. Type I installations represent single hardware locations with fewer than 25 IT/DP staff. It supports some applications with batch emphasis as the means of processing. Type II installations are multiple hardware locations with 25 - 50 staff members and run the same application programs. Type III installations share the classification of a multiple hardware environment with about 50 - 100 staff members and use more diverse types of applications. Type IV installations have between 100 and 200 staff members and diverse applications with emphasis on online or batch processing. Type V organizations typically have multiple location hardware environments with between 200 and 400 staff members. They have several diverse applications. Type VI organizations have multiple location hardware environments with over 400 staff members. They also handle a large number of diverse applications.

Additionally they plot, the income versus operating expense over a couple of years. The sample is then ranked by income and then divided into quintiles. The result of this is portrayed in a tabular form, comparing the premium income, average non-interest operating expense and average amount spent on IT. Another plotted graph shows income growth versus non-interest operating expense for the sample used by them.

The authors calculated some ratios, one being called the *operating cost efficiency ratio* (OPEX) which is the ratio of total operating expense to income (turnover). The organization with the

largest OPEX ratio represents the least profitable organization and the organization with the smallest, the most profitable. The organization with the largest CI was assumed the most computerized (see above). According to Harris and Katz, this allows the comparison of businesses with similar lines of business. The conclusion they come to, is that any company with expenses per monetary income that are higher than the competition is at a competitive disadvantage. Another ratio called *information technology expense ratio* (ITEX), is the ratio of IT expenses to non-interest operating expenses. The last ratio is the *IT cost efficiency ratio* that is the cost of information processing to sales revenue.

Harris and Katz reported that 75% of their sample used improved their profitability position while the operating expense ratio decreased. Their findings do suggest empirical relationships, namely the most profitable firms, or top performers, are more likely to spend a significantly higher proportion of their non-interest operating expense on IT. They note that every business situation should be evaluated on its own merits.

A.4.2 *Presentation of the formulae used to calculate the ratios*

A.4.2.1 *IT Efficiency Ratio [ITEX]*

This is the ratio of information technology expense to total operating expense as one measure of the degree of operating dependency on information technology.

$$\text{IT Efficiency Ratio} = \frac{\text{Information Technology Expense}}{\text{Total Operating Expense}}$$

A.4.2.2 *IT Costs Efficiency Ratio [ITCE]*

The IT costs efficiency ratio is a single-factor expense measure of the cost economies of IT. In this research three sources of information technology-based cost economies are relevant. They are scale economies, scope economies and economies due to learning effects (Harris and Katz: 1988).

The costs of information processing as a proportion of sales revenue (turnover) were investigated. The original formulae used premium income as a basis. The present study, however, because of the spread of organizations, substituted premium income with turnover (sales revenue).

$$\text{IT Cost Efficiency Ratio} = \frac{\text{Information Technology Expense}}{\text{Total Turnover}}$$

A.4.2.3 *Operating Cost Efficiency Ratio [OPEX]*

This is the ratio of non-interest operating expense to income.

$$\text{Operating Expense Ratio} = \frac{\text{Non-interest Operating Expenses}}{\text{Income}}$$

A.5 **Cost-Benefit Analysis Ratios**

A.5.1 *Introduction*

Brealey and Myers (1981), in a literature study of corporate finance, define cost-benefit analysis ratios as the net present value of a business. They note that projects with a cost benefit ratio >1, need to be considered. Weston and Brigham (1981) note that the cost-benefit ratio can be called the Profitability Index (PI). They posit that the PI reflects the relative profitability of any project, or the present value of benefits per rand of cost. They conjectured that riskiness, as part of these projects, should be evaluated directly. They note that it is not valid to assume that riskiness is proportional to the size of the project.

Shoval and Lugasi (1988), in a literature study on computer systems selection, posit that the decision-maker, while using a cost-benefit graph, can select among alternative computer selections. At the same time the decision maker can consider the cost-benefit ratio (CBA) and the relative importance of the benefit and cost factors in a given situation. They consider a selection of models (CBA, graphical CBA, and cost transformations) but come to the conclusion that the cost transformation method based on the utility model suits the purpose of graphical computer selection the best.

This model allows the evaluation by the decision maker for a set of attributes. The utility model can thus be applied to a cost transformation problem; from a given set of cost values of the utility

function. They conjecture that the more the decision maker seeks risk, the narrower is the range of values to prefer an alternative and the more risk averse the decision maker, the wider is the range for any alternative. Shoval and Lugasi prefer this method to any other method because it is based on a normative model, including axioms that reflect behavioral rules of the decision maker in determining preference, considering the important factors of risk and uncertainty. Graphs enabled them to highlight what is "hidden" in the cost-benefit ratio.

A.5.2 Presentation of the formulae used to calculate the CBA

The questionnaire asked a specific question about benefits received for the year and the total investment. Using the perceived factor, the presentation of the percentage value of the benefit(s) (PV.Benefits) for the period under investigation was completed (see Appendix K)(as supported by Ahituv and Neumann, Keen, Remenyi (1992) and King). It should, however, be mentioned that the percentage is subjective as it is purely the reflection of the personal view of the manager.

Appendix B:
Covering Letter:

Salutation and Address

Dear

RE: Research Data Collection - enclosed questionnaire.

With reference to our previous conversation, I have pleasure enclosing the questionnaire form my M.Comm degree in Information Systems (through the University of Cape Town). I am conducting research on the effect of investing resources in Information Technology (IT) on an organization's risk and profitability. As I am investigating Namibia as a whole your participation is greatly appreciated.

As discussed, could you please include copies of your balance sheets and/or budget working papers from 1990 to 1992? I can assure you that all the information gathered in this questionnaire will be treated in the strictest confidence. The data will be grouped into percentiles and averaged to ensure complete confidentiality and the questionnaires will be destroyed once they have been analyzed.

Could you please mail the questionnaire back to me at Rhodes University in the enclosed self-addressed postage paid envelope before 25 May 1993. Alternatively I can collect the complete information (questionnaire and balance sheets) on this date. If this is inconvenient in any way, please could you FAX the information to me at 0461-25049 before 25 May 1993.

This research would not be possible without your assistance, and I will send all respondents an executive summary of the research findings.

Thanking you in anticipation.

Yours Sincerely

Sam Lubbe

Prof M L Hart
Supervisor

The University of Cape Town

Department of Accounting

INFORMATION TECHNOLOGY INVESTMENT QUESTIONNAIRE

1. This questionnaire is to help the researcher in completing his research for his M.Com

2. All data will be treated in the strictest confidence

3. Please answer **all** questions

4. Please indicate your answers **clearly** in the box(es) right next to the questions

-
- (i) Please read the following three pages (page 2 - page 4) for a clarification of terms used in this questionnaire.
 - (ii) Classify your organization according to the framework supplied (page 5).
 - (iv) The completion of the data needed, starts on page 6.
 - (v) If possible, include a set of financial statements.
 - (vi) Please insert the completed questionnaire into the addressed envelope and mail it.
 - (v) IT means Information Technology

a. Breakdown of IT costs into categories:

<i>Hardware</i>	Central Processing Unit
	Peripherals
	Other
	Facilities Management and Timesharing
<i>Software</i>	Application
	Systems
<i>Communications</i>	Voice
	Data
	Other
<i>Miscellaneous</i>	Environment
	Personnel
	Supplies
	Other
<i>Personnel</i>	Information Processing Salaries and benefits
	Application Systems
	Technical Support
	Operations
	Management and Staff
	User Support Staff

b. *Detailed description of terms used:*

Hardware:

Include all equipment used for the information technology processing operation. This includes: traditional information processing equipment and office workstation systems, wordprocessors and micro- or personal computers. For purchased equipment, report the capitalized current year depreciation; rental or lease charges for non-purchased equipment. Also include annual maintenance charges for all equipment in the appropriate categories. Include gain or loss from equipment sold.

Central processing unit:

Include mainframe of large, mini- or microcomputer systems regardless of location. Include mini- or microcomputers located in and paid for by user departments. Report annual depreciation value and annual rental or lease charges separately on the data sheet. Include stand-alone processors such as word-processors, office systems and personal computers and their peripheral devices (eg printers, etc) regardless of their location or department with budget responsibility.

Peripherals:

Include tape and disk drives, mass storage devices, input/output devices (channels, printers, card readers/punches, etc), their associated controllers, and cables.

Other:

Include data collection/data entry devices, unit record equipment, OCR equipment (scanners), etc. Include computer output microfilm (COM) equipment -- readers, fiche duplicators or hardcopy equipment regardless of their location. Include supplies necessary for the operation of the equipment above - continuous forms and other printer stationery, tapes, ribbons, disk packs, cards, etc.

Facilities Management and Timesharing:

Include cost of facilities management of timesharing operations.

Software:

Include the purchase cost or annual amortization (as well as annual rental and lease fees associated with acquired software), the annual cost of maintenance agreements or vendor support (ie for installation, training, modification), contracted systems development (ie software designed and/or programmed outside of the company but commissioned by the company), software for mini- or microcomputers (including those in user areas), only software developed outside the company. In-house development should appear under salaries. Exclude gain from software sold.

