EVALUATING INFORMATION TECHNOLOGY INVESTMENTS IN FINANCIAL EXPERT SYSTEMS

GINA CLAIR SAFFY

A research report submitted to the Faculty of Commerce, Law and Management, University of the Witwatersrand, in partial fulfilment of the requirements for the degree of Master of Business Administration

Supervisor: DR LOUISE WHITTAKER

Johannesburg
November 2003

ABSTRACT

This research explored the feasibility of an exploratory approach to post-implementation evaluation in credit-scoring systems. In doing so, the researcher tried to expand the field of financial expert system evaluation beyond its current focus of research. A holistically based perspective is suggested for post-implementation evaluation. Practitioners use a variety of measures/methods in order to add value to the evaluation process in mainly two directions: quantitative and qualitative. The inductive evaluation model was derived from a panel of credit-scoring experts (the Delphi-panel). The value grew each time the Delphi-panel process occurred, from formulation, to validation of the exploratory model. Subsequently, the derived model was concerned with how to utilise the holistic evaluation measures and how to prevent the impracticality of the exploratory model, which aimed to bridge the gap between practice and theory. Evaluation measures that form the backbone of the descriptive model are aimed at improving the capacity-to-act of Banks, both in terms of risk management and overall competitiveness and shareholder value on all levels, namely industry/market level, organisational level and system level.

DECLARATION

I declare that this project report is my own, unaided work. It is submitted in partial fulfilment of the requirements of the degree of Master of Business Administration in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.

_____

Gina Saffy

30 October, 2003

ACKNOWLEDGEMENTS

I am grateful to the following people for their guidance and support:

- Dr Louise Whittaker, for her invaluable supervision of the research process;
- Anthony Stacey for facilitating the overall statistical analysis, and for sharing his knowledge;
- Antony Soicher for facilitating the research panel, and for his valuable time and input;
- The Delphi Panel of Experts for their invaluable input from the following companies: ABSA, Standard Bank, Standard Corporate and Merchant Bank, First National Bank, Nedcor, American Express, Deloitte & Touche, PriceWaterHouseCoopers, KPMG, Citicorp, PIC Solutions, CMS Group, ITC, Accenture.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

CHAPTER 1. INTRODUCTION

1.1 Context of this study

Information Technology (IT) exists solely to deliver value to enterprises. Yet, for many enterprises, that value is elusive. In today's cost-conscious and competitive world, demonstrating the value of IT is imperative, yet elusive (Roberts, 2002).

The literature suggests two reasons why the delivery of recognisable business value is difficult: Firstly, a major problem in evaluating information technology is that many of its benefits are intangible, and secondly, the fact that organisations use IT for different purposes further complicates the evaluation process (Turban, Mclean & Wetherbe, 1999). Underpinning this, IT needs to be measurable in terms of revenue, market share costs and competitive advantage and must therefore link to existing business strategies. Therefore, enterprises must expand their analytical skills to evaluate the full range of value created through IT investments, including both tangible and intangible benefits.

In recognition of the disparity between the knowledge enterprise and the current accounting practices, many standard bodies are attending to the classification and definition of intangibles. The United States (US) Financial Accounting Standards Board (FASB) has recently adopted new rules for treating some intangibles, categorising them as marketing-related, customer-related, contract-related and technology-related, thus effectively turning them into financial assets (Magrassi, 2002).

Despite this accomplishment, Mahoney (2002:1) notes that "investment in IT is usually a quest for direct cost reduction to the exclusion – or lack – of emphasis on other forms of enterprise value". Thus, not only have the intangible benefits of IT been poorly evaluated, but often these are not even considered strategic and are therefore ignored completely.

GTE's Ken Foster has pithily described the new realities as "products that are still evolving, delivered to a market that is still emerging, via a technology that is still changing on a daily basis" (Financial Times, 1998*).* This means there will be many more questions, with fewer and fewer universal answers. Einstein was mistaken when he

posited that a single theory can guide us. Questions, rather than answers, fundamentally drive the future, without much input from technology, as Pablo Picasso once pointed out “computers are useless. They only give us answers” (Dearlove, 1998).

However, the financial sector in South Africa (SA) has become increasingly dependent on IT system performance, as international banking regulations adjust to changing types and levels of risk. The Basel Committee of the Bank for International Settlements has drafted the new Accord (Basel II), which stresses that amounts of regulatory capital should be more closely aligned with actual risk, and that it should act as a spur to banks to improve risk management (Accenture, 2003). The main implementation challenges and assessment of industry readiness are as follows:

1] Assessment of Operational Risk

- Collect and organise internal loss data and supplement with external sources
- Measure heterogonous risk data consistently across the Group

2] Data Collection and Disclosure of Risk across All Risk Types

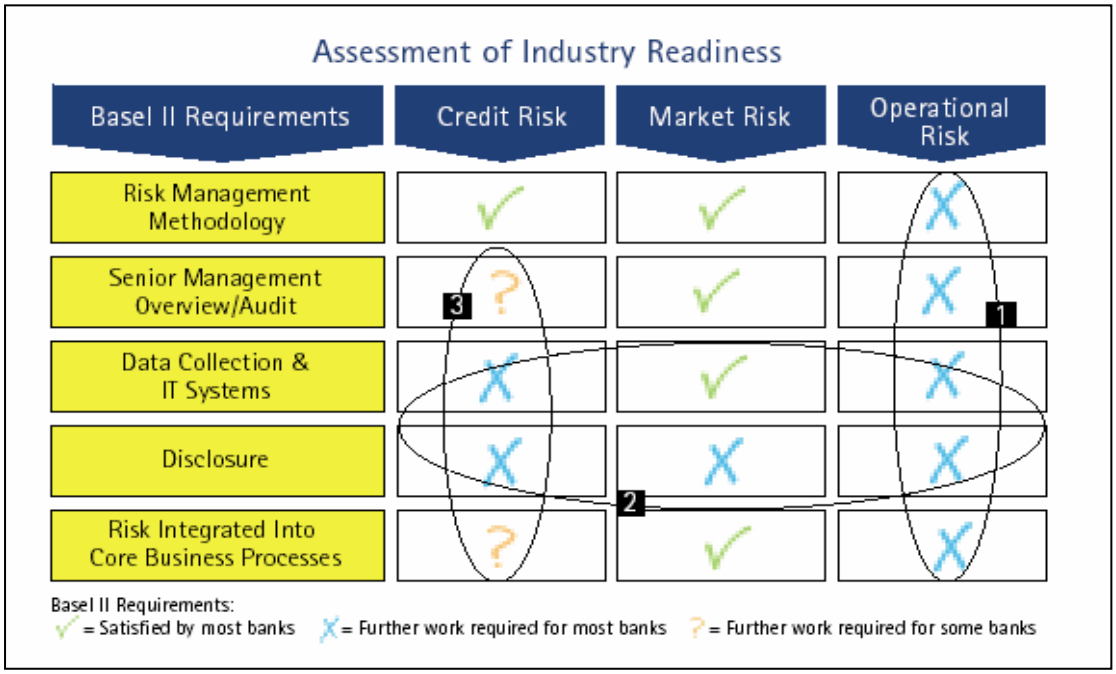
- Implement IT infrastructure in order to report consistently across all risk types and business units

3] Credit Risk

- Collect, organise and warehouse internal credit-loss experience required for chosen sophistication level, on a uniform basis across the Group
- Ensure internal credit rating processes, governance and systems are aligned with requirements outlined in the Accord

(Accenture 2003)

Figure 1.1: Assessment of Industry Readiness



Source: Accenture, 2003

Therefore, banks must inevitably upgrade systems' architecture and data applications, e.g. credit-scoring systems, and the focus must shift to planning and executing the processes, systems and governance changes that will allow the banks to realise real business benefits, both tangible and intangible.

This report explores how, and if, such benefits can be evaluated, and hence realised. A business model was proposed, which focuses on the impact of technology, i.e. credit-scoring systems and the tangible and intangible benefits thereof.

1.2 Purpose of this study

The author aimed to address four propositions at an exploratory methodological level, where exploratory research is concerned with discovering patterns in research data and explaining them. This lays a basic descriptive foundation and may lead to the generation of hypotheses (Fitzgerald & Howcroft, 1998). It is therefore the objective of this research to investigate how financial expert systems can best be evaluated.

In this research report, different approaches to the evaluation of financial expert systems used in practice were discussed. The aim of this report is to illustrate some of the practical issues that may arise in the conduct of evaluation and to consider how the evaluation itself might be improved. A model of effective evaluation methods in financial expert system investments is subsequently proposed. This extended view is intended to provide SA companies with new options for improving and clarifying the justification for IT investments by identifying tangible and intangible value creation.

Thus, the intention of this report is to provide the necessary analysis required for the induction of a descriptive evaluation model, which pinpoints the critical factors inherent in financial expert system investments. The author expects to make a contribution in the following areas:

- Investigation of the most recent market developments in financial expert system evaluation
- Assessment of the literature and identification of opportunities for current and future practitioners
- Division of a descriptive model as a benchmark evaluation methodology
- Articulation of a perspective that will assist organisations to make IT investments in concert with their business activities
- Extraction of some useful recommendations and areas for future research

1.3 The problem and sub-problems

The fundamental problem addressed during the course of the research is to establish how experts evaluate investments in financial expert systems and how this process can be optimised.

There are three sub-problems associated with this research. These may be stated as:

1. To review current evaluation techniques and establish consensus on those most frequently used, using the Delphi Technique
2. To identify the shortfalls of existing evaluation practices
3. To develop an improved method of evaluation

1.4 Delimitations and limitations

Delimitations

- The scope of this research report is limited to the post-implementation evaluation process for investments in credit-scoring systems and considers incremental project-upgrade evaluation.
- The focus of the evaluation methods used is very generic and therefore a detailed description of system functionality is not a requirement for the purposes of this research.
- Although three types of credit-scoring systems exist, namely rule-based/judgmental systems, behaviour/statistical-based scoring systems, and neural network systems, this research will focus on the former two credit-scoring systems, excluding the third system type.
- Both retail scoring and corporate scoring systems are the subject of this study and since a significant difference exists, the researcher adopted a high-level approach when developing the credit-scoring evaluation model.

Limitations

- There is a lack of statistical generalisability of the study; however, Delphi panels are considered a purposive sample, as experts have a specific purpose, as opposed to a random sample, which therefore mitigates this limitation.
- Attrition rates of 30% or more are common with Delphi techniques; hence those participants who participated in the final round of the Delphi process determined the effective sample size.
- Delphi can force conformance of opinions, which limits the robustness of the experts' knowledge.
- No tests were conducted to verify whether the panel was representative of the population of consultants, auditors and practitioners. Similarly, the cross-section of the sectors in the sample was not tested to verify whether they are representative of South African business.
- The researcher did not attempt to identify any causalities or dependence between the evaluation methods offered by the experts.

1.5 Significance of this study

Insight was gained in how experts are evaluating financial expert system investments hoped to fulfil strategic business needs, and what current shortcomings must be overcome. This report questions the limitations in evaluating expert systems within a positivist paradigm, and raised the need for a holistic approach to evaluating these investments. This holistic approach encompassed both positivist and interpretive aspects of IT evaluation more specifically, because expert systems are a Knowledge Management (KM) tool. A study involving KM itself is recognised to be a people-centric practice and, according to Wiig (1999), should therefore include social processes.

The three drivers of Technology, Institutions and Values have created an international, knowledge-based world, according to Ridderstrale and Nordstrom (2002), both economists from the Institute of International Business at the Stockholm School of Economics. We are not only deregulating economically but also morally and

technologically. However, state Ridderstrale and Nordstrom (2002), with choice comes responsibility.

The basis for the researcher's new approach is revealed in the literature review and can be supported by the evidence (Yan Tam, 1992; Ballantine & Stray, 1998) that organisations keep using evaluation methods, which are improper for IT evaluation, despite the development of an extensive list of IT-specific evaluation methods (Renkema & Berghout, 1997). It is these gaps that arise between theory and practice that are addressed in this research report.

The relevance of this field of research to the banking sector is that recently the world's top banks have been experiencing systemic risks that could see a domino-effect occurring very close to home (De Klerk, 2002). The Economist estimates total bad debts or forced write-offs by European banks for 2002 to be $130 billion, with the US figure doubling that. SA also faced systemic risk with the collapse of Saambou, mainly due to poor debt management (De Klerk, 2002).

It is therefore critical that local SA banks become more competitive, in order to attract fresh interest in the face of their ailing international and local counterparts. Dynamic provisioning to loan books will soon become the protocol in SA, whereby any default on a loan repayment will change the risk-score of a client's creditworthiness. This process can only be managed with effective credit-scoring systems (D. Khoury, personal communication, 22 October 2003).

Therefore, the most effective way banks can guard against systemic risk and non-performance is by curtailing bad debt and new legislation will soon be enforcing this.
Thus the emphasis on evaluating credit-scoring systems is of the utmost importance, as this will reveal how competitive the best banks prove to be. This research aims to assist South African banks to create and maintain their own company-specific credit-scoring profiles, and better determine their risk drivers, as required for an internal rating based risk assessment in Basel II.

1.6 Assumptions

The following are the underlying assumptions of the study:

- The panel has enough knowledge about the subject of financial expert systems to enable it to produce an all-encompassing and exhaustive list of evaluation methods currently used in practice.
- The list of methods that the panel developed is fully inclusive of the situation within South African business.
- At the point that the Delphi process was terminated, further rounds of the survey would have generated no significant changes in opinion.
- The results obtained at the end are representative of the final choices of the respondents if the process were to be repeated within an unchanged business environment.
- There is no overall bias brought about by the number and/or geographical location of the panel members or the organisations that they represent.
- All expert systems, other than neural-based systems, use some form of equation to develop a scorecard, where factors are weighted based upon either experience, judgmental systems, or statistical analysis, behaviour-based systems.

1.7 Definition of terms

For the purpose of this study, the terms Information Technology (IT) and Information Systems (IS) are considered synonymous and are therefore used interchangeably.

The term Positivist is used with reference to the positivist paradigm, which is the belief that the world conforms to fixed laws of causation, and complexity can be tackled by reductionism. The emphasis of positivism is on objectivity, measurability and repeatability.

The Interpretive paradigm holds that no universal truth exists. Uncommitted neutrality is impossible, and to understand and interpret is from the researcher's own frame of reference. The understanding of context is critical.

Credit-scoring has become a successful method of appraising and standardising consumer receivables. Lenders have used scoring tools to segment and price the various classes of their credit portfolio, to establish pricing and to monetise these assets. Capital markets have been able to understand better the risk involved in these monetisations due to the calibration and standardisation provided by credit-scoring. In turn, the capital markets have been able to utilise more accurate assessments of credit loans, ultimately leading to lower borrowing costs.

Corporate credit-scoring systems are essential to other important functions, including credit approval and underwriting. Ratings should also be used to determine the structure of the credit facility, such as collateral, repayment terms, guarantor, and loan-pricing ratings should guide price setting.

Retail credit-scoring systems are essentially credit-scoring systems which measure credit risk and differentiate individual credits and groups of credits by the risk they carry. This allows bank management to monitor changes and trends in risk levels and take proactive action to reduce loan losses.

By design, credit-scoring provides consistent, objective decisions, can identify potential high-volume customers and can enable increased credit limits to low-risk accounts.

A credit score is a single number, based on an analysis of information contained in a credit report, which provides an indication of how likely a person is to repay his or her debts. It is based on several types of information, including payment history, amount of debt owned, and types of credit used.

1.8 Subsequent chapters of the research report

The subsequent chapters of this research report are structured in the following way:

Chapter 2: provides a review of the literature pertaining to financial expert systems and their relationship to Knowledge Management in the organisational context. The review incorporates a discussion of six evaluation models which form a basis for the proposed

model. The basis for presenting these models is founded on the need for a holistic evaluation model whereby the importance of intangible benefits is seen to be included. The focus of IS evaluation techniques is explored and expert systems and Knowledge Management are evaluated in the current business environment. This chapter concludes with the propositions to the research problem.