Application:

Include all software that supports the operation of the company in any line of business (eg new business, accounting, agency, valuation systems, etc).

Systems:

Include all software that supports the information processing operation (eg operating systems, sorts, productivity aid, securing/auditing, communications, data base management systems, etc).

Communications:

Include equipment, services, and support expenses related to communications.

Voice:

Include personal phone system and line costs for the entire head office of the company (eg key, private branch exchange and centrex systems of any voice and data systems used primarily for voice). Include long distance voice services and public network voice services.

Data:

Include data communication services (eg electronic funds transfer systems, message switching services, direct distance dialling services, telex, videotext, teletext, tele-conference lines, facsimile, dedicated data lines and satellite usage costs, private data networks, microwave and fibre-optic connections between buildings). Include local area networks connecting terminals in the campus environment. Include data communication network (eg modems, controllers, concentrators, data switching equipment, multiplexors, front-end processors and network interface equipment) equipment.

Other:

Include terminals both intra-company and with remote sites. Include terminals used in field offices or user areas for direct network links to the mainframe or office systems. Include executive workstations and audio video conference rooms and equipment. Include cabling systems, wiring and outside plant. Include communications environment support systems (eg dedicated air conditioners, battery back-up systems, satellite dish, etc).

Miscellaneous:

Environment:

Include all information processing department areas. Include all central automation areas (eg word processing, office systems, etc). Include all items relating to the office or computer room environment (rent; heat, light and water, furniture and fixtures [all office furniture and equipment other than hardware, including typewriters and calculators]), general office maintenance (include maintaining computer equipment under the hardware category).

Personnel:

Include items that complement the personnel function over and above salaries and benefits regardless of who delivers or pays for services. Include costs for those employed by the information processing/automation function (eg data entry staff). Include costs for user related items as indicated: recruitment and employment, training, tuition refund, travel association dues, consulting.

Supplies:

Include that portion of general office supplies used for the information processing/automation operation: stationery and supplies [paper, pencils and other general desk equipment], printing and forms [eg training manuals], postage, books and periodicals used by information processing/automation department employees.

Other:

Other items to include: disaster recovery and insurance.

Personnel Expenses:

Information processing personnel:

Include all full-time information processing employees, regardless of their location in the company. Exclude all data entry personnel.

Salaries:

Include direct compensation (salary, bonuses, overtime, etc).

Benefits:

Include the benefits such as (over and above direct compensation listed above) vacations, holidays, sick leave, pension, insurance, savings, cafeteria, recreation, transportation, housing, etc as part of salaries.

Type of Data Processing Installation Matrix

ENVIRONMENTS	TYPE 1	TYPE 2	TYPE 3	TYPE 4	TYPE 5	TYPE 6
Hardware environment	Single location	Multiple location	Multiple location	Multiple location	Multiple location	Multiple location
	Single processor. Typical CPU; IBM 4331 up to IBM 4361 or equivalent MIPS* capability: less than 2	Single processor. at each. Typical CPU IBM 4331, up to IBM 4361 or equivalent. MIPS capability: 2 to less than 7	Multiple processor. Typical CPU IBM 4381, 3033 or 3083 or equivalent MIPS capability: 7 to less than 15	Multiple processor. Typical CPU IBM 4381, 3033 or 3083 or equivalent MIPS capability: 15 to less than 40	Multiple processor. Typical CPU IBM 4381, 3033 or 3083 or equivalent MIPS capability: 40 to less than 75	Multiple processor. Typical CPU IBM 3081, 3084 or 3090 or equivalent MIPS capability: 75 and over
Operational Environment	Batch processing and possible limited terminal online processing. Typical operating system - DOS/VSE.	As type 1. CPUs may be connected via teleprocessing	Batch processing and terminal on-line processing. Operating system MVS.	As type 3; at least one CPU from each location may be connected via teleprocessing. Operating system MVS/XA.	Extensive use of telecommunications connecting many CPU combinations. All locations interconnected. Operating Systems Multiple MVS/XA.	Extensive use of telecommunications connecting many CPU combinations. All locations interconnected. Operating Systems Multiple MVS/XA.
Systems and Programming Professional Staff	Less than 25	25 to less than 50	50 to less than 100	100 to less than 200	200 to less than 400	400 and over
Application Software Environment	Limited number of applications supported. Batch emphasis.	All locations run essentially the same application programmes.	Larger more diverse number of applications. On-line or batch emphasis. Possible use of DBMS.	Larger more diverse number of applications. Online or batch emphasis. Use of DBMS.	Very large number of diverse applications.	Very large number of diverse applications.
Management Environment	Single/Location Local Control	Multiple Locations/ Single Operations/ Local Control	Multiple Locations/ Local Control	Multiple locations/ Similar or dissimilar Operations/ Local Control.	Multiple Locations/ Dissimilar Operations/ Remote Control	Multiple Locations/ Dissimilar Operations/ Remote Control.

* MIPS: A Million Instructions per Second

It is suggested that you analyze your own installation in terms of each of the five environments. The five elements (far left vertical column) are defined in terms of the least complex (Type 1) and graduate in degree of complexity or sophistication to the most complex (Type 6) - horizontal columns. After reviewing each of the five elements, you will decide which type is the best overall fit for your installation. This will require some judgment on your part in weighting the individual elements.

**SECTION III:
A. GENERAL DETAILS**

1. What is your position in the organisation?	
2. Enter the configuration type (enter 1 - 6 from the matrix, page 5)	
3. In what year did your organisation begin using computers?	

B. LOCATION / PROJECT INVESTMENT DETAILS

For section B, indicate your answer (yes or no) by placing a tick (✓) in the appropriate space.

	YES	NO
4. Are your major computing facilities located only in the IT/DP department?		
5. Do you use any Discounted Cash Flow Techniques in your project investment analysis? (see note 1)		
Note 1: Discounted Cash Flow Techniques are methods of ranking investment proposals. Included are (1) internal rate of return method, (2) net present value method, and (3) profitability index or cost-benefit ratio.		

C. ORGANISATION ANALYSIS

For section C, please indicate your answer for the **end** of the financial year in question, eg. the end of the 1991 financial year. If there was no change from one year to the next, please indicate this by leaving that space blank or re-writing the number from the previous year.

	1990	1991	1992
6. Number of Computer Installations? (note 2)			
7. Size of your largest CPU? (note 3)			
8. Number of IT Department Shifts?			

Note 2: In this instance, a Computer Installation refers to any large multi-user Computer Hardware, eg a minicomputer or a mainframe or a LAN server. No single-user desktop are referenced here.

Note 3: Please indicate the type of processor your largest personal computer has, eg 80486, AS/400 B50, etc.

E. EXPENSE DETAILS

HARDWARE:	1990	1991	1992			
CPU Depreciation	R	R	R			
CPU Rent/Lease	R	R	R			
Peripherals	R	R	R			
Other	R	R	R			
Facilities Management & Timesharing	R	R	R			
COMMUNICATIONS:	1990	1991	1992			
Voice	R	R	R			
Data	R	R	R			
Other	R	R	R			
SOFTWARE:	1990	1991	1992			
Applications	R	R	R			
Systems	R	R	R			
MISCELLANEOUS:	1990	1991	1992			
Environment	R	R	R			
Personnel	R	R	R			
Supplies	R	R	R			
Other	R	R	R			
IT/DP STAFF:	1990 STAFF #	1990 SALARIES	1991 STAFF #	1991 SALARIES	1992 STAFF #	1992 SALARIES
Application Systems		R		R		R
Technical Support		R		R		R
Operations		R		R		R
Management and Staff		R		R		R
User's Support Staff		R		R		R
TOTAL # STAFF IN COMPANY	1990 STAFF #	1990 SALARIES	1991 STAFF #	1991 SALARIES	1992 STAFF #	1992 SALARIES
Clerical		R		R		R
Tech/Professional		R		R		R
Management		R		R		R

F. OTHER DETAILS

<i>Report all figures in whole Rand</i>	1990	1991	1992
Turnover	R	R	R
Other income	R	R	R
Total assets (as per Balance Sheet)	R	R	R
Total insurance	R	R	R
General expense (expenses incurred, not covered by section E/F)	R	R	R
Gross Profit	R	R	R
Net Profit	R	R	R
Income tax paid by your company	R	R	R
Number of application software (eg if your company uses Quattro Pro on 40 machines, Quattro Pro will only be counted once, etc)	R	R	R

G. PROBABILITY OF DOING AN IT INVESTMENT

Will your organization still follow your initial investment plan to invest resources into IT if the risk of your organization is affected:

See note 4		100%	80%	60%	40%	20%	0%
negatively	<i>to some extent (0 - 33%)</i>						
	<i>to a greater extent (33.01 - 67%)</i>						
	<i>to a large extent (67.01 - 100%)</i>						
positively	<i>to some extent (0 - 33%)</i>						
	<i>to a greater extent (33.01 - 67%)</i>						
	<i>to a large extent (67.01 - 100%)</i>						

Note 4: Please complete all lines for affected negatively and all for affected positively.

H. COST-BENEFIT DETAILS

1991	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100
What percentage (%) benefit, of your total investment in IT, did you receive in 1991?										
What percentage (%) benefit of your investment in IT for 1991 only did you receive in 1991?										

1992	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100
What percentage (%) benefit, of your total investment in IT, did you receive in 1992?										
What percentage (%) benefit of your investment in IT for 1992 did you receive in 1992?										

1993	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100
What percentage (%) benefit of your total investment in IT do you expect to receive in 1993?										
What percentage (%) benefit of your investment in IT for 1993 do you expect to receive in 1993?										

APPENDIX C

SUMMARIZED RATIOS

No	AVGITEX	AVGOPEX	AVGITCE	CI	OPEL	R _g	CBA	Probability AFFECT [-]	Probability AFFECT [+]	Rev stability*	IT Market value	Pretax Prodb/ TO	Profit Growth	Org Risk
1	0.741	0.600	0.445	4.40	1.00	3.62	10%	26.67%	100.00%	58.33	42000	0.400	58.33	25.71%
2	0.012	1.069	0.013	3.59	-0.96	-1.44	38%	33.33%	93.33%	-15.69	1500000	-0.084	-15.05	16.97%
3	0.015	0.691	0.010	4.67	1.84	32.49	10%	0.00%	0.00%	27.01	236660	0.318	26.67	12.01%
4	0.034	0.680	0.023	9.17	1.00	17.81	22%	100.00%	100.00%	73.96	3000000	0.320	73.96	19.18%
5	0.024	0.634	0.015	2.71	1.00	141.80	10%	6.67%	93.33%	39.35	486000	0.366	39.35	22.85%
6	0.434	0.735	0.316	4.38	-0.45	0.79	13%	0.00%	100.00%	25.72	395000	0.178	-41.10	28.94%
7	0.008	1.069	0.009	2.14	0.08	-14.37	20%	26.67%	80.00%	-15.69	150000	-0.084	-15.05	16.97%
8	0.310	0.870	0.270	3.88	19.47	8.18	17%	33.33%	100.00%	20.58	11500	0.098	-3.04	33.04%
9	0.319	0.890	0.284	4.15	1.09	0.03	60%	20.00%	100.00%	25.10	758000	0.125	96.63	22.87%
10	0.129	0.686	0.088	6.12	3.95	1.72	73%	66.67%	93.33%	2.76	1415000	0.301	-3.25	20.82%
11	0.007	1.016	0.007	7.74	79.56	-323.38	20%	20.00%	80.00%	2.37	108950	-0.278	-414.04	2418.46%
12	0.000	0.946	0.000	4.85	4.31	13.96	30%	40.00%	93.33%	7.90	1350000	0.064	33.63	11.68%
13	0.003	0.934	0.003	5.36	-6.12	15.94	20%	20.00%	80.00%	5.79	610000	0.049	-38.11	21.14%
14	0.000	0.963	0.000	8.52	35.44	121.55	40%	100.00%	100.00%	-10.76	96000	0.065	596.66	62.02%
15	0.045	0.707	0.032	5.83	-0.15	21.73	30%	33.33%	100.00%	30.76	1475000	0.273	23.17	25.26%
16	0.147	0.077	0.011	65.10	1.20	0.43	50%	100.00%	100.00%	45.51	45340000	0.934	44.08	102.01%

17	0.038	0.094	0.004	46.61	1.19	0.09	40%	100.00%	100.00%	54.36	160000000	0.915	55.41	104.12%
18	0.120	0.419	0.025	2.37	-4.30	5.88	40%	100.00%	100.00%	-7.41	1500000	0.406	-58.64	30.50%
19	0.116	0.472	0.054	18.26	4.38	21.19	40%	100.00%	100.00%	30.55	2242548	0.651	64.72	13.27%
20	0.220	0.392	0.082	11.72	-1.41	45.90	40%	100.00%	100.00%	-20.45	2000000	0.527	-33.91	63.10%
21	0.114	1.029	0.116	7.65	7.32	129.15	57%	40.00%	60.00%	37.95	20000	0.008	-13.03	200.03%
22	0.188	0.298	0.057	6.21	0.00	12.87	40%	100.00%	100.00%	-8.81	5000000	0.661	-23.30	51.21%
23	0.005	0.896	0.004	9.33	4.22	247.90	57%	40.00%	60.00%	67.76	20000	0.152	132.20	38.56%
24	0.211	0.064	0.013	10.57	12.52	40.08	40%	100.00%	100.00%	3.81	45000000	0.940	1.79	107.81%
25	0.052	0.206	0.011	12.27	2.58	181.84	40%	100.00%	100.00%	99.06	5081000	0.827	109.49	72.47%
26	0.375	0.600	0.225	4.81	1.00	17.45	15%	93.33%	100.00%	30.91	16500	0.400	31.21	25.77%
27	0.51	0.424	0.204	14.07	-0.22	2.29	100%	60.00%	100.00%	139.08	500000	0.759	296.99	32.15%
28	0.052	1.126	0.059	3.53	0.93	-1.82	100%	80.00%	100.00%	67.81	39000	-0.125	-67.81	4.79%
29	0.122	0.799	0.100	3.31	-1.88	1.83	100%	80.00%	80.00%	100.00	120000	0.110	120.00	89.53%
30	0.064	0.682	0.043	3.64	1.15	8.11	25%	100.00%	100.00%	-13.43	11037	0.313	-15.43	19.80%
31	0.006	0.670	0.004	2.83	2.43	43.50	25%	100.00%	100.00%	42.73	24671	0.370	82.48	22.22%
32	0.234	0.632	0.145	3.72	2.59	37.21	50%	53.33%	86.67%	36.33	15747	0.439	80.31	16.53%

33	0.027	0.893	0.024	3.35	3.06	3.94	15%	100.00%	100.00%	6.29	26733	0.144	108.39	26.10%
34	0.441	0.814	0.347	1.56	1.19	1.70	77%	0.00%	100.00%	315.79	13666	0.341	1705.73	99.28%
35	0.010	1.001	0.010	3.83	511.88	-0.35	97%	100.00%	100.00%	27.66	234500	-0.002	-152.85	78.97%
36	0.025	0.854	0.021	2.39	1.00	3.08	100%	0.00%	100.00%	20.00	170400	0.146	19.92	7.60%
37	0.095	0.176	0.017	1.64	0.00	51.27	100%	100.00%	100.00%	16.67	66000	0.806	12.80	89.32%
38	0.104	0.730	0.076	2.53	0.80	0.83	48%	100.00%	100.00%	24.64	800000	0.266	21.43	16.42%
39	0.077	0.841	0.065	7.15	-45.37	3.74	100%	0.00%	100.00%	3.68	504000	0.157	10.39	15.86%
40	0.131	0.719	0.094	2.01	0.13	4.25	100%	100.00%	100.00%	29.13	47200	0.257	10.71	19.07%
41	0.201	0.709	0.143	2.75	0.91	2.46	100%	100.00%	100.00%	27.68	60444	0.284	21.01	16.06%
42	0.176	0.876	0.154	2.77	1.00	4.48	60%	100.00%	100.00%	32.14	24580	0.124	32.14	6.35%
43	0.331	0.727	0.234	34.50	1.01	0.63	60%	0.00%	100.00%	289.09	397000000	0.235	167.02	15.52%
44	0.001	0.996	0.001	37.43	0.34	0.06	60%	0.00%	53.33%	48.45	310000000	0.003	35.71	4.49%
45	0.431	0.728	0.303	39.46	0.99	0.54	60%	0.00%	100.00%	289.62	311000000	0.234	169.35	15.33%
46	0.220	0.896	0.197	9.38	0.00	0.11	100%	0.00%	53.33%	25.00	1500000	0.107	33.33	7.41%
47	0.446	0.715	0.305	23.38	0.95	0.27	22%	0.00%	66.67%	288.04	310000000	0.235	147.06	18.18%
48	0.317	0.730	0.227	39.75	1.01	0.48	100%	0.00%	53.30%	289.62	350000000	0.234	173.77	14.89%