Chapter 3: describes the Delphi methodology employed in this research. This includes the sampling procedure and the method of data collection as well as the techniques used in the data analysis.

Chapter 4: presents the results and the interpretation of the Delphi study in round one. The construction of the Delphi model is described, followed by a presentation of the evaluation methods rating sheet.

Chapter 5: presents the results of the second round of the Delphi study. This includes the correspondence analysis as well as the correlation analysis and development of the inductive matrix model.

Chapter 6: presents the results of the third round of the Delphi study. The literature on the evaluation methods is reviewed followed by a discussion on the Delphi methods and a comment on the model. The quantitative and qualitative dynamics of the model are also discussed.

Chapter 7: presents an interpretation of the results, which are evaluated with respect to the research propositions and existing literature.

Chapter 8: presents the main findings of this research, together with traditional insights, recommendations and suggestions for further research.

CHAPTER 2. LITERATURE REVIEW

The literature review explains the relevance of constructing an inductive evaluation model for credit-scoring systems and concludes with four summative propositions.

2.1 Expert Systems (ES) and Knowledge Management (KM) in the current business environment

Dameri (2002) comments on the present concept of 'IT pervasivity' as related to not only the functions of the value chain (Porter, 1985), but also to the close connection between the IT organisation and people. This pervasive nature of IT must be clearly understood if companies are to choose and track IT investments for optimal payback and competitive advantage.

Pope John Paul II argues in his 1991 centesimus writings that "at one time the decisive factor of production was the land, and later capital. Today the decisive factor is man himself, that is, his knowledge" (Stewart, 1997:122). Increasingly, entire countries compete on the basis of knowledge, whereas in the not-too-distant past, all countries became rich through a combination of natural resources, labour and capital. Therefore, it is not enough to consider only the technological content of an IT investment, but the context in which the system must operate must also be considered.

This is of particular significance when evaluating financial expert systems, which can be defined as computer programs that exhibit, within a specific domain, a degree of expertise in problem solving that is comparable with that of a human expert (Jayaraman & Srivastava, 1996). O'Leary (1990), cited in Watkins and Eliot (1993), attests that the effects from implementing an expert system go beyond the direct benefits of increased output, higher quality and decreased operational personnel. De Salvo and Liebowitz (1990:98) echo this sentiment with their analogy that, "like robots, expert systems can have profound effects on work force considerations".

King (1993) describes numerous tasks performed by financial expert systems, including credit and loan review. These credit-scoring systems form the basis of this study and are of particular relevance to the sustainability of the financial sector.

It is well recognised that to be successful, banks must be able to measure risk accurately and the key to measuring risk is an effective credit-scoring system (The Nation, 2003). Essentially, credit-scoring systems measure credit risk and differentiate individual credits and groups of credits by the risk they carry. This allows bank management to monitor changes and trends in risk levels and take proactive action to reduce loan losses. Credit-scoring ratings are also essential to other important functions, including credit approval and underwriting. Ratings should also be used to determine the structure of the credit facility, such as collateral, repayment terms, and guarantor and loan-pricing ratings should guide price setting. The price for taking credit risk must be sufficient to compensate for the risk to earnings and capital where incorrect pricing can lead to risk/return imbalances, lost business and adverse selection (The Nation, 2003).

Types of Credit Scoring Systems

There are essentially three different approaches commonly used to develop a credit-scoring system, and a myriad of ways in which they can be combined.

Judgmental or Rule-Based Systems

A Judgmental, or Rule-Based, System is basically a method of evaluating the credit worthiness of customers by using a formula or a set of rules based upon a combination of internal and external credit experiences. Realistically, companies that are not using a formal credit-scoring system are using some version of a rules-based system; with the exception that the value placed on a given response is weighted subjectively by the evaluator, who, after gathering the answers to a series of questions, applies his/her judgment, based upon experience, to come up with a decision to accept or reject. In practice, this is the easiest for credit practitioners to formalise and the least expensive to implement.

Rule-Based Scoring is based on traditional standards of credit analysis and generally utilises at least the following: (1) payment history; (2) bank and trade references; (3) credit agency ratings, and (4) financial statement ratios. Once it is decided which factors should be considered, they are weighted based upon the past experience of the credit department.

The major problem with Rule-Based Scoring is the inherent difficulty of determining the source of error if the system makes a series of bad decisions. These systems do not have the advantage that statistical and neural systems have, of being able to determine easily which factors are most important to the final decision. Therefore, unlike statistical and neural systems, a Rule-Based Scoring system is difficult to improve.

A few items are highlighted and added benefits are:

- The development is the most straightforward - most organisations already use a rules-based methodology when policies are decided. Therefore, the upfront work to decide which rules to apply and how, is commonplace.
- There is flexibility with data sources and models – the best judgment systems make decisions based on what the experts value the most by weighting them while having the ability to leverage multiple data sources, e.g. there could be different data sources and/or models based on region, industry or company size.
- Ease of set-up and use – the rules are simple to set up and are easy for the practitioner to understand and use.
- Many practitioners are now using risk analyses from judgmental-scoring models to drive decisions on other business factors, such as pricing based on risk, or different collection strategies based on risk score.

Behaviour Scoring (Statistical-Based Scoring)

Behaviour Scoring is a method based upon statistical analysis, usually in the form of a multivariate regression model, which can estimate the probability that a new customer, or an existing customer, will default or become delinquent.

These systems are very similar in operation to judgmental systems except that the factors used and their assigned weights are based on a statistical analysis of a company's optimal past operations , i.e., under the best circumstances, historical data in an electronic format is available, so that the company's own history can be used as the basis for the Behaviour Scoring system.

There are many different multivariate models that can be used as the basis for a Behaviour Based System, including: Linear probability models that assume a linear relationship between the factors and the probability of default; Logit models that assume the probability of default is logistically distributed; Probit models that assume the probability of default is normally distributed and Discriminant analysis models that divide accounts into high and low default-risk classes.

In the development of all Behaviour models, however: (1) Many factors are considered simultaneously; (2) the model development process calculates and analyses multivariate correlations to identify factor tradeoffs, (3) the interaction between variables is eliminated, i.e. two variables in the model that are closely correlated are avoided – or else this will bias the results; and (4) users are able to identify sources of estimation error easily and improve model accuracy.

The Collection Scoring model, which companies are using to increase collection productivity, is an aspect of this system’s functionality. The Collection model allows companies to improve early- and late-stage collection efforts by facilitating the prioritising of collection activities. Another sub-type is Predictive Metrics models which help a company to evaluate quickly and definitively the risk that an account will become severely delinquent or written off and, thereby, provide an early warning system that produces improved collection activity by allowing the company to allocate their collectors' time intelligently to those accounts where they will get the best return for the effort employed.

Neural Network Systems

Neural Network Systems are based upon a method that analyses historical data and has the ability to classify potential or existing accounts into one of several classes of varying credit risk, such as: good; indeterminate; delinquent; charge-off and bankrupt.

Neural Network Systems are a product of the application of artificial intelligence algorithms that allow the system, through an analysis of historical data, to determine the relationship between account characteristics and the probability of default, pattern recognition. These systems can automatically determine which characteristics are most important in predicting default. In many instances, they are more flexible than standard statistical techniques, as no assumptions are made about the functional form of the relationship between factors and default probability, or about the distribution of the variables or model error. As with certain of the statistical models, they can easily deal with non-linear relationships and correlations between factors are accounted for. These models are adaptive, in that the nature of forecast errors, i.e., bad credit decisions, can easily be evaluated and the models improved accordingly.

How credit-scoring systems work

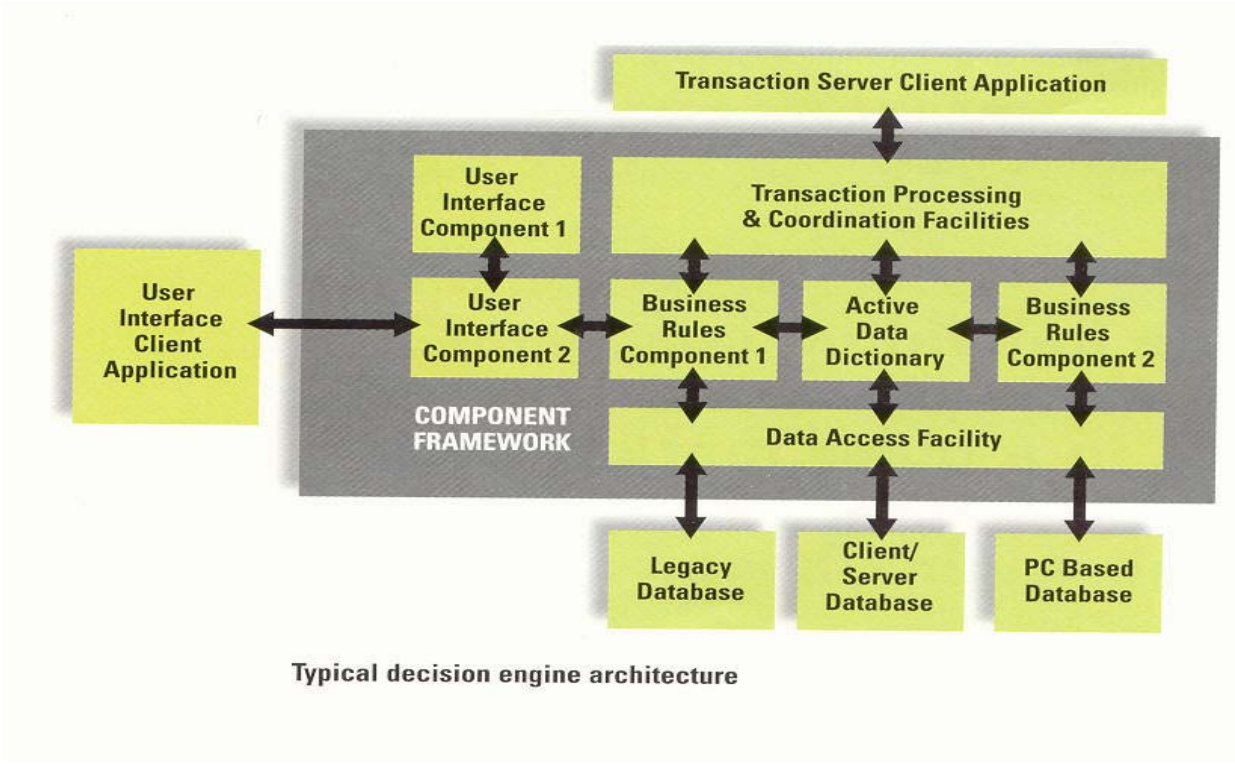
Bank Marketing International (2003) further explains that a credit's risk rating should determine how the relationship is administered. Higher risk credits should be reviewed and analysed more frequently, and higher risk borrowers should normally be contacted more frequently. This will mean that problem and marginal relationships must necessitate intensive supervision by management and debt collection specialists.

As well as using them to provide rapid decisions and customised pricing, providers of financial services are using credit-scoring to design marketing strategies and products (Bank Marketing International, 2003).

Credit-scoring packages are built from independent modules, or components, that interface seamlessly with the user’s application. Each component performs an independent function. Typical engine components are:

- Transaction processing and co-ordination capabilities
- User-defined rules and segmentation facilities
- Data access facilities for specifying actions as a result of decisions
- Simulation capabilities
- In-stream reporting

Figure 2.1: Typical decision engine architecture



SOURCE: FairIsaac (Undated)

An engine, when triggered, picks up required data and applies appropriate rule-sets to make a decision. In situations where large volume processing is required for potentially complex situations, e.g. in a lending environment, pay/no pay decisions or collection activities, this technology provides fast, consistent decisions that are applied in a cost-effective, efficient and timely manner.

Throughout the life cycle of an account, there are numerous points at which complex decisions – all multi-faceted and with interacting threads – are required. These decisions are often time-critical. Typical situations include:

- Opening a new account
- Making pay/no pay decisions
- Granting authorisations and credit limit increases
- Cross-selling selectively and appropriately
- Applying only the most effective collections actions
- Identifying fraudulent applications or transactions
- Reactivating dormant accounts

For example, a rule-based decision for opening a new account is where Fair Isaac's commercial credit-scoring system uses a 200- point scale, with 200 the highest score. At the 200 level, only 1 of every 31 loans becomes delinquent. As point scores decline, the predicted delinquency rate increases. Based on this odds scoring (% good to % bad), the request for credit is either accepted, rejected or referred.

A few key benefits of this IT architecture are:

- Shorter development times
- Distributed workflow
- User maintenance
- More efficient capital management, including allocation to business lines
- Reduced operational and credit risk, and hence losses
- Introduction/extension of risk adjusted pricing
- More intelligent reporting of exposures
- Improvement in processes and controls
- Improved cost management
- Enhanced reputation in the eyes of investors and equities analysts

Credit scoring is particularly applicable to accounts where it is desirable to keep the cost of the credit granting decision as low as possible, consistent with some predefined level of risk. It is very applicable, therefore, to high-volume small business accounts, where the Rand amount is small and the risk is high. Using a credit-scoring system for these types of accounts will tend to reduce the cost of the credit granting decision significantly. By design, credit scoring provides consistent, objective decisions, can identify potential high-volume customers and can enable increased credit limits to low-risk accounts (Business Credit, 2003).

All retail, commercial and investment banks have expenditure plans of between $50 million and $200 million to reach their target Basel status by end 2006 (Accenture, 2003).

Knowledge Management in the current business environment

On his categorization of KM tools, Jackson (1999) includes expert systems as a type of KM system. The evaluation of financial expert systems can therefore be considered a branch of (KM) appraisal techniques, since these systems provide an organisation with intellectual capital. Intellectual capital, according to Roos (1997), is concerned with knowledge possessed by an organisation. Expert systems capture the expertise of the knowledge workers through data processing and knowledge engineering and are therefore considered a type of KM tool.

Multiple concepts of KM exist in literature. Some focus on the activities involved in creating intelligence. For example, GartnerGroup defines KM as:

> "a business process for the management of an enterprise's intellectual assets. It is a discipline that promotes the collaborative and integrated approach to the creation, capture, organisation, access and use of information assets. These assets include structured databases, documents, and most importantly, the tacit expertise of individual workers" (Harris, Austin, Fenn, Hayward & Cushman, 1999:204)

The Business Process Resource Centre (BPRC, 2001) distinguishes between at least four different types of KM:

- Valuing knowledge

  This is a major concern for financial institutions. Knowledge is viewed as 'intellectual capital', and the focus is on quantifying and recognising the value of the organisation's knowledge base.

- Exploiting intellectual property

  This appeals to firms with a strong science and R&D base, which are looking beyond the conventional approach based on patents, to more effective ways of tapping into the commercial value of their existing knowledge base.

- Capturing project-based learning

  As firms increasingly move towards innovation and project-based organisation, many are recognising the need to capture the knowledge from individual projects and make it available throughout the organisation.

- Managing knowledge workers

> The shift towards knowledge work in many sectors creates problems for traditional ways of managing and motivating employees. In many firms, KM reflects managers' desire to increase the productivity of knowledge workers, breaking down some of the barriers to knowledge sharing which are associated with 'professionalism' (BPRC, 2001).

With globalisation levelling the playing fields from a financial, IT and natural resource perspective, it is the human capital element that is becoming the only sustainable competitive advantage. It is therefore critical that organisations harness the four types of KM defined by the BPRC. This would mean that comprehensive KM evaluation techniques would need to be employed, with particular reference to financial expert systems, since this is where the current business environment is most affected.

Although some work has already been undertaken with regards to KM evaluation, it appears to be in its infancy (Ruggles, 1997; Angus & Patel, 1998; Jackson, 1999 and Wensley, 2000). This research report should add to the current, underdeveloped body of knowledge in the expert systems' field of KM, since a holistic approach to evaluation will be proposed as an inductive credit-scoring model.

2.2 Evaluating Expert Systems and Knowledge Management

Angus and Patel (1998:1) point to the fact that KM is difficult to understand because the business processes it aims to computerise do not exist for most organisations, the result being “a product ivory tower built on conceptual quicksand”.

There is general agreement, however, as cited in Jackson (1999), that knowledge processes are multidimensional, provide value and are not the same thing as data or information. Jackson (1999:6) responds by saying that “the creation of technology tools for KM must not necessarily be constrained by the technological environment within which it will operate”. In practice, however, it is not technology that constrains KM implementation, according to Doswell and Reid (2000). Impediments to the practice of KM can be categorised into:

- Technological (6% – cost of IT)
- Attitudinal (53% – fear of sharing, cultural and professionalism)
- Structural (29% – lack of processes and time, geographical dispersion)
- Business (12% – no clear business plan)

In addition, respondents recognised the importance of dimensions such as culture and attitude and tended to think that their businesses focused too much on technology.

Therefore KM tools must not be evaluated only from a positivist perspective which, according to Savory (2001), is often the case. KM tools can only be understood in the context in which they are used and the methodologies that are associated with them. Wensley (2000) explains that tools are inert in and of themselves and do not play any part in KM. It is only when knowledge workers, who can assist in KM, use these tools in certain defined ways that the relevance of these knowledge workers is often forgotten when enterprises attempt to evaluate their KM systems.

Fairchild (2001:9) points out with regard to IT investment: “IT can help the growth and the retention of organisational knowledge if care is taken to remember that IT here is just a part of the story”. Fairchild explains that corporate culture and work practices are equally relevant and the IT best suited for this purpose should be expressly designed with KM and organisational capital in view.

Issues such as tacit knowledge sharing, creativity and innovation represent fundamental challenges in improving the business value chain (Ruggles, 1997). These too will have to be a focus of evaluation, if a competitive advantage is to be maintained.

Investments in expert systems have been growing rapidly and organisational structures have had to evolve to become more holistic. Those that distinguish themselves have shown the ability to make wholesale changes and become a business built around the KM concept (Angus & Patel, 1998). This is, however, a challenging task as shown in the current research (Jackson, 1999; Doswell & Reid, 2000; & Wensley, 2000).

Therefore we can see that the evaluation of ES and KM is likely to be a complex issue requiring understanding of financial, technical and contextual issues. This, however, is currently not well defined even in the general IS evaluation literature, as discussed in the following section.

2.3 The focus of IS evaluation techniques

Farbey, Land and Target (1999) discuss the concerns regarding evaluation. The primary concerns are the poor evaluation of costs, risks and benefits, with the emphasis often being placed on tangible rather than intangible factors. Discounted cash flow (DCF) methods, which originate from accounting, can be criticised as a means for IT evaluation. Both from a practical point of view, e.g. hard to quantify intangibles, as well as from an ontological point of view, i.e. information systems are primarily social systems, objections are raised against applying these methods to evaluate IT (Nijland, 2002). Therefore, although quantifiable, IT systems are not solely technical systems which can be evaluated in an unbiased, value-free and objective way. This is particularly relevant when considering KM systems which modify the use of intellectual capital in an organisation (King, 1993).

Savory's (2001) research has revealed that much of the cited work on IT evaluation has concerned itself with areas such as transaction processing systems, decision support and strategic information systems. In many ways these have looked at IT from a very positivist or objectivistic perspective. Thus IT has often been introduced under the assumption that its presence will lead to a unified approach to carrying out a particular process. Savory (2001) explains this may be the case for a payroll system, but it is much less plausible that providing a standard means for sharing knowledge will result in an automatic improvement in KM. Therefore, the positivist's assumption that organisational structures such as IS will directly influence the actions of people in the organisation may not be true in this context.

Walsham (1993:184) points out that, although financial methods may serve a ritualistic purpose, DCF approaches are "highly deficient in generating real understanding of the costs and benefits of a computer-based system and its human and organisational consequences". Walsham (1993) therefore proposes an interpretive or contextual approach to obtain a real understanding of the costs and benefits of systems.

Within the process of IT evaluation there have been a number of different approaches and tools adopted. The initial assumption of these approaches was based on IT needing to improve efficiency, especially where used to automate processes. The natural

assumption was that evaluation was based on financial measures. Typically, IT projects would be evaluated in much the same way as any other piece of machinery (Savory, 2001). In view of the increased importance of IT and decades of research into better ways of evaluating IS effectively, one might expect that the state of IS effectiveness in measurement practices would have improved over the last decade. Findings from a survey conducted by Seddon, Graeser and Willcocks (2001) revealed that IT evaluation practices have actually changed very little over this period.

The use of the cost benefit analysis (CBA) model of investment appraisal including: return on investment (ROI), net present value (NPV) and payback period, still provides the central basis for evaluation in today's business environment, where financial measures of performance maintain a significant impact on how IT is evaluated (Willcocks & Lester, 1999b). Though organisations display interest in IT evaluation methods to improve system management, in practice these methods are hardly ever adopted. The majority of organisations evaluating their IT investments use a discounted cash flow (DCF) method to assess them (Nijland, 2002).

Savory (2001) notes, that the need to project a professional approach may lead IT developers into the adoption of predominantly objectively-based methodologies. The choice of an evaluation technique is affected by the need to adopt a legitimate approach. Savory notes that commonly this legitimacy is based on the frame of reference of the finance professionals who, for what may be seen as sound business reasons, base their notion of validity on financial tests.

Business Credit (2002) highlights that one can see that, when evaluating a new source of credit system information, it is imperative to understand the context and whether the system information is required in its entirety. Another factor when considering a credit information source is the date of creation and the last time the information was modified or updated, or if it is a static resource when weighing the data. Business Credit (2002) suggests that, until a comfort level with a new source of system information has been established, the data found should be supplemented with multiple resources, both quantitative and qualitative. This process will allow one to determine and qualify the validity, reliability and authenticity of the system information being evaluated.

2.4 The importance of intangible benefits

Seddon, Graeser and Willcocks (2001) conducted a study on the overall evaluation of IT effectiveness in medium to large European and US firms, with an average annual turnover of US$4.5 billion and an annual IT budget of US$38 million. Respondents were presented with a list of nine common inhibitors to evaluation and asked to score them on a scale from 1, 'complete roadblock', through 4, 'a problem but not insurmountable', to 7, 'not an issue at all'. According to responses the five most important inhibitors, from most to least important, were:

- *Inability to identify intangible benefits*
- Inappropriate measures
- No satisfactory metrics available
- Financial focus of the organisation
- Poorly defined IT deliverables

It is increasingly suggested that evaluation should address intangible effects such as human and social issues, which draw more on qualitative data. This premise is based on the knowledge that, due to the complex multidisciplinary and multifaceted nature of IT evaluation, the aim of researchers to develop a comprehensive yet testable and normative method of expert system evaluation is not yet fully achieved (Turnbull, 1999).

Comprehensive research by Brynjolfsson and Hitt (1991) illustrates the multifaceted effects IT has on both the tangible content and intangible context of an organisation.
The commonly known 'productivity paradox' of IS is that, despite enormous improvements in the underlying technology, the benefits of IS spending have not been found in aggregate output statistics. One explanation is that IS spending may lead to increases in product quality or variety which tend to be overlooked in aggregate output statistics, even if they increase sales at the firm level (Brynjolfsson & Hitt, 1991). Using econometric models to assess the contribution of IS to firm-level productivity, Brynjolfsson and Hitt were able to reject the null hypothesis that the ROI for computer capital is no greater than the return for other types of capital investment and also find that IS labour spending generates several times as much output as spending on non-IS labour expenses. The authors therefore conclude that the 'productivity paradox' disappeared by 1991. In practice, however, firms still maintain the 'productivity paradox'

mindset, since they are perpetually unable to trace the contextual benefits of their IS systems. This may occur because, although the purpose of IT evaluation is wider than to assess only whether a project is to go ahead or continue (Serafeimidis & Smithson, 2000), it has been this focus on investment which predominates in the business environment.

From a theoretical stance, however, recognising that evaluation must take place on a wider perspective, a number of authors have developed more contextual normative frameworks. Parker, Trainor and Benson (1989) suggest the Information Economics framework. This provides a generalised framework (Appendix B) for evaluating and comparing IT-investments and projects by ranking several value and risk criteria connected to IT projects, namely:

1. Financial domain – Return on investment (ROI)
2. Organisational domain - Strategic match
   Competitive advantage
   Management information
   Competitive response
   Project or organisational risk
3. Technological domain - Strategic IS architecture
   Definitional architecture
   Technical uncertainty

A similar approach has been suggested by Ward (1990), with regard to the IS Portfolio. This classifies information systems based on a management judgment of the value of the systems' investment, in terms of one of four segments of the matrix, i.e. Strategic, Turnaround/High potential, Factory/Key operational, Support (Appendix C). The implication of these authors' work for IT evaluation has been to raise the importance of differences in the evaluation approach depending on the type of IS. The literature, therefore, supports the notion of linking the type of IS to the style of evaluation (Ward, 1990).

Remenyi, Sherwood-Smith and White (1997:61) point out that "evaluations are purposeful activities which are context dependent and subject to the evaluator's

purpose, needs and aspirations during the evaluation". Similarly, Serafeimidis and Smithson (2000) attribute most companies' failure to adopt newer, seemingly more appropriate, IT evaluation techniques to the difficulties of changing deep-rooted beliefs in the evaluation culture of the organisation.

Seddon, Graeser and Willcocks (2001) suggest that a set of powerful 'push' factors need to be operating before managers in an organisation confront the perceived serious costs and barriers to IT evaluation, and institute lasting improvements to their practices. This study highlights the key 'push' factors as being:

- Although fiscal costs are not a primary concern of central banks, they are concerned about financial stability, because of their role in monetary policy and as lenders of last resort, as well as the role that many play in their respective countries' payment, clearing and settlement systems. Given the large costs that a financial crisis can entail, it is imperative that systemic risk is minimised through prudent credit lending policies.
- Given reliable financial information, the most powerful force to ensure banks are well managed is, in fact, the market. Poorly managed banks will be unable to compete at a profit, unable to attract capital, and will eventually exit from the banking system.
- Credit risk is a common cause of problems, because the liabilities of banks are largely certain in value, but the assets are uncertain in value, i.e. the bank must still repay the full amount of a deposit, even though the loan it made using those same funds was not repaid. Therefore, the most common underlying cause for bank failure is actually poor credit management. If the credit granting and debt collection processes are not extremely well managed, a bank is almost certain to feel the effects thereof in its profitability and eventually its capital adequacy.

It is therefore a necessity for the relevant practitioners of credit-scoring systems to address any evaluation barriers and therefore optimise the evaluation process in light of the changing business environment. By doing this successfully bankers can minimise the downside of their business leading to higher and more sustainable profitability.

2.5 The need for a holistic evaluation model

Based on the findings by Ruggles, (1997); Angus and Patel, (1998); Jackson, (1999); Wensley, (2000); and Savory (2001), the need for IS to be appropriately valued is blatantly evident. Essentially, IS evaluation must combine both quantitative and qualitative measures if the true benefits of IS are to be assessed. This research report should add to the current, underdeveloped body in the literature on financial expert systems, as the author proposes to develop a holistic model, by means of an exploratory research methodology using the Delphi technique.

There are a number of models which, due to the combination of quantitative and qualitative metrics, form a basis for the proposed model. These are presented as follows:

- Seddon, Graeser and Willcocks' (2001) two groups of IT evaluation techniques.
- Sveiby's (2001) Intellectual Capital measurements
- Kaplan and Norton's (1996) Balanced Scorecard approach
- Fairchild's (2002) Intellectual Capital Scorecard
- Magrassi's (2002) Total Intangible Value model
- The Celemi Monitor (1999)

2.5.1 Seddon, Graeser and Willcocks (2001) – identify two groups of IT evaluation techniques.

1. Focuses on context, i.e. interests and opinions of individual users of IT
2. Focuses on content, i.e. management objectives (CBA)

The authors have drawn these parameters based on Symons' (1991) conceptualised model. Symons (1991) stressed that an exclusive focus on the content of evaluation, 'what we want to do', fails to take into account the context of evaluation, the forces for continuity in the situation, and thereby precipitates its own failure. She concludes that,

> "Consideration of the interaction between content, context and process in evaluation draws in the social and qualitative aspects of IT, and prevents

the narrow focus on technical, administrative and quantifiable economic elements which has in the past proved so dysfunctional" (Symons, 1991:211).

The key measures in Seddon, Graeser and Willcocks' (2001) model are presented in the table. These have been derived from measures used by numerous researchers.

Table 2.5. 1: Key Measures

Group	Definition	Key Measures	Key Authors
1] Context	Based on the interests and opinions of individual users of IT (i.e. individual-as-stakeholder category)	a) Individual Productivity b) User Satisfaction c) Information Quality d) Perceived Usefulness	Ives *et al.*. (1983), Doll and Torkzadeh (1988), Goodhue (1995) and Davis (1989)
2] Content	Based on the interests and opinions of management	a) Return on Investment b) Return on Management c) Cost savings d) Sales growth e) System efficiency	Strassmann (1990), Weill (1992), Mukhopadhyay *et al.*. (1995) and Willcocks and Lester (1999)

2.5.2 Sveiby (2001) – proposes 'intellectual capital' measurements in his paper Methods for measuring intangible assets, which are predominantly KM based.

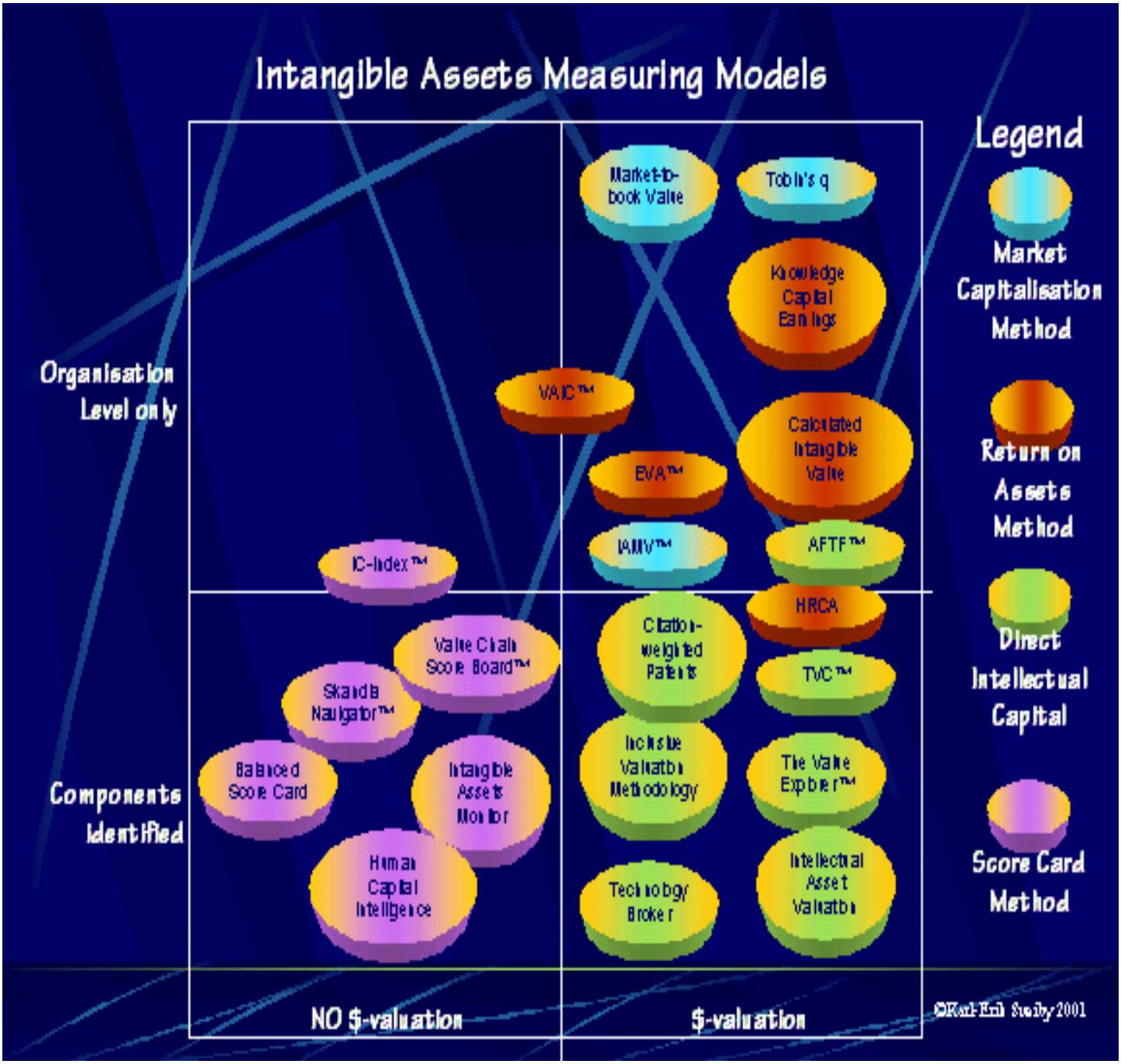
Sveiby's metrics are divided into four categories:

1. **Direct Intellectual Capital Methods (DIC)** – these metrics address the intangible 'intellectual property' of an enterprise, e.g. tacit knowledge and skills, explicit knowledge and research development, patents and management processes, which are all ES related, since it is the intellectual capital of the enterprise that engineers this type of IT.