* Revenue stability or turnover growth as used in some textbooks

APPENDIX D

FINAL COMPUTERIZATION INDEX

No	SMA 1990	SMA 1991	SMA 1992	OCA 1990	OCA 1991	OCA 1992	MCA 1990	MCA 1991	MCA 1992	TPA 1990	TPA 1991	TPA 1992	YEAR OF USE	NO OF INSTALL.	SIZE OF CPU	SHIFTS	LOCATION	PI ANA	HW COST	MAN ACT LEVEL	SW	STAFF	CI
1	1	1	1	6	6	6	6	6	7	6	6	6	7	2	3	1	2	2	1	4.2	20	2	4.40
2	1	1	0	2	2	2	4	4	4	5	5	5	10	1	6	1	5	2	3	1.9	11	2	3.59
3	0	0	0	3	3	5	6	6	6	4	4	4	16	1	4	1	5	2	2	3.1	15	1	4.67
4	0	0	1	1	1	5	0	1	7	0	3	18	23	10	4	1	5	2	3	5.1	31	19	9.17
5	0	0	0	0	0	0	0	2	2	0	0	0	10	3	4	1	5	2	2	0.4	2	6	2.71
6	0	0	0	8	8	8	6	6	6	6	6	8	4	1	3	1	2	2	2	4.4	19	7	4.38
7	0	0	0	0	0	0	1	3	3	0	0	0	7	1	4	1	2	2	2	0.6	3	5	2.14
8	0	0	0	6	6	6	5	6	6	6	6	6	4	1	3	1	2	2	1	3.6	18	6	3.88
9	0	0	0	3	3	3	6	6	6	5	5	5	8	1	5	2	5	2	2	2.6	14	8	4.15
10	0	0	0	10	10	10	7	7	7	9	9	9	9	2	5	2	5	5	3	5.3	26	4	6.12
11	1	1	1	12	12	12	10	10	10	7	7	7	19	2	5	1	5	5	2	6.7	30	3	7.74
12	0	0	0	5	6	6	5	7	7	7	7	7	10	2	5	1	5	2	1	3.9	20	2	4.85
13	0	0	0	5	5	5	4	5	5	7	7	7	13	6	4	1	2	2	2	3.2	17	9	5.36
14	0	0	1	7	9	13	7	9	12	23	24	26	6	4	4	1	2	2	1	9.3	52	2	8.52
15	2	2	2	3	3	3	5	5	5	3	3	3	19	1	6	1.5	5	5	3	3	13	12	5.83
16	1	1	1	8	8	8	8	8	8	8	8	8	34	8	6	1	2	2	4	5.2	25	941	65.10
17	1	1	1	21	21	21	22	22	22	24	24	24	35	25	6	3	5	2	4	13.5	68	500	46.61
18	0	0	0	0	0	0	0	0	0	3	3	3	9	1	5	1	5	2	3	0.3	3	3	2.37
19	2	2	2	25	25	25	30	30	30	43	43	45	24	1	6	3	5	5	3	18.8	102	15	18.26

20	0	0	0	0	5	10	16	6	8	11	4	4	4	17	5	5	3	2	2	3	7.4	31	64	11.72
21	0	0	0	9	11	11	3	3	3	3	9	9	9	23	5	6	2	5	2	1	4.8	17	17	7.65
22	0	0	0	2	3	6	2	2	3	6	4	5	6	11	2	6	2	5	2	3	3.6	18	23	6.21
23	0	0	0	1	1	2	0	0	0	0	4	4	4	23	7	3	1	5	2	1	1	44	44	9.33
24	0	0	0	1	2	2	4	4	4	4	4	5	4	23	9	5	3	5	2	4	1.8	10	83	10.57
25	0	0	1	4	5	5	6	6	6	7	6	6	6	18	1	6	3	5	2	3	3.9	19	110	12.27
26	1	1	1	9	9	9	7	7	7	7	7	7	7	3	1	2	1	5	2	1	5.2	24	5	4.81
27	0	0	0	35	40	47	4	4	4	4	5	5	5	23	7	5	2	5	2	2	15.4	56	11	14.97
28	0	0	0	4	4	4	7	7	7	7	4	4	4	8	1	3	1	2	2	1	3	15	0.5	3.53
29	0	0	0	4	4	4	4	5	5	5	1	1	1	10	2	3	1	2	2	2	2.3	10	0.5	3.31
30	0	0	0	3	3	4	3	4	4	4	5	5	5	12	1	3	1	2	2	1	2.5	13	1	3.64
31	0	0	0	2	2	2	6	6	6	6	5	5	5	5	1	3	1	2	2	1	2.3	13	0.5	2.83
32	1	1	1	1	1	1	4	4	4	4	4	4	4	8	10	2	1	2	2	1	1.9	10	2	3.72
33	0	0	0	0	0	0	7	7	7	7	3	3	3	13	3	2	1	2	2	1	1.7	10	0.5	3.35
34	0	0	0	0	0	0	0	0	1	1	0	4	4	3	1	3	1	2	2	1	0.6	5	2	1.56
35	0	0	0	1	1	1	3	3	3	3	5	5	5	15	1	5	1	5	2	2	1.4	9	5	3.83
36	0	0	0	1	1	3	1	1	1	3	1	1	3	3	3	2	1	2	2	2	1.8	9	0.5	2.39
37	0	0	0	2	2	2	0	0	0	0	1	1	1	3	2	3	1	5	2	1	0.7	3	0.5	1.64
38	0	0	0	2	2	2	3	3	3	3	4	4	4	3	1	5	1	5	2	2	1.6	9	2	2.53
39	0	0	0	4	4	4	6	6	6	6	7	7	7	28	9	6	1	5	2	2	3.1	17	5	7.15
40	0	0	0	2	2	2	0	0	0	0	4	4	4	4	2	1	1	5	2	1	1	6	2	2.01
41	0	0	0	4	4	4	5	5	5	5	3	3	3	3	2	3	1	2	2	1	2.5	12	0.5	2.75
42	0	0	0	4	4	4	4	4	4	4	4	4	4	3	2	4	1	2	2	1	2.4	12	0.5	2.77
43	6	7	9	11	13	13	18	18	18	18	50	50	50	25	1	6	3	5	5	5	16.1	90	312	34.50
44	2	2	2	23	23	23	16	16	16	16	34	34	34	23	2	6	3	2	5	5	14.3	75	392	37.43

45	4	6	7	9	29	29	11	26	26	35	42	42	24	3	6	3	5	5	5	20.9	104	347	39.46
46	0	1	1	13	16	20	6	9	10	7	7	7	15	2	6	2	2	2	3	9.1	38	15	9.38
47	0	0	1	6	8	9	8	9	9	8	8	8	25	1	6	2	5	5	5	5.7	27	260	23.38
48	5	7	9	12	17	19	10	24	24	20	22	25	22	2	6	3	2	5	5	16.6	77	415	39.75
AVG	0.58	0.71	0.88	6.23	7.27	8.04	5.98	7.00	7.42	8.6	9.0	9.56	35	25	6	3	5	5	5	20.9	104	941	65.1

APPENDIX E

COMPUTERIZATION INDEX DATA

No.	SMA 90	SMA 91	SMA 92	OCA 90	OCA 91	OCA 92	MCA 90	MCA 91	MCA 92	TPA 90	TPA 91	TPA 92	YEAR OF USE	NO OF INSTALL.	SIZE OF CPU	SHIFTS	LOCATION	PI ANA	HW COST.	MAN ACT LEVEL	S/W	STAFF
1	1	1	1	6	6	6	6	6	7	6	6	6	7	2	386	1	2	2	42000	4.2	20	2
2	1	1	0	4	4	4	4	4	4	5	5	5	10	1	Unsys 7000/40	1	5	2	1500000	1.9	11	2
3	0	0	0	6	6	6	6	6	6	4	4	4	16	1	486	1	5	2	236660	3.1	15	1
4	0	0	1	0	1	5	0	1	7	0	3	18	23	10	486	1	5	2	3000000	5.1	31	19
5	0	0	0	0	0	0	0	2	2	0	0	0	10	3	486	1	5	2	486000	0.4	2	6
6	0	0	0	6	6	8	6	6	6	6	6	8	4	1	386	1	2	2	395000	4.4	19	7
7	0	0	0	1	3	3	1	3	3	0	0	0	7	1	486	1	2	2	150000	0.6	3	5
8	0	0	0	5	6	6	5	6	6	6	6	6	4	1	386	1	2	2	11500	3.6	18	6
9	0	0	0	6	6	3	6	6	6	5	5	5	8	1	VS-6	2	5	2	758000	2.6	14	8
10	0	0	0	7	7	10	7	7	7	9	9	9	9	2	AS 400 e35	2	5	5	1415000	5.3	26	4
11	1	1	1	10	10	12	10	10	10	7	7	7	19	2	Sys 38/600	1	5	5	108950	6.7	30	3
12	0	0	0	5	6	6	5	7	7	7	7	7	10	2	As 400 h10	1	5	2	1350000	3.9	20	2
13	0	0	0	4	5	5	4	5	5	7	7	7	13	6	486	1	2	2	610000	3.2	17	9
14	0	0	1	7	9	13	7	9	12	23	24	26	6	4	486	1	2	2	96000	9.3	52	2
15	2	2	2	3	3	3	5	5	5	3	3	3	19	1	IBM mainframe	1.5	5	5	1475000	3	13	12
16	1	1	1	8	8	8	8	8	8	8	8	8	34	8	Perotel 8/90-8	1	2	2	45340000	5.2	25	941
17	1	1	1	22	22	21	22	22	22	24	24	24	35	25	9000 m 580	3	5	2	16000000	13.5	68	500
18	0	0	0	0	0	0	0	0	0	3	3	3	9	1	AS 400	1	5	2	1500000	0.3	3	3
19	2	2	2	25	25	25	30	30	30	43	43	45	24	1	IBM 3090	3	5	5	2242548	18.8	102	15