2. **Market Capitalisation Methods (MCM)** – these metrics establish the sustainable competitive advantage an enterprise has developed over time based on investor sentiment and the economic value-added.
3. **Return on Assets Methods (ROA)** – these metrics distinguish between hard assets and intangible assets and quantify the value created by the enterprise and its market valuation.
4. **Scorecard Methods (SC)** – these metrics reveal the actualisation of strategic objectives of the enterprise, e.g. growth, process efficiency, risk reduction and customer satisfaction, which form the premise for credit-scoring system investment.

The matrix illustrates what level of measurement the four categories occupy, i.e. Organisational or Component, and whether they are qualitative, No $-valuation, or Quantitative, $-valuation.

Figure 2.5. 1: Intangible Assets Measuring Models



The matrix is divided up as follows:

1. No dollar valuation / dollar valuation (*x*-axis)
2. Organisational level only / Components identified (*y*-axis)

The metrics in the 'Organisational level only' quadrant are based on the overall performance of the organisation, whereby the total intangible value of the enterprise is translated into monetary terms. Sveiby then breaks up the overall performance of the organisation into its specific components that contribute to the total outcome. These fall into the 'Components identified' quadrant and measure both tangible and intangible assets.

The table provides a brief overview of Sveiby's 21 approaches, with definitions given.

Table 2.5. 2: Sveiby's 21 approaches

Label	Major Proponent	Category	Description of Measure
Technology Broker	Brooking (1996)	DIC	Value of intellectual capital of a firm is assessed, based on diagnostic analysis of a firm's response to twenty questions, covering four major components of intellectual capital.
Citation-Weighted Patents	Bontis (1996)	DIC	A technology factor is calculated based on the patents developed by a firm. Intellectual capital and its performance is measured based on the impact of research development efforts on a series of indices, such as number of patents and cost of patents to sales turnover, that describe the firm's patents.
Inclusive Valuation Methodology (IVM)	McPherson (1998)	DIC	Uses hierarchies of weighted indicators that are combined, and focuses on relative rather than absolute values. Combined Value Added = Monetary Value Added combined with Intangible Value Added.
The Value Explorer™	Andriessen and Tiessen (2000)	DIC	Accounting methodology proposed by KMPG for calculating and allocating value to 5 types of intangibles: (1) Assets and endowments, (2) Skills and tacit knowledge, (3) Collective values and norms, (4) Technology and explicit knowledge, (5) Primary and management processes.
Intellectual Asset Valuation	Sullivan (2000)	DIC	Methodology for assessing the value of Intellectual Property.
Total Value Creation, TVC™	Anderson and McLean (2000)	DIC	A project initiated by the Canadian Institute of Chartered Accountants. TVC uses discounted projected cash flows to re-examine how events affect planned activities.
Accounting for the Future (AFTF)	Nash H. (1998)	DIC	A system of projected discounted cash flows. The difference between AFTF value at the end and the beginning of the period is the value added during the period.

Tobin's Q	Stewart (1997) Bontis (1999)	MCM	The 'Q' is the ratio of the stock market value of the firm divided by the replacement cost of its assets. Changes in 'Q' provide a proxy for measuring effective performance of a firm's intellectual capital.
Investor assigned market value (IAMV™)	Standfield (1998)	MCM	Takes the Company's True Value to be its stock market value and divides it into Tangible Capital + (Realised IC + IC Erosion + SCA (Sustainable Competitive Advantage)
Market-to-Book Value	Stewart (1997) Luthy (1998)	MCM	The value of intellectual capital is considered to be the difference between the firm's stock market value and the company's book value.
Economic Value Added (EVA™)	Stewart (1997)	ROA	Calculated by adjusting the firm's disclosed profit with charges related to intangibles. Changes in EVA provide an indication of whether the firm's intellectual capital is productive or not.
Human Resource Costing & Accounting (HRCA)	Johansson (1996)	ROA	Calculates the hidden impact of HR related costs which reduce a firm's profits. Adjustments are made to the P&L. Intellectual capital is measured by calculation of the contribution of human assets held by the company, divided by capitalised salary expenditures.
Calculated Intangible Value	Stewart (1997) Luthy (1998)	ROA	Calculates the excess return on hard assets, and then uses this figure as a basis for determining the proportion of return attributable to intangible assets.
Knowledge Capital Earnings	Lev (1999)	ROA	Knowledge Capital Earnings are calculated as the portion of normalised earnings over and above expected earnings attributable to book assets.
Value Added Intellectual Coefficient (VAIC™)	Pulic (1997)	ROA (doesn't quite fit any of the categories)	Measures how much and how efficiently intellectual capital and capital employed create value based on the relationship to three major components: (1) capital employed; (2) human capital; and (3) structural capital.
Human Capital Intelligence	Jac Fitz-Enz (1994)	SC	Sets of human capital indicators are collected and benchmarked against a database. Similar to HRCA.
Skandia Navigator™	Edvinsson and Malone (1997)	SC	Intellectual capital is measured through the analysis of up to 164 metric measures, 91 intellectually based and 73 traditional metrics, that cover five components: (1) financial; (2) customer; (3) process; (4) renewal and development; and (5) human.
Value Chain Scoreboard™	Lev B. (2002)	SC	A matrix of non-financial indicators arranged in three categories according to the cycle of development: Discovery/Learning, Implementation and Commercialisation.
IC-Index™	Roos, Roos, Dragonetti and Edvinsson (1997)	SC	Consolidates all individual indicators representing intellectual properties and components into a single index. Changes in the index are then related to changes in the firm's market valuation.

Intangible Asset Monitor	Sveiby (1997)	SC	Management selects indicators, based on the strategic objectives of the firm, to measure four aspects of creating value from intangible assets. By: (1) growth (2) renewal; (3) utilisation/efficiency; and (4) risk reduction/stability.
Balanced Score Card	Kaplan and Norton (1992)	SC	A company's performance is measured by indicators covering four major focus perspectives: (1) financial perspective; (2) customer perspective; (3) internal process perspective; and (4) learning perspective. The indicators are based on the strategic objectives of the firm.

Source: Sveiby, 2001

The relevant Sveiby measures are: HRCA (Human Resource Costing and Accounting) which ties into the Delphi measure of turnaround times;

Intangible Asset Monitor which ties into the Delphi measure of profit drivers by score; and

Tobin's Q which ties into the Delphi measure of decrease in bad debt

2.5.3 Kaplan and Norton (1996) – the Balanced Scorecard approach

In their book, *The Balanced Scorecard*, Kaplan and Norton (1996) present a model illustrating the chain of cause and effect that leads to strategic success. This model is potentially fundamental to understanding KM metrics. However, although the balanced scorecard can form the foundation for organisational strategic success, it is not sufficient in itself. Firestone (1998) points out that measuring KM benefits/costs to other processes in the organisation is an important area for extending the present Kaplan and Norton framework. This can be addressed using Sveiby's 'intangible assets' model. However, the key benefit of Kaplan and Norton's scorecard is that it seeks to complement the "financial measures of past performance with measures of the drivers of future performance" (Seddon, Graesar & Willcocks, 2001:8).

Also, according to Viedge (1999), an unintended consequence of the process of implementing a Balanced Scorecard (BSC), is that knowledge is created and disseminated throughout the organisation. This is because much dialogue

and debate is needed to establish the measures in the four aspects of the BSC namely: financial, customer, internal, learning and growth. The discussion generated by the BSC therefore recrafts the mental models of employees and brings them in line with what needs to be done to create value for customers. Viedge (1999) concludes that, in addition, the measures established by the BSC can also be used to monitor the effective use of knowledge in an organisation. Kaplan and Norton's approach lays the foundation for Fairchild's evaluation model.

2.5.4 Fairchild (2002) – Intellectual Capital Scorecard

This approach uses the different types of capital available in an organisation to be the four different scorecard perspectives of how KM is leveraged in the organisation. The four capitals which make up a knowledge-centric organisation (KCO) are (Neilson, 2000):

1. **Human capital** consists of all individual capabilities; the knowledge, skill and experience of the employees and managers. Since a KM organisation is exceedingly system-centric, the culture of the organisation needs to be accepting of any business process re-engineering.
2. **Intellectual capital** includes the intangibles such as information, knowledge and skills which can be leveraged by an organisation to produce an asset of equal or greater importance than land, labour and capital. Credit-scoring systems need regular modification, as economic conditions have a direct impact on bank lending policies. It is therefore the experts who are responsible for aligning system functionality with business strategy.
3. **Structural capital** includes the processes, structures and systems that a firm owns, less its people. Credit-scoring systems have a profound effect on the organisational architecture of the firm, from cross-selling, to real-time system integration.
4. **Social capital** is the goodwill resulting from physical and virtual interchanges between people with like interests. This is directly

impacted, since credit-scoring systems streamline decision processing by capturing expert knowledge and, therefore, act as a direct substitute for this type of interchange.

The four capitals can be directly related to the traditional Kaplan and Norton BSC method, as shown in the table below.

Table 2.5.4. 1: Balanced Scorecard and Intellectual Capital Perspectives

Balanced Scorecard Perspective	**Generic Measures**	**Intellectual Capital Perspective**	**Generic Measures**
Financial	ROI EVA	Intellectual	Value Scoreboard IC-Index Value Added Intellectual Coefficient (VAIC) Intangible Asset Monitor
Customer	Satisfaction, retention, market and account share	Social	KOPE (Truche, 2001): K-KM strategy O-Organisational and Cultural enablers P-Process enablers E-Enabling technologies
Internal	Quality, response time, cost of new product introductions	Structural	Value Explorer (Andriessen & Tiessen, 2000)
Learning and Growth	Employee satisfaction, IS availability	Human	HRCA (Johansson, 1996) Human Capital Intelligence

NOTE: refer to Sveiby's table for definition of measures

2.5.5 Magrassi (2002) – adopts a model which artificially translates the total intangible value of an enterprise into monetary terms

Based on Sveiby's 'Organisational level' metrics, these measurements involve trying to identify the flows that change, or otherwise influence, the market value of an organisation's assets, both tangible and intangible.

Magrassi's model accomplishes this by using the following metrics:

- **Market to Book Value (MBV)**

i.e. market value per share / book value per share

This compares the market value of the firm's investment to its cost, where a value less than 1 means a firm is destroying value.

- **Tobin's Q**

This is also known as 'replacement value' and is the ratio of market price to replacement cost, i.e. the cost incurred in setting up an identical firm.

- **Calculated Intangible Value (CIV)**

Calculates the excess return on hard assets, then uses this figure as a basis for determining the proportion of return attributable to intangible assets.

- **Knowledge Capital Earnings**

Knowledge Capital Earnings are calculated as the portion of normalised earnings over and above expected earnings attributable to book assets.

- **Economic Value Added (EVA)**

$$\left[\frac{\text{NOPAT}}{\text{SALES}} * \frac{\text{SALES}}{\text{NET ASSETS}} - \text{WACC}\right] * \text{NET ASSETS}$$

Key: NOPAT – Net Operating Profit after Tax

WACC - Weighted Average Cost of Capital i.e. we * ke + wd * kd

we = Equity/Net Assets

ke = before tax cost of Equity

wd = Debt/Net Assets

kd = after tax cost of Debt

2.5.6 Celemi Monitor (1999) – A Swedish Company's model, specialised for **learning tools** (Appendix A)

Halal (1998) noted five different typology approaches to measuring KM in an organisation, which are also applicable to the IT investment in KM:

1. Anecdotes: Success stories
2. Indicators: Issues that focus on behaviours and outcomes
3. Analysis: Cost/benefits received and best practices
4. Enterprise model: Treating KM as a competitive venture
5. Organisation: Measuring structural capital

Halal notes that, in comparing the advantages and disadvantages to these typologies, the conclusion might be made that there is no clear-cut winning approach; given that the audience of measurement tends to be senior management, who appreciate bottom line figures, but require solid proof points as well.

The Celemi Monitor incorporates four of Halal's typologies on the basis of tangible versus intangible assets, for example:

1. Indicators: the 'People competency' metrics
2. Analysis: the 'Financial capital' metrics
3. Enterprise model: the 'Customer competitiveness' metrics
4. Organisation: the 'Internal structure/Organisation' metrics

Since expert systems are classified as a type of KM learning tool (Jackson, 1999), the Celemi Monitor can be considered a comprehensive KM evaluation approach, since all but one of Halal's typology approaches have been included and are applicable to the IT investment in KM (Appendix A).

Conclusion

Evaluating expert systems, in particular credit-scoring systems, can therefore be seen to be a new under-developed body of science and the importance of these expert systems in business has been made evident. The focus of IS evaluation techniques has been primarily functionalist and hence overlooks the importance of intangible benefits. There is therefore a need for a holistic evaluation model, the development of which this research has explored. There are four propositions that are researched by means of a Delphi Methodology used to construct an inductive evaluation model. These propositions are stated in the following section.

2.6 Propositions

Proposition 1

Traditional appraisal techniques, such as Cost Benefit Analysis, ROI and the Discounted Cash Flow Method, which do not account specifically for IT characteristics, are still dominant in IT evaluation and account for the majority of post-implementation techniques used in practice.

Proposition 2

The majority of evaluation methods are used to assess only the functional performance and financial cost benefit of the systems, while failing to address implementation issues, such as culture and strategy.

Proposition 3

Many methods are theoretical rather than realistic and are therefore of limited practical use.

Proposition 4

A universal IT evaluation process for financial expert systems does not exist. A holistic model can therefore be proposed, whose value lies in its ability to optimise the evaluation process for credit-scoring systems.

CHAPTER 3. RESEARCH METHODOLOGY

3.1 Method

The incorporation of the Delphi method makes possible the refinement of this research objective, i.e. to develop a holistic approach to evaluating credit-scoring investments, presented as a benchmark model. Based on the outcome of the Delphi survey, together with the supporting literature, the model has been conceptualised and validated by these experts in the third round of the Delphi survey. Some useful recommendations have been extracted and the model refined.

3.1.1 The Delphi technique – an overview

"Delphi may be characterized as a method for structuring a group communication process, so that the process is effective in allowing a group of individuals, as a whole, to deal with complex problems" (Linstone & Turoff, 1975:3). The literature clearly suggests that Delphi is an appropriate method of forecasting and surveying, where the study considers an innovative situation (Ward *et al,* 1999).

Critcher and Gladstone (1998) quote the six phases in the Delphi method as:

1. formulation of issues
2. exposing options
3. determining initial positions on issues, especially areas of agreement and disagreement
4. exploring reasons for disagreements
5. evaluating such reasons
6. re-evaluation of options in light of the above

For the current study the researcher proposed only the first three rounds, based on views expressed by Critcher and Gladstone (1998).