20	0	0	0	0	5	10	16	6	8	11	4	4	4	4	17	5	3084	3	2	2	2000000	7.4	31	64
21	0	0	0	0	9	11	11	3	3	3	9	9	9	9	23	5	771	2	5	2	20000	4.8	23	17
22	0	0	0	0	2	3	6	2	3	6	4	5	6	6	11	2	Prime 6450	2	5	2	5000000	3.6	18	23
23	0	0	0	0	1	1	2	0	0	0	4	4	4	4	23	7	80386	1	5	2	20000	1	6	44
24	0	0	0	0	1	2	2	4	4	4	4	5	4	4	23	9	AS400 d80	3	5	2	45000000	1.8	10	83
25	0	0	1	4	5	5	5	6	6	7	6	6	6	6	18	1	IBM Mainframe	3	5	2	5081000	3.9	19	110
26	1	1	1	9	9	9	9	7	7	7	7	7	7	7	3	1	286	1	5	2	16500	5.2	24	5
27	0	0	0	0	35	40	47	4	4	4	5	5	5	5	23	7	AS 400 R50	2	5	2	500000	15.4	56	11
28	0	0	0	0	4	4	4	7	7	7	4	4	4	4	8	1	386	1	2	2	39000	3	15	0.5
29	0	0	0	0	4	4	4	5	5	5	1	1	1	1	10	2	386	1	2	2	120000	2.3	10	0.5
30	0	0	0	0	3	3	4	3	4	4	5	5	5	5	12	1	386	1	2	2	11037	2.5	13	1
31	0	0	0	0	2	2	2	6	6	6	5	5	5	5	5	1	386	1	2	2	24671	2.3	13	0.5
32	1	1	1	1	1	1	1	4	4	4	4	4	4	4	8	10	286	1	2	2	15747	1.9	10	2
33	0	0	0	0	0	0	0	7	7	7	3	3	3	3	13	3	286	1	2	2	26733	1.7	10	0.5
34	0	0	0	0	0	0	0	0	1	1	0	4	4	4	3	1	386	1	2	2	13666	0.6	5	2
35	0	0	0	0	1	1	1	3	3	3	5	5	5	5	15	1	IBM 36	1	5	2	234500	1.4	9	5
36	0	0	0	0	1	1	3	1	1	3	1	1	3	3	3	3	286	1	2	2	170400	1.8	9	0.5
37	0	0	0	0	2	2	2	0	0	0	1	1	1	1	3	2	386	1	2	2	66000	0.7	3	0.5
38	0	0	0	0	2	2	2	3	3	3	4	4	4	4	3	1	IBM 400	1	5	2	800000	1.6	9	2
39	0	0	0	0	4	4	4	6	6	6	7	7	7	7	28	9	Persiel Mainframe	1	5	2	504000	3.1	17	5
40	0	0	0	0	2	2	2	0	0	0	4	4	4	4	4	2	MAC LC	1	5	2	47200	1	6	2
41	0	0	0	0	4	4	4	5	5	5	3	3	3	3	3	2	386	1	2	2	60444	2.5	12	2
42	0	0	0	0	4	4	4	4	4	4	4	4	4	4	3	2	486	1	2	2	24580	2.4	12	5
43	6	7	9	11	13	13	13	18	18	18	50	50	50	50	25	1	IBM Mainframe	3	5	5	39700000	16.1	90	312

44	2	2	2	23	23	16	16	16	34	34	23	2	IBM + Hitachi	3	2	5	310000000	14.3	75	392
45	4	6	7	9	29	11	26	26	42	42	24	3	IBM Mainframe	3	5	5	311000000	20.9	104	347
46	0	1	1	13	16	6	9	11	7	7	15	2	NCR mainframe	2	2	2	1500000	9.3	39	15
47	0	0	1	6	8	9	9	9	8	8	25	1	AMDAHL + IBM	2	5	5	310000000	5.7	27	260
48	5	7	9	12	17	10	24	24	20	22	22	2	IBM mainframe	3	2	5	350000000	16.6	77	415

APPENDIX F

INFORMATION TECHNOLOGY RATIOS

No	1990		1991		1992		1992		1992		1992		
	ITEX	OPEX	ITCE	ITEX	OPEX	ITCE	ITEX	OPEX	ITCE	ITEX	OPEX	AVGITEX	AVGOPEX
1	0.78	0.60	0.47	0.70	0.60	0.42	0.74	0.60	0.44	0.741	0.600	0.445	
2	0.01	1.06	0.01	0.01	1.06	0.01	0.02	1.08	0.02	0.012	1.069	0.013	
3	0.01	0.68	0.01	0.01	0.71	0.01	0.02	0.68	0.01	0.015	0.691	0.010	
4	0.03	0.68	0.02	0.03	0.68	0.02	0.04	0.68	0.03	0.034	0.680	0.023	
5	0.03	0.63	0.02	0.02	0.63	0.01	0.02	0.63	0.01	0.024	0.634	0.015	
6	0.48	0.62	0.30	0.40	0.76	0.31	0.42	0.82	0.34	0.434	0.735	0.316	
7	0.01	1.06	0.01	0.01	1.06	0.01	0.01	1.08	0.01	0.008	1.069	0.009	
8	0.32	0.88	0.28	0.28	0.83	0.23	0.32	0.90	0.29	0.310	0.870	0.270	
9	0.32	0.92	0.29	0.28	0.88	0.24	0.37	0.87	0.32	0.319	0.890	0.284	
10	0.13	0.68	0.09	0.12	0.68	0.08	0.14	0.70	0.10	0.129	0.686	0.088	
11	0.01	0.91	0.01	0.01	0.86	0.01	0.01	1.28	0.01	0.007	1.016	0.007	
12	0.00	0.95	0.00	0.00	0.95	0.00	0.00	0.94	0.00	0.000	0.946	0.000	
13	0.00	0.92	0.00	0.00	0.93	0.00	0.00	0.95	0.00	0.003	0.934	0.003	
14	0.00	0.99	0.00	0.00	0.96	0.00	0.00	0.93	0.00	0.000	0.963	0.000	
15	0.04	0.71	0.03	0.05	0.68	0.03	0.05	0.73	0.03	0.045	0.707	0.032	
16	0.16	0.06	0.01	0.14	0.11	0.01	0.14	0.07	0.01	0.147	0.077	0.011	
17	0.04	0.09	0.00	0.04	0.10	0.00	0.04	0.09	0.00	0.038	0.094	0.004	

18	0.28	0.09	0.02	0.05	0.57	0.03	0.04	0.59	0.02	0.120	0.419	0.025
19	0.12	0.48	0.06	0.10	0.58	0.06	0.13	0.35	0.05	0.116	0.472	0.054
20	0.12	0.37	0.04	0.40	0.34	0.14	0.14	0.47	0.07	0.220	0.392	0.082
21	0.21	0.99	0.21	0.08	1.11	0.08	0.05	0.99	0.05	0.114	1.029	0.116
22	0.17	0.21	0.04	0.18	0.34	0.06	0.21	0.34	0.07	0.188	0.298	0.057
23	0.00	0.89	0.00	0.00	0.95	0.00	0.00	0.85	0.00	0.005	0.896	0.004
24	0.22	0.04	0.01	0.15	0.09	0.01	0.26	0.06	0.02	0.211	0.064	0.013
25	0.05	0.21	0.01	0.06	0.23	0.01	0.05	0.17	0.01	0.052	0.206	0.011
26	0.43	0.60	0.26	0.37	0.60	0.22	0.33	0.60	0.20	0.375	0.600	0.225
27	0.37	0.54	0.20	0.52	0.49	0.25	0.66	0.24	0.16	0.516	0.424	0.204
28	0.07	1.13	0.08	0.05	1.13	0.05	0.04	1.13	0.04	0.052	1.126	0.059
29	0.09	0.90	0.08	0.09	0.61	0.05	0.18	0.89	0.16	0.122	0.799	0.100
30	0.00	0.68	0.00	0.08	0.68	0.06	0.11	0.69	0.07	0.064	0.682	0.043
31	0.00	0.71	0.00	0.01	0.67	0.01	0.01	0.63	0.00	0.006	0.670	0.004
32	0.18	0.67	0.12	0.22	0.67	0.14	0.30	0.56	0.17	0.234	0.632	0.145
33	0.04	0.93	0.03	0.02	0.90	0.02	0.02	0.86	0.02	0.027	0.893	0.024
34	0.37	1.09	0.40	0.34	0.69	0.24	0.61	0.66	0.40	0.441	0.814	0.347
35	0.01	1.00	0.01	0.01	1.00	0.01	0.01	1.00	0.01	0.010	1.001	0.010
36	0.03	0.85	0.02	0.02	0.85	0.02	0.03	0.85	0.02	0.025	0.854	0.021
37	0.11	0.17	0.02	0.09	0.17	0.02	0.08	0.19	0.02	0.095	0.176	0.017
38	0.12	0.73	0.08	0.10	0.73	0.07	0.10	0.73	0.07	0.104	0.730	0.076
39	0.07	0.85	0.06	0.08	0.83	0.06	0.09	0.84	0.07	0.077	0.841	0.065

40	0.13	0.70	0.09	0.12	0.71	0.08	0.15	0.74	0.11	0.131	0.719	0.094
41	0.23	0.70	0.16	0.18	0.71	0.13	0.19	0.72	0.14	0.201	0.709	0.143
42	0.18	0.88	0.16	0.18	0.88	0.16	0.17	0.88	0.15	0.176	0.876	0.154
43	0.53	0.66	0.35	0.27	0.76	0.20	0.19	0.77	0.15	0.331	0.727	0.234
44	0.00	1.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.001	0.996	0.001
45	0.75	0.66	0.50	0.32	0.76	0.25	0.22	0.77	0.17	0.431	0.728	0.303
46	0.20	0.90	0.18	0.20	0.89	0.18	0.25	0.89	0.23	0.220	0.896	0.197
47	0.76	0.63	0.48	0.35	0.75	0.26	0.23	0.76	0.18	0.446	0.715	0.305
48	0.48	0.67	0.32	0.25	0.76	0.19	0.22	0.77	0.17	0.317	0.730	0.227

APPENDIX G

ITEX, OPEX, ITCE DATA

No	1990			1991			1992			1993			1994					
	OP EXP	IT EXP	T.OVER	ITEX	OPEX	ITCE	OP EXP	IT EXP	T.OVER	ITEX	OPEX	ITCE	OP EXP	IT EXP	T.OVER	ITEX	OPEX	ITCE
1	144000	113000	240000	0.78	0.60	0.47	217200	151600	362000	0.70	0.60	0.42	228000	168800	380000	0.74	0.60	0.44
2	32498000	376600	30624000	0.01	1.06	0.01	38231999	393000	36028305	0.01	1.06	0.01	27974530	426600	25818556	0.02	1.08	0.02
3	12949199	170928	19018623	0.01	0.68	0.01	15143177	222747	21312664	0.01	0.71	0.01	16468226	268044	24156349	0.02	0.68	0.01
4	65280000	1976000	96000000	0.03	0.68	0.02	95880000	3148000	141000000	0.03	0.68	0.02	113560000	4546000	167000000	0.04	0.68	0.03
5	85527	2440	134982	0.03	0.63	0.02	106634	2490	168294	0.02	0.63	0.01	119179	2505	188093	0.02	0.63	0.01
6	864000	415300	1392000	0.48	0.62	0.30	1107000	444300	1450000	0.40	0.76	0.31	1439000	602400	1750000	0.42	0.82	0.34
7	32498000	301200	30624000	0.01	1.06	0.01	38231999	212600	36028345	0.01	1.06	0.01	27974530	265000	25818556	0.01	1.08	0.01
8	699995	225995	796996	0.32	0.88	0.28	814475	220975	983389	0.28	0.83	0.23	866943	281463	961000	0.32	0.90	0.29
9	126050	39800	136983	0.32	0.92	0.29	141793	39000	162022	0.28	0.88	0.24	149874	54746	171372	0.37	0.87	0.32
10	5344000	668000	7858823	0.13	0.68	0.09	5600100	700000	8235295	0.12	0.68	0.08	5642238	770000	8075337	0.14	0.70	0.10
11	112707	774	123931	0.01	0.91	0.01	113188	927	131674	0.01	0.86	0.01	162111	938	126863	0.01	1.28	0.01
12	258238000	73000	272337000	0.00	0.95	0.00	249550000	81000	261892000	0.00	0.95	0.00	275017000	90000	293858000	0.00	0.94	0.00
13	17235000	520000	188049000	0.00	0.92	0.00	178705000	580000	191480000	0.00	0.93	0.00	189220000	610000	198946000	0.00	0.95	0.00
14	198727000	15000	200402000	0.00	0.99	0.00	168429000	10000	174971000	0.00	0.96	0.00	167171000	191000	178840000	0.00	0.93	0.00
15	63701000	2630000	89720000	0.04	0.71	0.03	70414000	3170000	103126000	0.05	0.68	0.03	85272000	4100000	117320000	0.05	0.73	0.03
16	806466	128587	14308921	0.16	0.06	0.01	1184834	162636	10935830	0.14	0.11	0.01	1366256	196627	20820224	0.14	0.07	0.01
17	950962	35100	10410075	0.04	0.09	0.00	1182695	44200	11291993	0.04	0.10	0.00	1368628	55250	16069416	0.04	0.09	0.00
18	2124	586	23442	0.28	0.09	0.02	12225	560	21338	0.05	0.57	0.03	12888	505	21706	0.04	0.59	0.02
19	27031	3244	55889	0.12	0.48	0.06	39082	3265	56780	0.10	0.58	0.06	25429	3286	72964	0.13	0.35	0.05
20	80219	9344	219134	0.12	0.37	0.04	25760	10405	76690	0.40	0.34	0.14	82521	11579	174325	0.14	0.47	0.07

46	1080000	220000	1200000	0.20	0.90	0.18	1340000	270000	1500000	0.20	0.89	0.18	1340000	340000	1500000	0.25	0.89	0.23
47	58	44	92	0.76	0.63	0.48	161	56	215	0.35	0.75	0.26	273	63	357	0.23	0.76	0.18
48	122	58	183	0.48	0.67	0.32	324	82	428	0.25	0.76	0.19	546	122	713	0.22	0.77	0.17

APPENDIX H:

Return On IT Assets

No	Operating Income 1992	IT investment	R, 1992
1	152000	42000	3.62
2	-2155974	1500000	-1.44
3	7688123	236660	32.49
4	53440000	3000000	17.81
5	68914	486	141.80
6	311000	395000	0.79
7	-2155974	150000	-14.37
8	94057	11500	8.18
9	21498	758000	0.03
10	2433099	1415000	1.72
11	-35248	109	-323.38
12	18841000	1350000	13.96
13	9726000	610000	15.94
14	11669000	96000	121.55
15	32048000	1475000	21.73
16	19453968	45340000	0.43
17	14700788	160000000	0.09
18	8818	1500	5.88
19	47535	2243	21.19
20	91804	2000	45.90
21	2583	20	129.15
22	64358	5000	12.87
23	4958	20	247.90
24	1803439	45000	40.08
25	923923	5081	181.84
26	288000	16500	17.45
27	11469	5000	2.29
28	-71076	39000	-1.82
29	220000	120000	1.83
30	89547	11037	8.11
31	1073190	24671	43.50
32	586000	15747	37.21

33	105454	26733	3.94
34	23251	13666	1.70
35	-83194	234000	-0.35
36	525240	170400	3.08
37	3384000	66000	51.27
38	664418	800000	0.83
39	1886500	504000	3.74
40	200616	47200	3.74
41	148838	60444	2.46
42	110000	24580	4.48
43	251	397	0.63
44	19	310	0.06
45	167	311	0.54
46	160000	1500000	0.11
47	84	310	0.27
48	167	350	0.48

Appendix I

Operating Leverage and Profit Growth

NO	EBIT 92	EBIT 90	TO 1992	TO 1990	OPEL	Profit Growth
1	152000	96000	380000	240000	1.00	58.33
2	-2155974	-1874000	25818556	30624000	-0.96	-15.05
3	7688123	6069424	24156349	19018623	1.84	26.67
4	53440000	30720000	167000000	96000000	1.00	73.96
5	68914	49455	188093	134982	1.00	39.35
6	311000	528000	1750000	1392000	-0.45	-41.10
7	-2155974	-1874000	25818556	30624000	0.08	-15.05
8	94057	97001	961000	796996	19.47	-3.04
9	21498	10933	171372	136983	1.09	96.63
10	2433099	2514823	8075337	7858823	3.95	-3.25
11	-35248	11224	126863	123931	79.56	-414.04
12	18841000	14099000	293858000	272337000	4.31	33.63
13	9726000	15714000	198946000	188049000	-6.12	-38.11
14	11669000	1675000	178840000	200402000	35.44	596.66
15	32048000	26019000	117320000	89720000	-0.15	23.17
16	19453968	13502455	20820224	14308921	1.20	44.08
17	14700788	9459113	16069416	10410075	1.19	55.41
18	8818	21318	21706	23442	-4.30	-58.64
19	47535	28858	72964	55889	4.38	64.72
20	91804	138915	174325	219134	-1.41	-33.91
21	2583	2970	318066	230571	7.32	-13.03
22	64358	83913	97412	106826	0.00	-23.30
23	4958	2135	32525	19388	4.22	132.20
24	1803439	1771745	1918965	1848508	12.52	1.79
25	923923	441030	1117014	561153	2.58	109.49
26	288000	219500	720000	550000	1.00	31.21
27	11469	2889	15110	6320	-0.22	296.99
28	-71076	-42355	568270	338634	0.93	-67.81
29	220000	100000	2000000	1000000	-1.88	120.00
30	89547	105891	286478	330908	1.15	-15.43
31	1073190	588126	2901306	2032787	2.43	82.48
32	586000	325000	1336000	980000	2.59	80.31