Procedure: An expert sample was selected and briefed on the requirements of the Delphi process. The questionnaire was designed to elicit the expert opinion of the panel

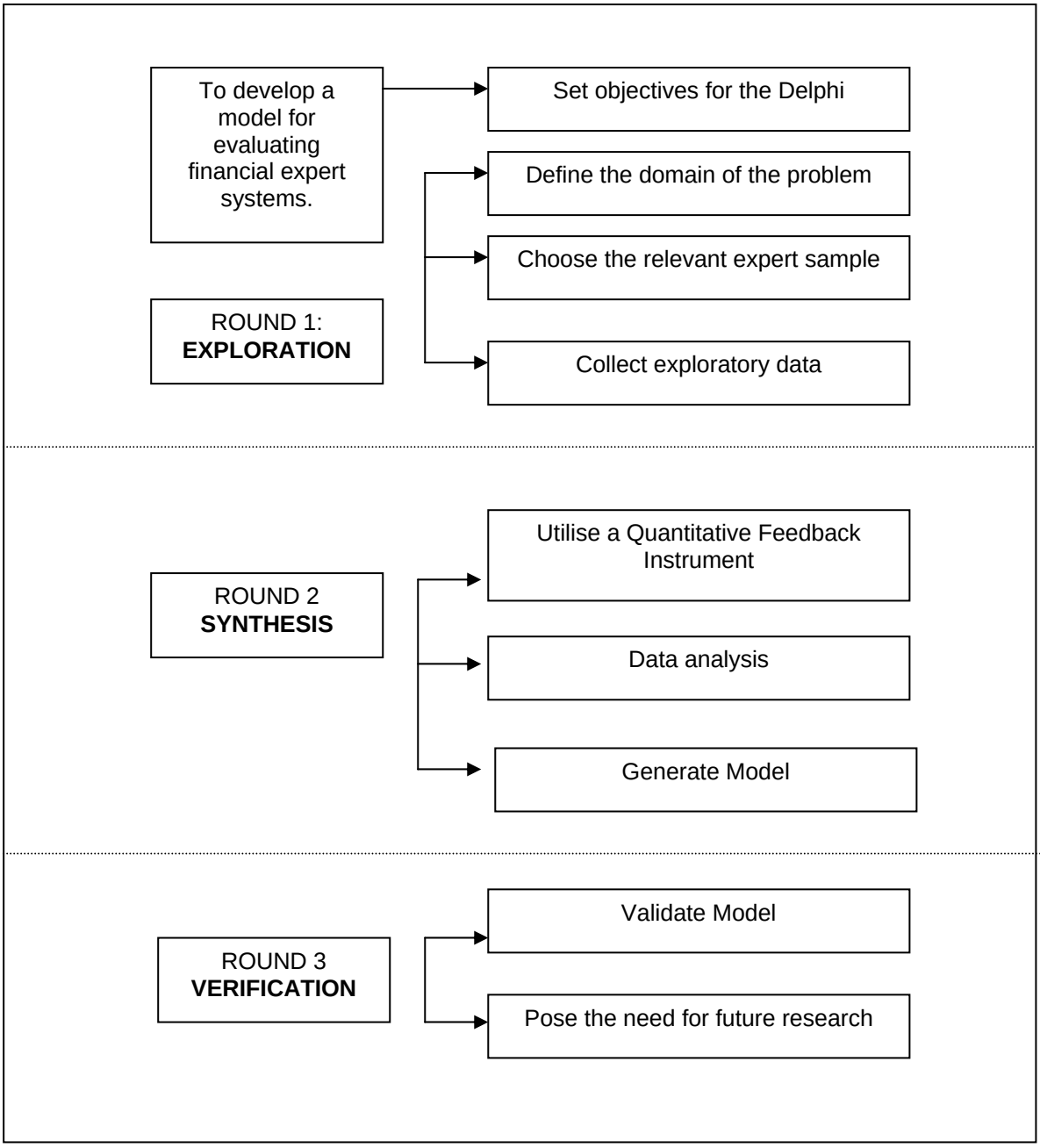
and the typical rules for questionnaires apply, i.e. neutrality, consistency, coding, simplicity, rationale for answering, pilot test and unambiguity. After consent and commitment to the study was obtained, the process followed the route described below:

Table 3.1. 1: The Delphi Process

ROUND 1	Open-ended questions on the subject of the study were sent to each panel member. **The research questions were:** **a) What methods do you use to evaluate your credit-scoring systems?** **b) What are the advantages of these methods?** **c) What are the disadvantages of these methods?** **d) To what extent are these measurements application specific (i.e. specialised techniques used solely for credit-scoring systems)?** The members were requested to share their expert opinion and return their list to the coordinator of the panel. The list was summarised by the coordinator for the second round.
ROUND 2	The panel was asked to rate the methods generated in Round 1; this formed a collective response that was requested from the panel. This rating was done on a 100 point Likert scale, which was utilised to produce a final list where the convergence and consensus levels were established. This list was then statistically analysed and an interpretation as to what the most used evaluation methods were, was obtained. Methods from the literature was added to those obtained inductively.
ROUND 3	The panel was asked to comment on the model proposed by the author. This validated the author's research questions and lays the foundation for future research.

The process is illustrated as follows:

Figure 3.1. 1: The Delphi Methodology



Source: adapted from Story *et al* (2001).

The first part is the 'exploration' of the research domain, through defining the objectives of the study and conducting experience surveys with an expert sample. The second part, which is the essence of a classical Delphi study, is the 'synthesis' of expert view

points, through iteration and feedback of responses into a working consensus. The final stage is the 'verification' of responses, to ensure stability in the expert panel responses has been achieved (Story *et al,* 2001).

Although the process does not produce unanimity, the output narrows down the quartile range to converge towards some level of consensus (Makridakis & Wheelright, 1998). Rowe and Wright (1999) also discuss some of the characteristics of the method. These include anonymity (through questionnaires), iteration (through a series of 'rounds'), controlled feedback (through summaries of group response) and statistical aggregation of group response (through judgment based on panellists' responses at the end of the final round). The Delphi technique is conducive to independent thought on the part of the experts, but complements the gradual formation of a considered opinion, as opposed to direct confrontation (Story *et al,* 2001).

3.1.2 Disadvantages

UM-C's Delphi study (Undated) of digital libraries revealed shortcomings of the Delphi technique to be:

- the tendency to eliminate alternate solutions by aiming at consensus
- limited courses of action, due to the narrowing down to the one considered most likely
- features of anonymity can engender apathy
- often, decision-makers, not experts, are the ones polled, since they will ultimately be the people with the power to make the policy changes

Also, Makridakis and Wheelright (1998) state other disadvantages of the Delphi technique as being insufficient reliability, oversensitivity of results, difficulty in assessing the degree of expertise of the panel and the impossibility of taking into account the unexpected. Rowe and Wright (1999) suggest that the conformance may be due to attrition, because members with extreme views are likely to drop out during the early stages of the process.

However, Hines (1995) declares that Delphi is still reported to be the most commonly used methodology for forecasting, whereby, “its wide use, success, and longevity speak well to its overall validity”.

3.1.3 Advantages

Delphi opens the possibility for performance of human groups that exceeds the composite performance curve and this phenomenon has been termed “collective intelligence” by Hiltz and Turoff (1978). Essentially, this is the ability of the group to produce a result that is of better quality than any single individual in the group could achieve acting alone.

To overcome the Delphi’s reliance on quantitative evaluation of options, opportunities can be provided for respondents to include written qualitative additions to their numerically weighted selections. This complicates the procedure, but allows for the fleshing-out of nuances that tend to get lost when using the original Delphi process (Passing, 1996).

The technique is convenient, i.e. no face-to-face interviews are required, it is cost efficient and can be performed in unison on all panellists (Balderston, Birnbaum, Goodman & Stahl, 1984). Also, a diverse panel can be effective in ensuring that the entire problem area is objectively covered (Makridakis & Wheelright, 1998). The panel is kept anonymous and Balderston *et al* (1998) argue that this is an advantage, because it prevents personality from biasing the consensus-seeking process. The method also allows for consensus to be generated where the participants would otherwise not independently agree on the issues.

3.1.4 The justification and implication for use of the Delphi Technique for this study

Justification: The researcher considered the Delphi technique the most appropriate survey method needed to address the subproblems of the research topic. The Delphi technique, which uses a series of questionnaires, pools expert’s judgments on a complex subject. Responses from one round of questionnaires were used to formulate

the next round. This iterative process continued until an issue had been sufficiently explored and a convergence of experts' opinions emerged. The Delphi Technique was effective for identifying goals and objectives, evaluating alternatives and gaining insight into values and preferences. It was very useful when a very large number of participants had to be accommodated, when participants wished to remain anonymous, or when participants were too hostile to meet face-to-face.

Implication: Very careful survey design and synthesis of input from each survey was required to make this technique effective. Rowe and Wright (1999) highlight some criticisms on some research work in which the Delphi technique has been used. These include 'sloppy execution', ranging from poorly worded and ambiguous questionnaires, to type and form of feedback. Other issues relate to poor selection of panellists in terms of expertise and diversity of views and criteria for convergence to determine cessation of the process.

As far as the number of panellists is concerned, Rowe and Wright (1999) state that, although studies have been conducted to attempt to determine the relationship between panel size and effectiveness, these have been inconclusive. The group sizes that have been used in previous studies given in the literature reviewed by the researcher (Linstone & Turoff, 1975; Makridakis & Wheelright, 1998; Balderston *et al,* 1984) range from 5-19; although there has been a recommendation for a minimum of ten and a maximum of fifty, suggested by Critcher and Gladstone (1998).

3.2 Population and sample

The selection of the 'suitable' experts must be a procedure based on explicit criteria, which can vary according to the scope of the application and the context in which the technique is used. The criteria applied were: the knowledge and practical experience of the arguments investigated, the ability and propensity to contribute to the exploration of a specific problem and ability in both written communication and in expressing priorities on a measurement scale (Da Vinci, 2002).

Therefore, the population in this research can be considered to be all the practitioners, facilitators and evaluators that are engaged in, or have participated in, credit-scoring

investments and implementation. The sample consists of a panel drawn from consultants, auditors and practitioners who were contacted by electronic mail. In selecting the panel, the objective was to ensure that the subject was adequately covered, whilst avoiding uniformity of response introduced by any biased panel membership. The main criteria in selecting the group were therefore expertise and diversity. Rowe and Wright (1999) quote studies that have found that the accuracy of studies increased over rounds for 'expert' groups, as opposed to 'inexpert' groups, where traditional survey methods were used.

As far as the size of the group is concerned, the study aimed to retain no less than ten participants at the end of the study, based on recommendations by Critcher and Gladstone (1998). Participation rates typically reduce by between a third and one-half at each stage of the Delphi study (Critcher & Gladstone, 1998): the initial group size was therefore determined with this in mind.

The researcher selected a total of 20 experts as participants in the study from 14 companies : auditing (3), practitioners (9) and consulting (2) – As a result of attrition due to a delay between rounds two and three, the researcher interviewed the small group remaining in round three for richer data. Round two experienced a fifty percent attrition rate with only ten respondents left and round three had seven remaining in total.

Table 3.2. 1: The Delphi Panel of Experts

Institution	Contact
KPMG	Peter Mcdonald Leigh Wormald
PricewaterhouseCoopers (PwC)	Tersia Kruger
Deloitte & Touche	Ingrid Goodspeed
ABSA	Peter Chalmers - Homeloans Gavin Muller – Group Consultant
Standard Bank	Ray Anderson - IT Owen Sorour - Credit Cards Leon Barnard - Homeloans

	Norbert Martens – Risk Management
FNB	Patrick Muthui
Nedcor	Stefan Bolling Jeetesh Kathawaroo
American Express	James Cullen
SCMB	Gary Garrett
Citicorp	Daniel Grossman
PIC Solutions	Mike Hill
ITC	Anelda Knoesen Product Manager
CMS Group	Piers Marsden
Accenture	Rob Latham

3.3 Data collection

The nominated participants were contacted via electronic mail and, on occasion, introductory interviews. The brief invited them to participate in a three-round Delphi study. It also included an explanation of the study and provided an estimate of the duration of the Delphi process and, therefore, the anticipated time commitment for participation. The experts were requested to indicate their willingness to participate in the study. Those who consented then became participants in the first round of the study.

3.4 Data analysis

3.4.1 Delphi Round 1: Identification of appraisal techniques

The first round was expected to produce a number of issues pertaining to the evaluation methods used in credit-scoring investments. After Round 1, the responses from the survey were analysed and distilled into logical methods, which were then used during the feedback and ranking phase in Round 2. The typical format of the summaries comprised the method, the advantages, the disadvantages and the specificity of the technique to credit-scoring systems.

Table 3.4. 1: Delphi Round One

METHOD	Discounted Cash Flows (DCF)
ADVANTAGES	Accounting metrics quantifying tangible benefits
DISADVANTAGES	Ignores intangible benefits and ontology.
SPECIFICITY	Generic method used with all IT investment decisions

3.4.2 Delphi Round 2: Feedback and ranking

At the end of the second round each of the participants indicated their final ratings on each of the methods. This was done on a 100-point numeric scale. The data was examined using descriptive statistics and correlation and correspondence analysis.
The rating scale produces ratio data. The mean scores were calculated for each of the methods as scored in the second round. The magnitude of the means for each of the factors was representative of the relative extent to which the methods were regarded. Therefore, the methods were ranked based on the above procedure. The literature was added to derive the model in round three

3.4.3 Delphi Round 3: Validation of the model

The model was sent to the experts for validation and feedback. The remaining panellists were interviewed for their feedback and this round ensured content validity and hence made sure that the research propositions had been fully covered.

3.5 Validity and Reliability

High levels of validity and reliability are important in research. Validity refers to the accuracy of the study and reliability can be defined as, "the consistency with which a measuring instrument yields a certain result when the entity being measured hasn't changed" (Leedy & Ormrod, 2001:31).

3.5.1 External validity

External validity is defined as the correspondence between judgments and true value (Churchill, 1995); in Delphi terms, this is often referred to as ‘accuracy’ (Ono & Wedemeyer, 1994). In order to ensure that research can be generalised across persons, one would ideally have a random and representative sample. In the proposed research, although tests were not done to verify randomness and representivity, the need for diversity and full cover was expressed to the individuals from whom the nominations were solicited. Utilising various sources to get nominations also promoted the required cover, in terms of possible participants.

3.5.2 Internal validity

For the proposed research, the content validity was essential; that is, ensuring that the topic was fully covered. To achieve this, the research questions were fully discussed with the research supervisor. This was even extended to the extent that a pilot group of prospective participants was requested to give their opinion on their understanding of what was being asked.

The construct validity was attempted through the questions in which the respondents were requested to elaborate on and justify their choices. The summaries at each stage were therefore generated with the above aspects in mind. Also, the newly modelled methods were communicated back to the participants and they were in a position to confirm the retention of the author’s descriptive model.

3.5.3 Reliability

Reliability refers to the consistency or reproducibility of a result, i.e. the measurements are not influenced by random error (Woudenberg, 1991; Bravo and Potvin, 1991). In order to enhance the reliability of the study, the panellists were asked the same questions every time and some definitions and explicit explanations were considered for this research when communicating with the respondents.

CHAPTER 4. DELPHI ANALYSIS – ROUND ONE

4.1 Introduction

Chapter 4 presents the results and the interpretation of the Delphi study in round one. The construction of the Delphi model is described, followed by a presentation of the evaluation methods rating sheet. This chapter describes how the model was constructed (using three levels) based on the research questions asked and the relative feedback given. It concludes with an electronic evaluation methods rating sheet which includes all thirty one Delphi measures. In Round 1 of the Delphi survey the respondents were asked to answer an open-ended question and three sub-questions.

The research questions are:

1) What methods do you use to evaluate your credit-scoring systems?

a) What are the advantages of these methods?

b) What are the disadvantages of these methods?

c) To what extent are these measurements application specific (i.e. specialised techniques used solely for credit-scoring systems)?