33	105454	50605	731661	688333	3.06	108.39
34	23251	-1448	68211	16405	1.19	1705.73
35	-83194	-32903	35124016	27514023	511.88	-152.85
36	525240	438000	3600000	3000000	1.00	19.92
37	3384000	3000000	4200000	3600000	0.00	12.80
38	664418	547180	2500000	2005697	0.80	21.43
39	1886500	1709000	12011000	11585000	-45.37	10.39
40	200616	181209.6	780000	604032	0.13	10.71
41	148837.7	123000	523488	410000	0.91	21.01
42	110000	83248	890000	673552	1.00	32.14
43	251	94	1070	275	1.01	167.02
44	19	14	5638	3798	0.34	35.71
45	167	62	713	183	0.99	169.35
46	160000	120000	1500000	1200000	0.00	33.33
47	84	34	357	92	0.95	147.06
48	167	61	713	183	1.01	173.77

Appendix J

The calculation of revenue stability

No	Turnover 1990	Turnover 1992	Revenue Stability*
1	240000	380000	58.33
2	30624000	25818556	-15.69
3	19018623	24156349	27.01
4	96000000	167000000	73.96
5	134982	188093	39.35
6	1392000	1750000	25.72
7	30624000	25818556	-15.69
8	796996	961000	20.58
9	136983	171372	25.10
10	7858823	8075337	2.76
11	123931	126863	2.37
12	272337000	293858000	7.90
13	188049000	198946000	5.79
14	200402000	178840000	-10.76
15	89720000	117320000	30.76
16	14308921	20820224	45.51
17	10410075	16069416	54.36
18	23442	21706	-7.41
19	55889	72964	30.55
20	219134	174325	-20.45
21	230571	318066	37.95
22	106826	97412	-8.81
23	19388	32525	67.76
24	1848508	1918965	3.81
25	561153	1117014	99.06
26	550000	720000	30.91
27	6320	15110	139.08
28	338634	568270	67.81
29	1000000	2000000	100.00
30	330908	286478	-13.43
31	2032787	2901306	42.73
32	980000	1336000	36.33
33	688333	731661	6.29

34	16405	68211	315.79
35	27514023	35124016	27.66
36	3000000	3600000	20.00
37	3600000	4200000	16.67
38	2005697	2500000	24.64
39	11585000	12011000	3.68
40	604032	780000	29.13
41	410000	523488	27.68
42	673552	890000	32.14
43	275	1070	289.09
44	3798	5638	48.45
45	183	713	289.62
46	1200000	1500000	25.00
47	92	357	288.04
48	183	713	289.62
* - Revenue stability or Turnover growth			

Appendix K:

Cost benefit analysis ratio (CBA) and probability of affecting organizational risk when making an IT Investment

Item	Expected % Cost-Benefit Analysis Ratio	Probability of affecting org. Risk [-]	Probability of affecting org. Risk [+]
1	10%	26.67%	100.00%
2	38%	33.33%	93.33%
3	10%	0.00%	0.00%
4	22%	100.00%	100.00%
5	10%	6.67%	93.33%
6	13%	0.00%	100.00%
7	20%	26.67%	80.00%
8	17%	33.33%	100.00%
9	60%	20.00%	100.00%
10	73%	66.67%	93.33%
11	20%	20.00%	80.00%
12	30%	40.00%	93.33%
13	20%	20.00%	80.00%
14	40%	100.00%	100.00%
15	30%	33.33%	100.00%
16	50%	100.00%	100.00%
17	40%	100.00%	100.00%
18	40%	100.00%	100.00%
19	40%	100.00%	100.00%
20	40%	100.00%	100.00%
21	57%	40.00%	60.00%
22	40%	100.00%	100.00%
23	57%	40.00%	60.00%
24	40%	100.00%	100.00%
25	40%	100.00%	100.00%
26	15%	93.33%	100.00%
27	100%	60.00%	100.00%
28	100%	80.00%	100.00%
29	100%	80.00%	80.00%
30	25%	100.00%	100.00%
31	25%	100.00%	100.00%
32	50%	53.33%	86.67%
33	15%	100.00%	100.00%
34	77%	0.00%	100.00%
35	97%	100.00%	100.00%

36	100%	0.00%	100.00%
37	100%	100.00%	100.00%
38	48%	100.00%	100.00%
39	100%	0.00%	100.00%
40	100%	100.00%	100.00%
41	100%	100.00%	100.00%
42	60%	100.00%	100.00%
43	60%	0.00%	100.00%
44	60%	0.00%	53.33%
45	60%	0.00%	100.00%
46	100%	0.00%	53.33%
47	22%	0.00%	66.67%
48	100%	0.00%	53.30%

APPENDIX L

Risk (coefficient of variance)

No	EBIT 1992	EBIT 1991	EBIT 1990	TURNOVER 1992	TURNOVER 1991	TURNOVER 1990	Factor 1992	Factor 1991	Factor 1990	Coefficient of Variance (Risk)
1	152 000	144 800	96 000	380 000	217 200	240 000	0.400	0.667	0.400	25.71%
2	(2 155 974)	(2 203 694)	(1 874 000)	25 818 556	38 231 999	30 624 000	-0.084	-0.058	-0.061	16.97%
3	7 688 123	6 169 487	6 069 424	24 156 349	15 143 177	19 018 623	0.318	0.407	0.319	12.01%
4	53 440 000	45 120 000	30 720 000	167 000 000	95 880 000	96 000 000	0.320	0.471	0.320	19.18%
5	68 914	61 660	49 455	188 093	106 634	134 982	0.366	0.578	0.366	22.85%
6	311 000	343 000	528 000	1 750 000	1 107 000	1 392 000	0.178	0.310	0.379	28.94%
7	(2 155 974)	(2 203 654)	(1 874 000)	25 818 556	38 231 999	30 624 000	-0.084	-0.058	-0.061	16.97%
8	94 057	168 914	97 001	961 000	814 475	796 996	0.098	0.207	0.122	33.04%
9	21 498	20 229	10 933	171 372	141 793	136 983	0.125	0.143	0.080	22.87%
10	2 433 099	2 635 195	2 514 823	8 075 337	5 600 100	7 858 823	0.301	0.471	0.320	20.82%
11	(35 248)	18 486	11 224	126 863	113 188	123 931	-0.278	0.163	0.091	2418.46%
12	18 841 000	12 342 000	14 099 000	293 858 000	249 550 000	272 337 000	0.064	0.049	0.052	11.68%
13	9 726 000	12 775 000	15 714 000	198 946 000	178 705 000	188 049 000	0.049	0.071	0.084	21.14%
14	11 669 000	6 542 000	1 675 000	178 840 000	168 429 000	200 402 000	0.065	0.039	0.008	62.02%
15	32 048 000	32 712 000	26 019 000	117 320 000	70 414 000	89 720 000	0.273	0.465	0.290	25.26%
16	19 453 968	9 750 996	13 502 455	20 820 224	1 184 834	14 308 921	0.934	8.230	0.944	102.01%

17	14 700 788	10 109 298	9 459 113	16 069 416	1 182 695	10 410 075	0.915	8.548	0.909	104.12%
18	8 818	9 113	21 318	21 706	12 225	23 442	0.406	0.745	0.909	30.50%
19	47 535	23 698	28 858	72 964	33 082	55 889	0.651	0.716	0.516	13.27%
20	91 804	50 930	138 915	174 325	25 760	219 134	0.527	1.977	0.634	63.10%
21	2 583	(30 132)	2 970	318 066	309 978	230 571	0.008	-0.097	0.013	200.03%
22	64 358	64 358	83 913	97 412	33 054	106 826	0.661	1.947	0.786	51.21%
23	4 958	1 237	2 135	32 525	23 184	19 388	0.152	0.053	0.110	38.56%
24	1 803 439	1 828 883	1 771 745	1 918 965	181 395	1848 508	0.940	10.082	0.958	107.81%
25	923 923	463 130	441 030	1 117 014	138 294	561 153	0.827	3.349	0.786	72.47%
26	288 000	260 000	219 500	720 000	390 000	550 000	0.400	0.667	0.399	25.77%
27	11 469	3 497	2 889	15 110	3 322	6 320	0.759	1.053	0.457	32.15%
28	(71 076)	(55 714)	(42 355)	568 270	494 041	338 634	-0.125	-0.113	-0.125	4.79%
29	220 000	590 000	100 000	2 000 000	910 000	1 000 000	0.110	0.648	0.100	89.53%
30	89 547	105 891	105 891	286 478	225 017	330 908	0.313	0.471	0.320	19.80%
31	1 073 190	886 962	588 126	2 901 306	1 783 163	2 032 787	0.370	0.497	0.289	22.22%
32	586 000	358 000	325 000	1 336 000	714 000	980 000	0.439	0.501	0.332	16.53%
33	105 454	61 750	50 605	731 661	532 632	688 333	0.144	0.116	0.074	26.10%
34	23 251	8 849	(1 448)	68 211	20 024	16 405	0.341	0.442	-0.088	99.28%
35	(83 194)	(1 343)	(32 903)	35 124 016	31 388 298	27 514 023	-0.002	0.000	-0.001	78.97%
36	525 240	490 224	438 000	3 600 000	2 869 776	3 000 000	0.146	0.171	0.146	7.60%