The survey was conducted over a website, where confidentiality was assured and the respondents could remain anonymous if they so desired. The data was then sorted by using conceptual analysis. This is a type of content analysis, where a concept is chosen for examination (here credit-scoring evaluation) and the analysis involves quantifying and tallying its presence. Also known as thematic analysis, the focus is on looking at the occurrence of selected terms, i.e. methods of evaluation, within a text or texts, although the terms may be implicit as well as explicit (Colostate, 2003).

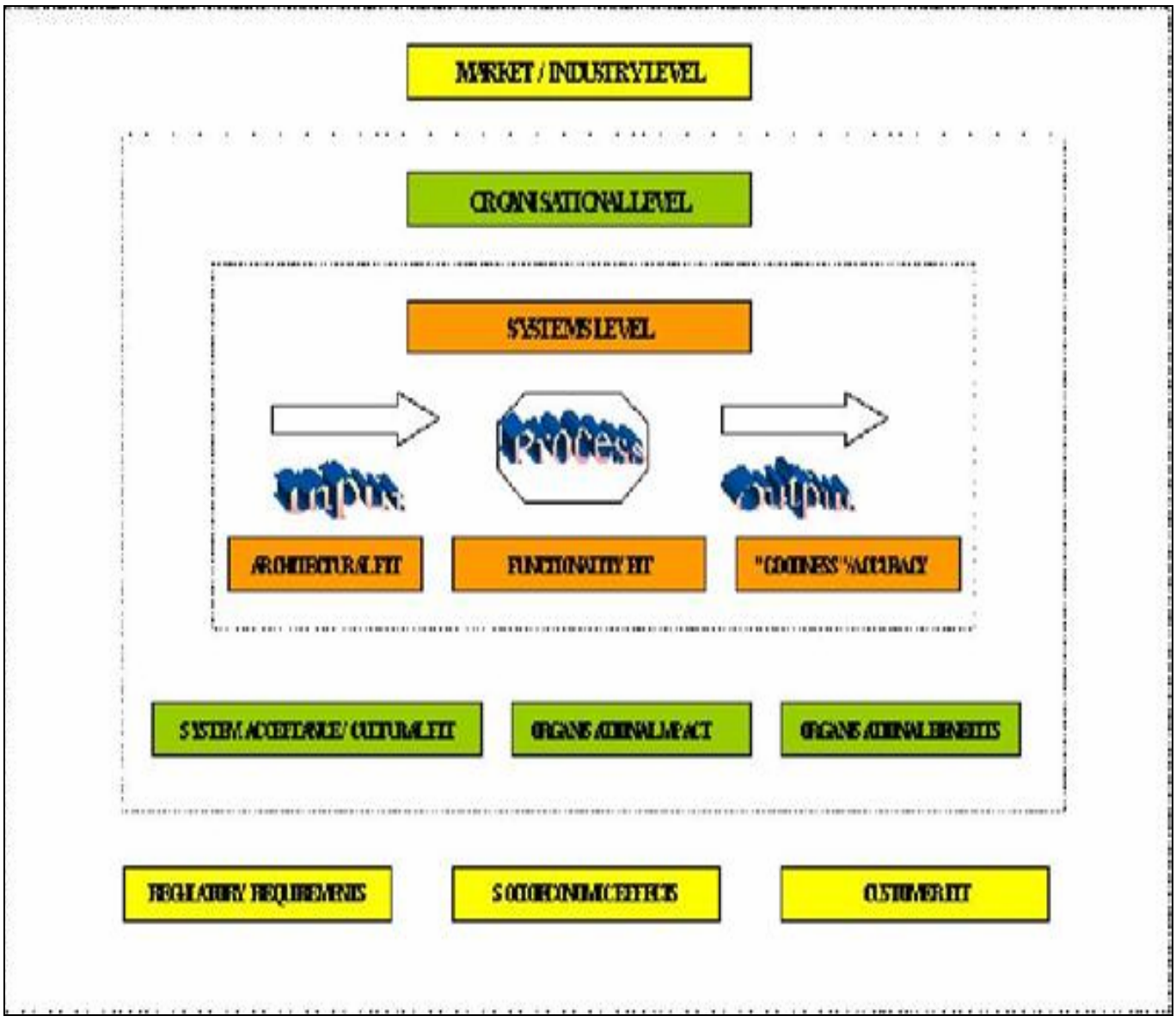
The resulting model is a very broad-based schematic representation of what the panellists thought were the most relevant measures of post-implementation evaluation of credit-scoring systems, on the following three levels; a system level, an organisational level and an industry/market level.

These levels are further sub-divided into general system-effects, with relative measures/methods of evaluation for each, namely:

System Level	Organisational Level	Industry/Market Level
Architectural-fit	System Acceptance/Cultural-fit	Regulatory Requirements
Functionality	Organisational Impact	Socio-Economic Effects
Accuracy/'Goodness' of System Performance	Organisational Benefits	Customer-fit.

A graphic representation of the first round Delphi model is illustrated below:

Figure 4.1. 1: The Delphi Model



Three distinct themes were identified, which formed the three categories of system, organisational and industry/market level measures.

4.2 The System Level that has been identified:

1.1) MIS system integration – the degree to which the new systems integrate with existing databases.

Effective use of the scorecards means, amongst others, effective MIS for managing the business and for optimising strategies. Post-evaluation reviews are aimed primarily at ensuring that it integrates well into the rest of the credit administration process, decision support and MIS process. The primary regulatory drive is Basel II.

1.2) Extent to which system provides desired functionality in assessment of credit risk, for example through the use of:

1.2.1) Financial ratio analysis, e.g.

A] Numerical ratings to assess the risk of default

Credit scoring is driven by an application using a minimum of five years worth of historical financial data. This is inputted into the model, which generates a numerical rating which is indicative of credit quality. All the financial information is used to derive key ratios, which are then measured against S&P (Standard & Poors), default data and statistics, as well as historical information on default data obtained by the risk analytics unit.

B] Debt-to-income ratio

Expert systems use specific proxies and programmers code queries around them. A commonly used proxy in banking is the debt-to-income ratio, i.e. debt repayment divided by income relative to total income.

1.2.2) Cost-of-living index

This is the criterion used to assess living expenditure and therefore affordability. The cost-of-living index assesses affordability by measuring living expenditure including mobiles, transport, food and dependents among others. Scoring effectively is about

being able to read the affordability of individuals. All variables chosen are proxy points to assist in determining affordability.

1.2.3) Customer profile analysis

A scoring engine is used, driven by specific business rules relating to credit limits, e.g. combinations of credit bureau score and other factors, like income, to set the appropriate limits. The way the credit-scoring system is evaluated, is on the results. A variety of accounts with different profiles are booked, representative samples built up in the various rule categories and account performance is monitored over time. Once the sample has been incubated and results analysed, it will be rolled out to a larger population.

1.2.4) Interest rate proxies

A commonly used proxy in banking is interest rates, where expert systems use specific proxies and programmers code a query around it. The main approach within the scoring world is to set one's objectives based on the findings and the justification of new implemented scorecards and then to track and monitor, to ensure that the initial objectives are attained. The tracking really just assists in ensuring that problems that could result in one not obtaining the correct proxies are picked up sooner, rather than later.

1.3) Extent to which system provides desired functionality in product management for example:

1.3.1) Product pricing

From this respondent's perspective, a scoring (rating) system is but the first step towards product pricing, so a lot of the post-implementation review actually focuses on the next steps. Assess products in terms of typical product attributes, but particularly 1) fit in terms of desired usage; 2) compatibility with local conditions, e.g. in terms of data requirements and architecture and 3) integrity of mapping to underlying methodology.

1.3.2) Portfolio risk management

Evaluate methodologies in terms of what one wants to achieve, e.g. active portfolio risk management or local characteristics. The methodologies would be the usual suspects

i.e. contingent, migration and actuarial. Effective use of the scorecard means, amongst others, effective use for portfolio management, e.g. bad debt provisioning, capital allocation and regulatory reporting.

1.3.3) Gini-coefficient

When a scorecard is first developed, the focus is primarily on the Gini Coefficient, or a measure of predictive power, to rate whether or not the development is acceptable. The formula for the Gini Coefficient is g=1.0-(σ((B(I)-B(I-1))*(G(I)+G(I-1))), where a result of 0% indicates the model is not at all predictive and 100% indicates perfect prescience.

1.3.4) Performance monitoring in terms of:

A] Odds scoring

Risk is measured by dividing the number of good accounts at each score, by the number of bad accounts. This measurement of odds is then benchmarked against the performance of 12 months ago. Here the Gini Coefficient is the percentage of the overlapping area of the two variables being measured, i.e. good versus bad.

B] Contribution / profit drivers by score

After a scorecard has been in for a while, the organisation can look at their profit drivers by score. This gives them a better idea of the financial benefit and the ability of the scorecard to reduce loss and maximise profit. Net interest earned, customer contribution, provision requirements and actual loss are examples of the types of variables that can be tracked by score.

1.3.5) Statistical analysis including:

A] Kolmogorov-Smirnov (KS) Test

This is an estimate of the maximum distance between the cumulative distribution functions of the scores of class A (Bad) and class B (Good). This measure is equivalent to choosing a classification threshold, which minimises a particular weighted combination of the proportion of class A misclassified and the proportion of class B misclassified, using a classification threshold that is a function of the data.

B] Kullback-Leibler distance

The information value is a symmetric Kullback-Leibler distance, and as it integrates over all possible values of the score. This means that it ignores the classification threshold and it uses irrelevant information about the absolute values of the scores.

C] Student's t-test

The mean difference score is the test statistic used in Student's t-test: the standardised difference between the means of the class A and class B score distributions. This ignores the classification threshold and the class priors, and also uses information about the absolute values of the scores.

1.3.5) Logistic regression

The methods used by this respondent are based around the mathematics of the scorecard building technique 'Logistic Regression', which is widely recognised by statisticians as the most appropriate scorecard construction technique for a binary outcome (default/non-default). This methodology answers the following questions:

- Are scorecard populations the most appropriate ones?
- Are the correlations in the data being adequately catered for?
- Are the attribute splits correct?
- Has the meaning of the underlying data changed?

4.3 The Organisational Level that has been identified:

2.1) Process adherence, including:

A] Override rates

These tell the analyst the extent to which people in the field are overriding the scorecard. In most systems, the person motivating the override will have to provide a reason, even if it is just a code. Tracking of override rates will provide an indication of whether or not the front-line staff trust the score results and strategies, and will also allow tracking to see whether the overrides are performing better or worse than other

applications. Model accuracy is also evaluated via monitoring the number of manual overrides that are made, to scores produced by the various models. The risk modelling techniques will provide a scientific basis for decision-making and enable useful predictive decisions to be made. A committee process, where senior, experienced management and industry experts are represented, will provide an override in certain cases where this is appropriate.

B] User satisfaction

Override rates are used to indicate the level of user satisfaction present in the organisation. It could have a triple negative impact on the bottom line, i.e. cost of overriding, cost of manual decision and the cost of getting it wrong. This ties into the cultural and political buy in, which sets the context for the organisation and affects the level of system output efficiency. Human intervention/overrides are important for management business decisions and not just credit decisions.

2.2) Referral rates

This is the extent to which policy and/or score are causing some form of human intervention in a decision. In many instances, policy rules will dominate for a long time before the business becomes comfortable with the scores, and many applications will be referred because of something in the application form.

2.3) The system impact on credit lending strategy, namely acceptance by score

Acceptance rate by score tracks the adherence to the cut-off policy/strategy. This tracking should be followed up by override analysis, which will assist in identifying the reasons for going against the scorecard's decisions. Effective use of the scorecard means effective strategy design for initial acceptance, credit limit increases, authorisations and collections. The business case analysis shows service level mandates breaking even in *x*-months, based on credit lending strategy, namely acceptance by score.

2.4) Process efficiency, including:

A] Improved turnaround times

Evaluation encompasses systems, processes and people. Systems take account of increased turnaround times for application approval. Effective use of scorecards means effective experimental design improving turnaround times and assessed by auditors against established practice. Quantitative and qualitative benefits are reviewed pro forma and turnaround times are included.

B] Decreased labour costs

Clerks amounted to R2.5 million in wasted cost, according to one of the respondents. Credit managers are appraised on process efficiency, override targets and bad loan savings.

2.5) Increase in interest bearing income

Percentage uptake of surplus limits, once the bank has pre-approved client's credit risk and increased personal credit limit ceiling. This amounts to the increase in interest bearing income.

2.6) Reduction in bad debt

Evaluation encompasses systems processes and people. Processes take account of reduction in bad debt. No risk of bias, as credit approval is now automated and therefore objective, as well as maintaining process efficiency.

4.4 The Industry/Market Level that has been identified:

3.1) Basel II

There are a variety of opinions on the costs involved to become Basel II compliant, but most are quite high. Collectively, it is higher than R1billion.

The major forms of 'destabilisation' this respondent can see it causing are:
(a) Change: many amendments to data and processes will occur, no doubt resulting in some disruption;
(b) Increased income volatility: banks will have to incur some upfront costs, which will doubtless have an earnings impact. Added to this is the income volatility that will result from the approaches to provisioning as per AC133;

(c) Potential increases in financial sector instability, as dynamic risk measures cause foreign banks to withdraw funds if short-term issues locally impact on their capital requirements. This is a global developing countries' issue;
(d) Increased levels of disclosure may impact on changes to banks' share prices, which are input into many banks' default probability models, thereby potentially impacting on their ratings and cost of funds; and
(e) Volatility in banks' regulatory capital requirements, as a result of frequent changes in their reported risk as per Basel II.

A] Loss Given Default (LGD)

This measures the proportion of the exposure that will be lost if a default occurs.

B] Probability of Default (PD)

This measures the likelihood that the borrower will default over a given time horizon.

C] Exposure at Default (EAD)

This is for loan commitments. It measures the amount of the facility that is likely to be drawn if a default occurs.

3.2) AC133

This is a standard on accounting for financial instruments. The primary regulatory drive is Basel II, the requirements for which are not currently cast in stone. The accounting requirements relate primarily to AC133.

3.3) The extent of socio-economic effects

Banks are considered Deposit Taking Institutions and therefore scoring models must be designed to protect depositors, according to the Banking Supervision Department, so as not to put them at risk, while the socio-economic effects of these scoring models must be considered, such as uncleared effects, unemployment, displacement and job insecurity.

3.4) Applicant profile comparison

Reports benchmark the current acceptance rate to a historic benchmark. Over time, the two profiles will gradually diverge and the risk-to-score relationship will deteriorate and a new model will be developed.

3.5) Customer retention rates

Evaluation encompasses systems, processes and people. People take account of customer retention ratios and customer satisfaction. Customer contribution is a profit driver by score and amounts to certain financial benefits.

The rating sheet bellow was sent to respondents in electronic format where they were asked to allocate a rating of 100 across all the measures. After conducting the content analysis, these measures were assimilated and rated on the scale depending on the relative importance of each measure.