37	3 384 000	3 504 000	3 000 000	4 200 000	696 000	3 600 000	0.806	5.034	0.833	89.32%
38	664 418	595 330	547 180	2 500 000	1 586 799	2 005 697	0.266	0.375	0.273	16.42%
39	1 886 500	2 075 000	1 709 000	12 011 000	9 912 000	11 585 000	0.157	0.209	0.148	15.86%
40	200 616	197 011	181 210	780 000	489 389	604 032	0.257	0.403	0.300	19.07%
41	148 838	132 020	123 000	523 488	327 180	410 000	0.284	0.404	0.300	16.06%
42	110,000	94,600	83,248	890000	670 800	673 552	0.124	0.141	0.124	6.35%
43	251	156	94	1 070	486	275	0.235	0.321	0.342	15.52%
44	19	18	14	5 638	4821	3798	0.003	0.004	0.004	4.49%
45	167	104	62	713	324	183	0.234	0.321	0.339	15.33%
46	160 000	160 000	120 000	1 500 000	1 340 000	1 200 000	0.107	0.119	0.100	7.41%
47	84	54	34	357	161	92	0.235	0.335	0.370	18.18%
48	167	104	61	713	324	183	0.234	0.321	0.333	14.89%

APPENDIX M:

Calculations:

No	Coefficient of Variance (Risk)	CBA Ratio
1	25.71%	10%
2	16.97%	38%
3	12.01%	10%
4	19.18%	22%
5	22.85%	10%
6	28.94%	13%
7	16.97%	20%
8	33.04%	17%
9	22.87%	60%
10	20.82%	73%
11	2418.46%	20%
12	11.68%	30%
13	21.14%	20%
14	62.02%	40%
15	25.26%	30%
16	102.01%	50%
17	104.12%	40%
18	30.50%	40%
19	13.27%	40%
20	63.10%	40%
21	200.03%	57%
22	51.21%	40%
23	38.56%	57%
24	107.81%	40%
25	72.47%	40%
26	25.77%	15%
27	32.15%	100%
28	4.79%	100%
29	89.53%	100%
30	19.80%	25%
31	22.22%	25%
32	16.53%	50%

33	26.10%	15%
34	99.28%	77%
35	78.97%	97%
36	7.60%	100%
37	89.32%	100%
38	16.42%	48%
39	15.86%	100%
40	19.07%	100%
41	16.06%	100%
42	6.35%	60%
43	15.52%	60%
44	4.49%	60%
45	15.33%	60%
46	7.41%	100%
47	18.18%	22%
48	14.89%	100%

Transformations based on the utility model:

M.1 The case - indifferent to risk

$$a) \quad 0.660p + 0(1-p) = 0.571p + 0.087(1 - p)$$

$$0.660p = 0.571p + 0.087 - 0.087p$$

$$0.660p = 0.484p + 0.087$$

$$0.176p = 0.087$$

$$p = 0.4943$$

$$b) \quad 0.571p + 0.087(1 - p) = 0.312p + 1(1 - p)$$

$$0.484p + 0.087 = -0.688p + 1$$

$$1.172p = 0.913$$

$$p = 0.779$$

M.2 The case - risk averse

a) $0.660p = 0.571p + 0.867(1 - p)$

$$0.660p = -0.296p + 0.867$$

$$0.956p = 0.867$$

$$p = 0.9065$$

b) $0.571p + 0.867(1 - p) = 0.312p + 1(1 - p)$

$$-0.296p + 0.867 = -0.688p + 1$$

$$0.392p = 0.133$$

$$p = 0.3392$$

M.3 The case - risk seeker

a) $0.660p = 0.571p + 0.46(1 - p)$

$$0.660p = 0.525p + 0.64$$

$$0.135p = 0.046$$

$$p = 0.3407$$

b) $0.571p + 0.046(1 - p) = 0.312p + 1(1 - p)$

$$0.571p + 0.046p - 0.046 = -0.312p + 1 - p$$

$$1.213p = 0.954$$

$$p = 0.7865$$

Appendix N:

List of the Population:

AC & V	CASH BOOKKEEPING CENTRE
ACA INSURERS	CATHOLIC HOSPITAL
ACADEMY	CDM
ACCOUNTING & ASS SERVICES	CENTRAL SPARES
ADVANTAGE PROMOTIONS	CERNOL CHEMICALS
AEG Namibia	CHAMBER OF MINES, NAMIBIA
AEG Spares	CITY APOTHEKE
AEGIS Namibia	COIN SECURITY
AFROX	COLLEGE OF LEARNING
AGRA	COMMERCIAL BANK OF NAMIBIA
AIR NAMIBIA	COMPUTERLAND
ALFA KOOP	CONTINENTAL HOTEL
ALLSURE PLAN INSURANCE	CP DE LEEW, QS
ALPHAMED	CSO VALUATION
AMA Marketing	CYMOT
ANKER DATA SYSTEMS	D & H COMPUTER SERVICES
ASAB DATA	DIAL-A-MOVIE
ATLAS COPCO	DIESEL ELECTRIC
AUAS DELTA	DTA
BANK OF NAMIBIA	EDUMEDS
BANK WINDHOEK	EKSEKUTEURSKAMER
BAYER-AGRO-CHEM Namibia	ENKE MACHINES
BCS COMPUTER SERVICES	FNDC
BETTER BUSINESS CENTRES	GAY DE KOCK AGENTUUR
BP	GENDEV
BRINKMAN & CO	GENERAL DEV CO OF NAMIBIA
BUILDING & ALLIED TRADING	GENERAL DEVELOPMENT
CAD SERVICES	GEORGE HUYSAMEN
CALTEX NAMIBIA	GILBEY AND TAUBER
CAMEL GRAFFITI	GOLDFIELDS
CANON BUS MACHINES Nam	GPO
CANYON HOTEL	HANSA BREWERIES
CASALEE NAMIBIA	HARTLIEFS

HNR	NAMIBIA BEVERAGES
ICL	NAMIBIA BREWERIES
IHR Buro	NAMIBIA FISHING
IMAG AGENCIES	NAMIBIA PLASTIC CONVERTERS
IMCOR MANAGEMENT SERVICES	NAMIBIA ROCK LOBSTER
IMLT	NAMIBIA WINERIES
INDO ATLANTIC NAMIBIA	NAMIBIAN BANKING CORPORATION
INFO SERVICES	NAMIBIAN ENGINEERING
INFORMATICA	NAMIBIAN MEAT CORPORATION
INFORMATION SERVICES	NAMIBIAN POLICE
INTERNATIONAL KARAKUL SEC	NATIONAL EDUCATION
JAN JONKER SERVICE STATION	NBC
JAPIE STEENKAMP & KIE	NCR
JOB HUNTERS	NEUHAUS, A
JOHN MEINERT	NEW WAVE COMMS
JOSEPH AND SNYMAN	NICTUS
KEETMANSHOOP MUNICIPALITY	NOVA TYRE
KESSLER CAR HIRE	NOVEL FORD
KNIGHT, WC & PARTNERS	OCEANA FISHING
KOLA DRAKENSBERGSTOET	OFFICE WORLD
KPMG AITKEN & PEAT	OMRU FEEDS
LANDBANK	OTJIWARONGO GAME LODGE
LINTAS	OTJIWARONGO MUNICIPALITY
LUMLEY, NAMIBIA	P DE V REKLAME
MAAKSEKERPLAN INS	PJ MALHERBE
MIETJE AND ZIEGLER	PLASTIC PACKAGING
MINISTRY OF FINANCE	PRIME GRO INS
MINISTRY OF FOREIGN AFFAIRS	PRIORITY ONE
MINISTRY OF TRANSPORT	PUPKEWITZ
MINISTRY OF WATER AFFAIRS	RASSIE MAARTENS INS
MOKUTI LODGE	REPUBLIKEIN
MULLER AND SON	RIAN KRUGER
MUNICH RE-INSURANCE	ROSSING
MUNICIPALITY MARIENTAL	SAFARI MOTEL
NAMIB BUILDING SOCIETY	SCHOEMANS COMPUTERS
NAMIB MILLS	SEA FISHERIES

SECURITAS INS
SECURITAS INSURANCE BROKERS
SECURITY TINTINPALAST
SHELL NAMIBIA
SIEMENS
SONNEX
SPORTSENTRUM
STANDARD BANK NAMIBIA
SWA REKENAARS
SWA TOYOTA
SWABOU
SWAKOPMUND MUNICIPALITY
SWAPEN
SWATAX
SWATRUST
SWATYRE
SWAVET
SWAWEK
SYSNET
TAEUBER AND CORSEN
TETRAPLAN
TNC
TRIP TRAVEL
TSUMEB MUNICIPALITY
TUNACOR
ULTRAPRESS
VAN WYK LOUW ENG
VIDEORAMA
WECKE & VOIGTS
WELWITSCHIA INSURANCE
WINDHOEK MUNICIPALITY
WOKER TRAVEL