The Delphi measures are depicted below:

Figure 4.1. 2: Evaluation Methods Rating

EVALUATION METHODS RATING

1. SYSTEM MEASURES	**INSTRUCTIONS**	
	Please allocate a **TOTAL** of 100 points across the methods, giving the most points to the most important methods, with the option of giving zero points to some methods (enter value in relevant box no.)	
1.1 Architectural Fit		
1] MIS systems integration The degree to which the new systems integrate with existing databases	1	1.1.1]
1.2 Functionality		
1] *Extent to which system provides desired functionality in assessment of credit risk for example through the use of:*		
1. Financial ratio analysis e.g.		
A) Numerical ratings to assesses the risk of default	1	1.2.1]-1A
B) Debt-to-income ratio	1	1.2.1]-1B
2. Cost of living index (i.e. assess affordability by measuring living expenditure incl. mobiles, transport, food, dependents)	1	1.2.1]-2
3. Customer profile analysis	1	1.2.1]-3
4. Interest rate proxies	1	1.2.1]-4

2] *Extent to which system provides desired functionality in product management for example:*		
1. Product pricing	1	1.2.2]-1
2. Portfolio risk mgmt	1	1.2.2]-2
3] *Extent to which system has data requirements compatible with existing data*	1	1.2.3]

SYSTEM MEASURES CONTINUED

1.3 Accuracy/'Goodness' of System Performance

1] Gini Coefficient	1	1.3.1]
2] Performance Monitoring		
A) 'Odds' scoring - % good to % bad	1	1.3.2]-A
B) Contribution/Profit drivers by score	1	1.3.2]-B
3] Statistical Analysis		
A) Kolmogorov-Smirnov (KS) Test	1	1.3.3]-A
B) Kullback-Leibler distance	1	1.3.3]-B
C) Student's t-test	1	1.3.3]-C
4] Logistic regression (i.e. a statistical technique for a binary outcome (default/nondefault) using the marginal Chi-squared report)	1	1.3.4]

2. ORGANISATIONAL MEASURES

2.1 System Acceptance/Cultural Fit

1] Process Adherence		
A) 'Override' rates	1	2.2.1]-1A
2] User Satisfaction	1	2.2.1]-2

2.2 Organisational Impact

1] Referral Rates (due to policy rules not yet modelled into the system)	1	2.2.2]-1
2] The systems impact on credit lending strategy, namely Acceptance by score (accept, reject, refer)	1	2.2.2]-2

2.3 Organisational Benefits

1] Process Efficiency		
A) Improved turnaround times	1	2.3.1]-A
B) Decreased labour costs	1	2.3.1]-B
2] Increase in interest bearing income	1	2.3.2]

3] Reduction in bad debt	1	2.3.3]

3. INDUSTRY MEASURES

3.1 Regulatory Requirements

1] Basel II		
A) Loss Given Default (LGD)	1	3.1.1]-A
B) Probability of Default (PD)	1	3.1.1]-B
C) Exposure at Default (EAD)	1	3.1.1]-C
2] AC133 Standard on accounting for financial instruments	1	3.1.2]

3.2 Socio-Economic Effects of the System

1] The extent of socio-economic effects of credit decisions on different class groups in the SA population	1	3.2.1]

3.3 Customer Fit

1] Applicant Profile Comparison (benchmark current to historic acceptance rates)	1	3.3.1]
2] Customer retention rates	1	3.3.2]
	31	**TOTAL**

The premise for including the three levels, i.e. industry, organisational and system level and the panellists' most statistically relevant measures was based on the current literature researched by the author and the feedback obtained from the panel, in terms of advantages and disadvantages of the these suggested measures. This will be discussed in the following chapters.

CHAPTER 5. DELPHI ANALYSIS – ROUND TWO

5.1 Introduction

Chapter 5 presents the results of the second round of the Delphi study. This includes the correspondence analysis as well as the correlation analysis and development of the inductive matrix model. In Round Two of the Delphi Analysis the researcher explains what statistical analyses were used to construct the matrix model included in the research report. In this chapter the panel was asked to rate each measure in degrees of relative importance on a scale of 1-100. The data was run subject to statistical analysis, i.e. correlation and correspondence analysis, and descriptive statistics, and the final model was validated in Round 3 once the measures researched in the literature were added.

5.2 Construction of the Holistic Model

The approach for constructing the holistic model was by means of a quantitative analysis encompassing the *statistically relevant* measures suggested by the panel. Those measures left out were either too varied to categorise by means of factor analysis, or else not enough significant dependency was established. As a rule of thumb, any value of the correlation coefficient, i.e. the square root of the trace taken from the eigenvalue report, in excess of 0,2 indicates significant dependency (Bendixen, 1996).

A correspondence analysis of the experts' ratings was conducted using a software package (Appendix D) and the following results were analysed.

Factor 1

Table 5.1. 1: Principal Coordinate Section for Rows - Axis 1

Name	Mass	Inertia	Distance	Factor	COR	CTR	Angle	Eigenvalue
7 Port risk	*0,044*	*0,060*	*1,727*	*-1,275*	***0,941***	*0,138*	*14,0*	*0,071553*
8 Prod pric	*0,073*	*0,032*	*0,552*	*-0,674*	***0,823***	*0,064*	*24,9*	*0,033161*
26 PD	*0,095*	*0,249*	*3,320*	*-1,802*	***0,978***	*0,595*	*8,6*	*0,308415*

The measures with the highest inertia and strongest factor and correlation were 7, 8, and 26, namely: product-pricing, portfolio risk management and probability of default (PD).

As can be seen on the correspondence plot, these measures were weighted by only two panellists, Walter and Gary, and hence must be accepted/rejected on the basis of this minimal weighting of the panellists. This will be established with the validation of the model in Round 3.

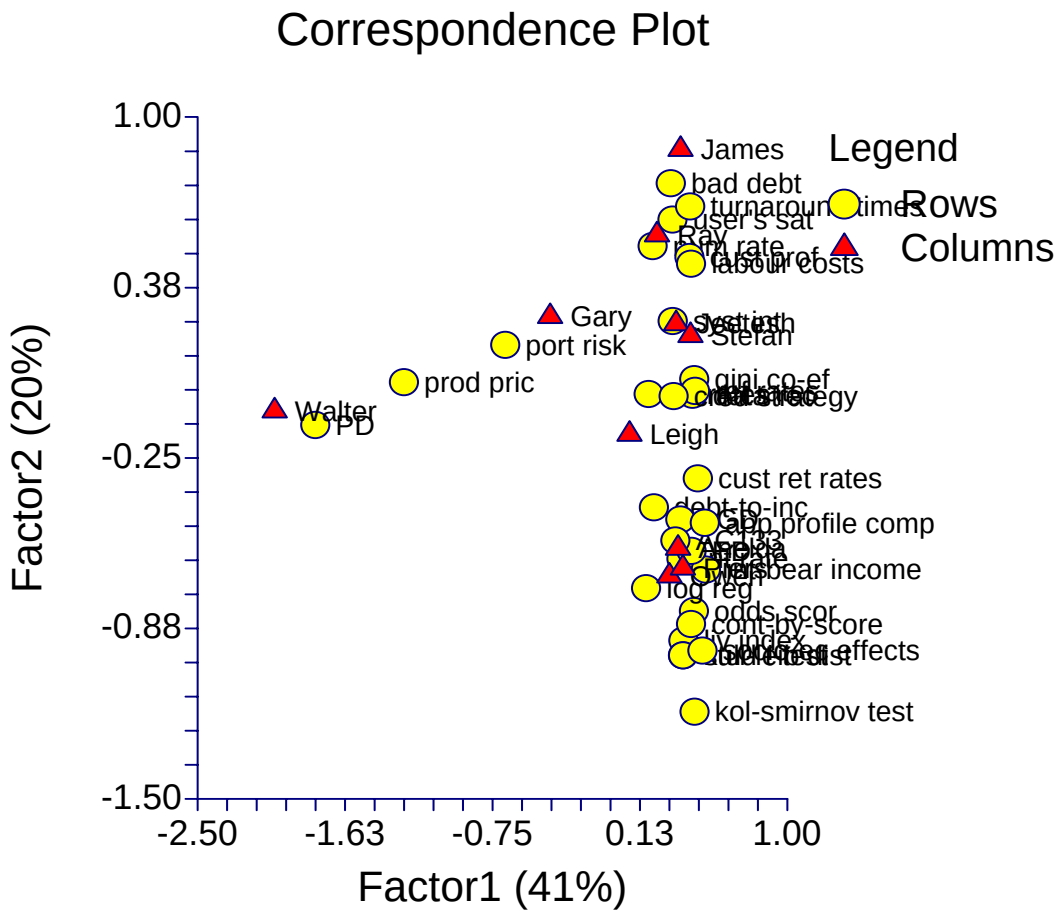


Figure 5.1. 1: Correspondence Plot (Axis 1 & 2)

Dimensionality of the Solution

As can be seen in the correspondence plot, the first and second axis account for 41% and 20% of the inertia respectively, i.e. a cumulative total of 61%. This is referred to as the retention of the solution. Noticeably, the higher the retention, the more subtlety in the

original data is retained in the low-dimensional solution. Due to the anomaly found in Factor 1 of only two prime respondents, a 2-factor solution has been chosen, where axis 2 and axis 3 are used, due to the benefit of practicality.

Factor 2

The statistically relevant measures found along axis 2 are divided into a group with positive weightings and a group with negative weightings, as follows:

Table 5.1. 2: Principal Coordinate Section for Rows - Axis 2

Name	Mass	Inertia	Distance	Factor	COR	CTR	Angle	Eigenvalue
2 num rate	*0,074*	*0,038*	*0,651*	*0,526*	***0,426***	*0,081*	*49,3*	*0,020507*
4 liv index	*0,0180*	*,021*	*1,469*	*-0,920*	***0,576***	*0,060*	*40,6*	*0,015223*
11 odds sc	*0,031*	*0,036*	*1,466*	*-0,812*	***0,449***	*0,081*	*47,9*	*0,020419*
12 contribution / profit drivers by score	*0,025*	*0,032*	*1,608*	*-0,859*	***0,459***	*0,073*	*47,4*	*0,018450*
13 kol-test	*0,018*	*0,043*	*3,012*	*-1,180*	***0,463***	*0,099*	*47,1*	*0,025084*
18 user sat	*0,040*	*0,025*	*0,800*	*0,624*	***0,486***	*0,061*	*45,8*	*0,015559*
21 improved turnaround times	*0,048*	*0,031*	*0,814*	*0,672*	***0,554***	*0,085*	*41,9*	*0,021648*
24 reduction in bad debt	*0,058*	*0,043*	*0,938*	*0,757*	***0,610***	*0,131*	*38,6*	*0,033209*

<u>Positive axis: measures and relative rows</u>

a) numerical ratings – 2
b) user satisfaction – 18
c) improved turnaround times – 21
d) reduction in bad debt - 24

Except for Row 2 (numerical ratings), these measures can be clustered under the heading ‘Organisational Measures’, including cultural fit and process efficiency.

<u>Negative axis: measures and relative rows</u>

a) cost of living index - 4
b) odds scoring – 11
c) contribution/profit drivers by score – 12
d) Kolmogorov-Smirnov test - 13

Here, a ‘System Measures’ cluster could be formed with the measures identified above.

Factor 3

In the correspondence plot between Factor 2 and Factor 3, the following measures along the Factor 3 axis are clustered into a positive and negative group, both of which comprise Industry Measures. This is broken down as follows:

Positive axis: measures and relative rows

a) loss given default (LGD) – 25
b) AC133 – 28

Negative axis: measures and relative rows

a) increase in interest bearing income – 23
b) socio-economic effects – 29
c) applicant profile comparison – 30
d) customer retention ratios – 31

Except for Row 23 (increase in interest bearing income), the rest of these measures are all ‘Industry Measures’ falling under Customer Fit, Regulatory Requirements and Socio-Economic Impact.

These measures are illustrated in the Correspondence Plot below:

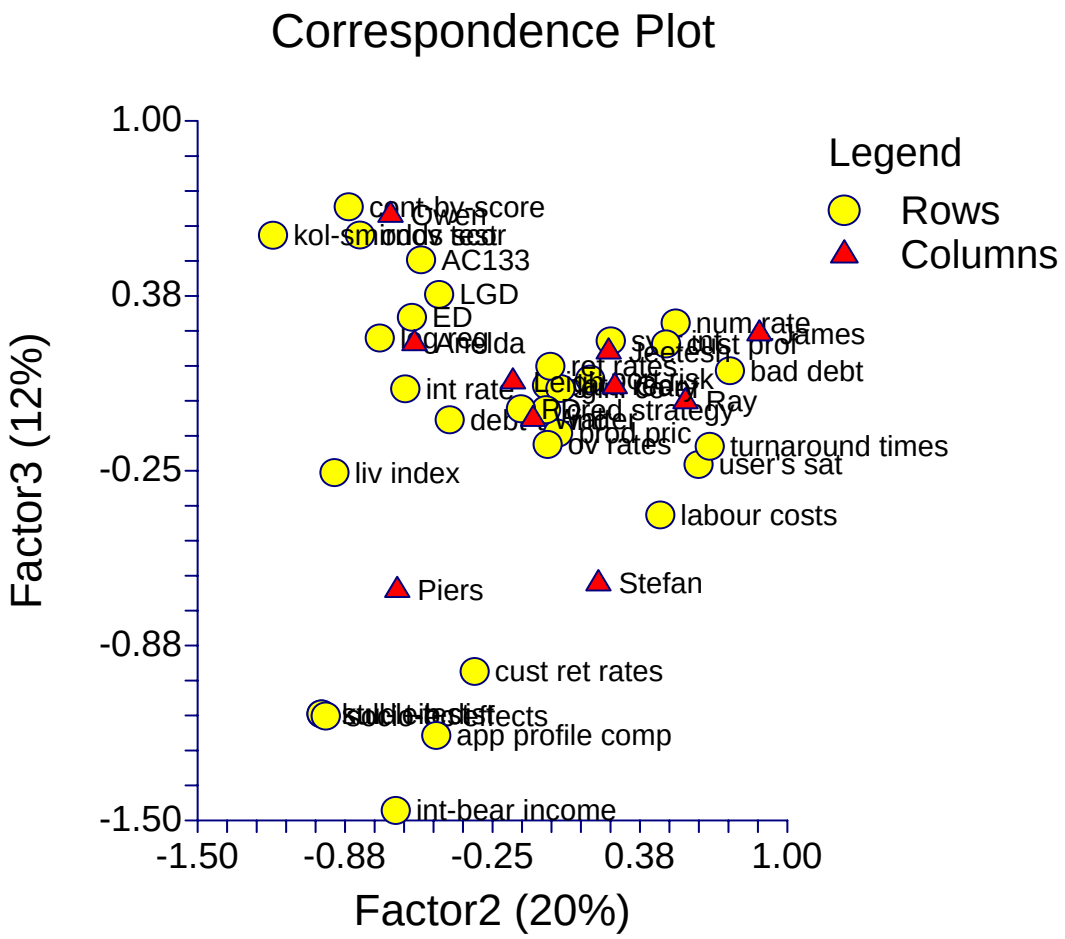


Figure 5.1. 2: Correspondence Plot (Axis 2 & 3)

The Factor Matrix

Since Factor 1 was weighted most heavily by only two panellists, the Factor matrix will only include those clusters found on the Factor 2 and Factor 3 axes. This is illustrated as follows:

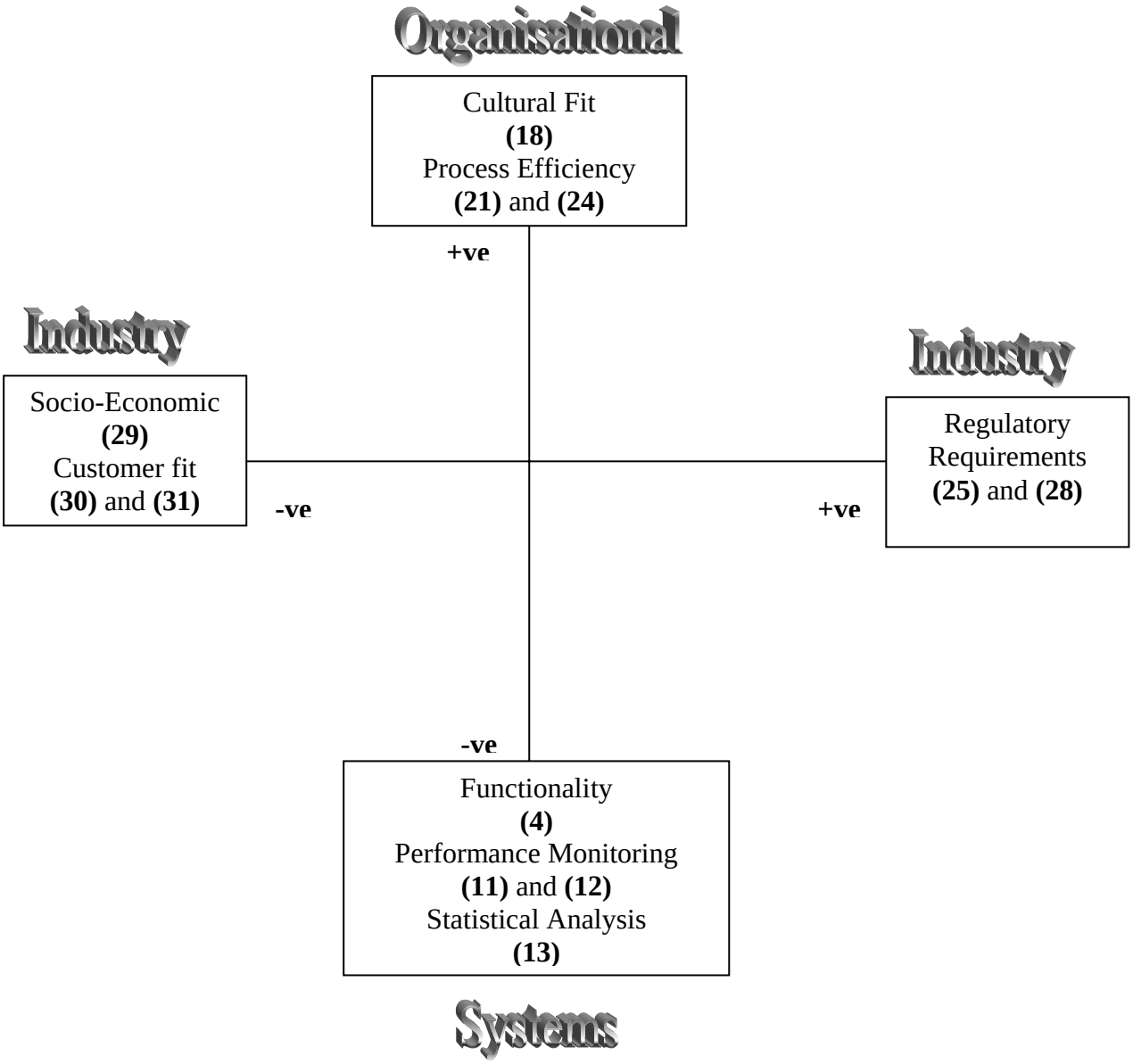


Figure 5.1. 3: The Factor Matrix

Key: (18) – User Satisfaction

(21) – Improved turnaround times

(24) – Reduction in bad debt

(25) –Loss Given Default

(28) – AC133

(29) – Socio-economic effects

(30) –Applicant profile comparison

(31) –Customer retention rates

(4) – Cost of living index

(11) –Odds scoring

(12) –Contribution/profit drivers by score

(13) –Kolmogorov-Smirnov test

Correlation Analysis

The assumption that retail scoring and corporate scoring cannot be studied in unison, was tested against a correlation between the five retail panellists and the four corporate panellists, of which the fifth panellist belongs to the ITC. The following relationships can be identified:

At a 95% confidence level (blue markings), a strong positive correlation exists between the following panellists: Owen (retail) – Anelda (corporate)

Ray (retail) – Gary (corporate)

James (retail) – Leigh (corporate)

James (retail) – Gary (corporate)

As expected, a strong positive correlation exists, at a 99% confidence level, between 4 out of 5 retail panellists and between 3 out of 4 corporate panellists.

	Retail	*Retail*	*Corporate*	*Corporate*	*Retail*	*Retail*	*Corporate*	*Retail*	*Corporate*	*Corporate*
	Owen	*Ray*	*Leigh*	*Gary*	*James*	*Jeetesh*	*Anelda*	*Stefan*	*Piers*	*Walter*
Owen	1.000									
Ray	.068	1.000								
Leigh	.207	.354	1.000							
Gary	.114	.407	.714	1.000						
James	-.071	.553	.445	.398	1.000					
Jeetesh	.122	.469	.175	.273	.496	1.000				
Anelda	.435	.160	-.089	-.057	-.032	.005	1.000			
Stefan	-.248	.623	-.174	.097	.269	.522	-.002	1.000		
Piers	.057	-.201	-.016	.038	-.133	-.080	-.121	.002	1.000	
Walter	.033	-.015	.314	.579	-.085	-.036	-.069	-.165	-.114	1.000

31 sample size

± .355 critical value .05 (two-tail)
± .456 critical value .01 (two-tail)

Figure 5.1. 4: Correlation Matrix of the 10 Delphi Experts

Therefore, the conclusion could be made that, despite popular belief, there is a significant overlap between post-implementation evaluation methods and hence corporate and retail credit-scoring systems. This is substantiated by a correspondence analysis, as seen below, which shows that no clusters/relationships result between the panellists, but rather a large degree of overlap is evident.

Table 5.1. 3: Cluster Analysis Distance Section

Row	Cluster	Dist1	Dist2
1 (retail)	2	7,1820	4,3631
2 (retail)	1	3,9661	7,1933
3 (corporate)	2	5,4813	3,5648
4 (corporate)	1	4,4483	6,7538
5 (retail)	1	4,9916	7,6604
6 (retail)	1	4,1882	5,7990
7 (ITC)	2	6,2130	4,2094
8 (retail)	1	4,9006	6,6432
9 (corporate)	2	7,8640	4,8581
10 (corporate)	1	6,2082	8,3811

5.3 Supplementing the Delphi measures with those researched in the literature

A process of elimination was followed, based on which Delphi measures had the highest averages, supplementing the Delphi measures with those researched in the literature. The descriptive stats reports (Appendix E) for the Factor 1, 2, and 3 measures show the highest averages, i.e. > 5, to be:

a) Row 26 – Probability of default (PD)
b) Row 18 – User satisfaction
c) Row 21 – Turnaround times
d) Row 24 – Decrease in bad debt
e) Row 7 – Product pricing
f) Row 8 – Portfolio risk management
g) Row 11 – Odds scoring
h) Row 12 – Profit drivers by score

On this basis the most relevant measures from the literature were added to each of the above. This was done based on the researcher's reasoning as to which measures had the closest match and most concurred with the Delphi measures, namely:

Delphi Measures	***Literature Measures***
i) Row 26 – Probability of default (PD)	MBV-Magrassi
j) Row 18 – User satisfaction	Expert Turnover-CM
k) Row 21 – Turnaround times	HRCA-Sv, Fairchild
l) Row 24 – Decrease in bad debt	Tobin's Q-Magrassi, Sv
m) Row 7 – Product pricing	Revenues from New Prods-CM
n) Row 8 – Portfolio risk management	Market & Account Share-K&N
o) Row 11 – Odds scoring	Revenue Growth-CM
p) Row 12 – Profit drivers by score	Intangible Asset Monitor-Sv, Fairchild

The measures from the literature are those which most closely concur with the relevant, statistically based Delphi measures. The sources are abbreviated and in order of appearance read as: Magrassi (2002), Celemi Monitor (CM-1999), Sveiby (Sv-2001), Fairchild (2002), Kaplan and Norton (K&N-1996). An explanation of these measures is given:

Literature Measures	***Descriptions***
• MBV (Market-to-Book Value)	The poorer the credit score, the higher the probability of default and the less the market cap. MBV compares the market value of the firm's operations to its cost. A value of 1 means a firm is losing value.
• Expert Turnover -	Number of experts leaving, divided by the number of experts at the beginning of the year.
• HRCA (Human Resource Costing & Accounting)	Calculates the hidden impact of HR related costs, which reduce a

	firm’s profits. Intellectual capital is measured by calculation of the contribution of human assets held by the company, divided by capitalised salary expenditures.
• Tobin’s Q	The ’Q’ is the ratio of the stock market value of the firm, divided by the replacement cost of its assets. Changes in ’Q’ provide a proxy for measuring effective performance of a firm’s intellectual capital.
• Revenues from New Products	Share of revenues from Products/concepts launched less than 5 years ago.
• Market and Account Share	Market and account share of customer base.
• Revenue Growth	Where there is more Good:Bad in odds scoring index.
• Intangible Asset Monitor	Management selects indicators, based on the strategic objectives of the firm, to measure four aspects of creating value from intangible assets: by 1) growth-response 2) renewal-retention 3) utilisation-revenue and 4) risk reduction-risk.

The other measures scoring high averages were: MIS integration, numerical ratings, debt-to-income ratio, Gini coefficient, override rates, and strategy, namely acceptance by score. These measures were not included in the model since the value of the correlation coefficient, i.e. the square root of the trace taken from the eigenvalue report, was not in excess of 0.2, and therefore lacked significant dependency.

The completed holistic model is therefore broken down as follows:

A] INDUSTRY **(Context)**

6 factor measures + 1 literature measure

B] ORGANISATIONAL **(Content)**

3 factor measures + 3 literature measures

C] SYSTEM **(Process)**

6 factor measures + 4 literature measures

Total measures=23 statistically based credit-scoring measures.

This model will be validated by the experts in Round 3 of the Delphi survey and implications discussed in the conclusion. The Factor Matrix is the choice of model representation, where those measures in the literature, which most closely concur with the Delphi measures, are added. The third round model, which is now a holistic, inductive research model, is therefore illustrated below:

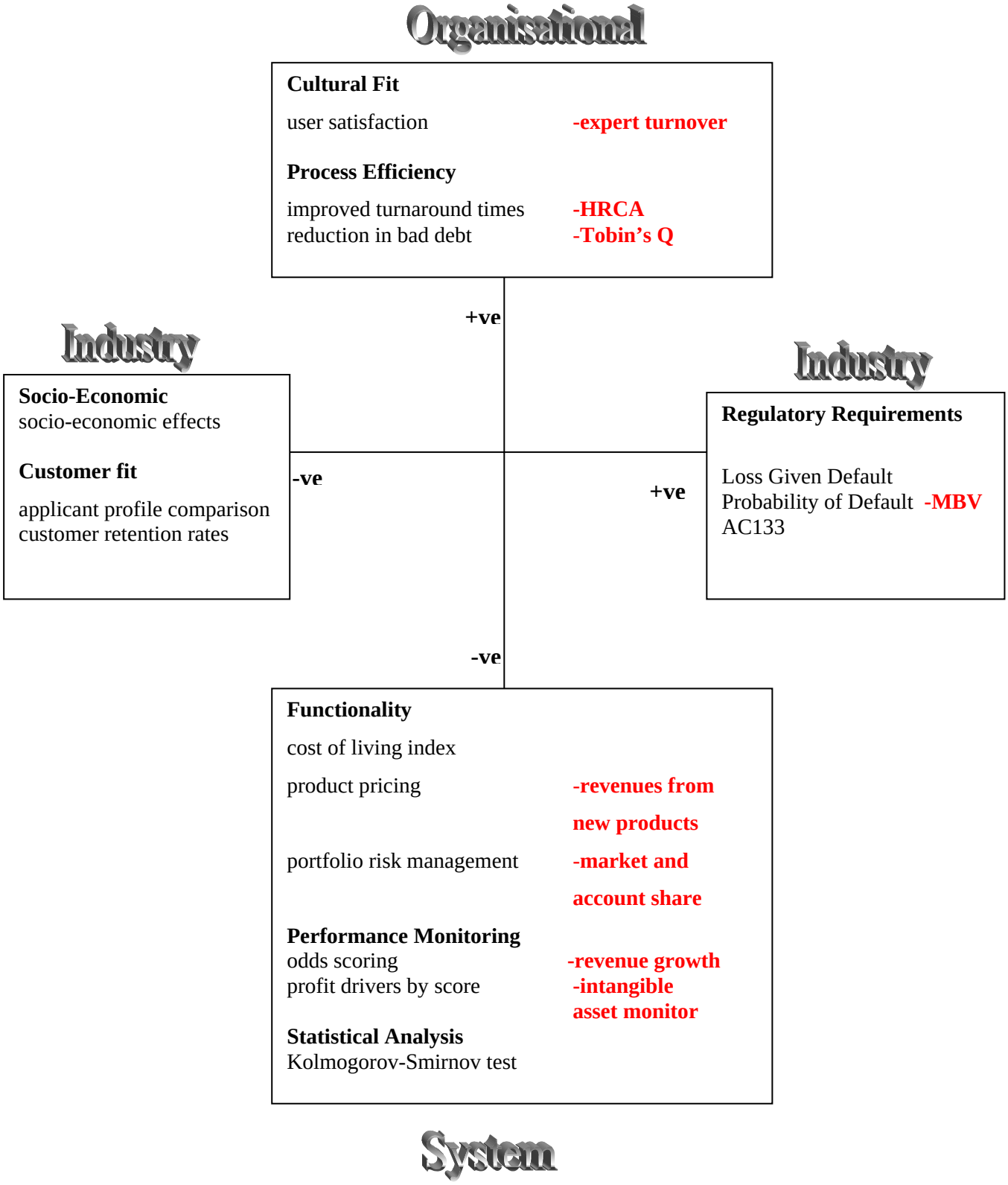


Figure 5.1. 5: The Holistic, Inductive Research Model

CHAPTER 6. DELPHI ANALYSIS – ROUND THREE

6.1 Introduction

Chapter 6 presents the results of the third round of the Delphi study. The literature on the evaluation measures is reviewed followed by a discussion on the Delphi methods and a comment on the model. The quantitative and qualitative dynamics of the model are also discussed. The objective of this chapter is to evaluate and discuss the results of the literature on credit-scoring evaluation measures, as well as the in-depth, semi-structured interviews conducted with the respondents. The meaning of the results is discussed, using comments from the transcribed interviews, to provide additional insight into each factor associated with the model's measures. Please note that the quotes taken directly from the transcript have been quoted verbatim, notwithstanding possible grammatical error.

The data gathering involved the integrated model being presented to seven interviewees, and the questions asked in the interviews were as follows:

1) Which of the literature measures would be useful and why?
2) Comment on the model
3) The literature suggests using qualitative measures – why do you think the model is a quantitative development?

The analysis of the data was done by using content analysis of the transcriptions of the in-depth, semi-structured interviews.

The chapter begins by exploring the Delphi measures substantiated by the literature and those advantages mentioned by the panel. The results connected to those Delphi measures with special mention from the panel are then transcribed. This is followed by the results relating to the measures from the literature, which concur most with the Delphi measures, and are all encompassing. Thereafter, the results linked to the factors, which form a comment on the model as an assessment tool used in practice, are evaluated and discussed. The chapter concludes by identifying the factors that cause the model to be a quantitative development, whereas the literature suggests using more qualitative measures.

6.2 Review of measures raised by Delphi against existing literature

There is sufficient literature to substantiate the importance of the Delphi methods in evaluating credit scoring applications used in business today. These are underlined by the inclusion of the advantages of these methods suggested by the Delphi Panel.

1] SYSTEM MEASURES

1.1 Architectural Fit

1] MIS system integration

Management Information Systems (MIS) are an important control, because they provide feedback about the risk rating system. In addition to static data, risk rating system MIS should generate, or enable the user to calculate, the following information: 1) The volume of credits whose ratings changed more than one grade, i.e. 'double downgrades'; 2) Seasoning of ratings, the length of time credits stay in one grade; 3) The velocity of rating changes - how quickly they are changing; 4) Default and loss history by rating category; 5) The ratio of rating upgrades to rating downgrades and 6) Rating changes by line of business, loan officer and location.

MIS reports should display information by both rand volume and item count, because some reports can be skewed by changes in one large account (The Nation, 2003).

1.2 Functionality

1] Financial ratio analysis

For commercial quality, the key indicator for practitioners is corporate earnings. If this drops to 5% or less, then enough problems will emerge, that lenders will tighten credit. Another is net interest expense and charge-off rates, which are tracked over a five-year period. Others follow ratios of debt-to-income and interest-expense to pre-tax profits (Snyder, 2000).

Proxies most commonly used for determining affordability are fixed parameters, i.e. debt-to-income, and are therefore not thorough, as this is not in keeping with current socio-economic changes (G. Muller, personal communication, 22 June 2003). Also, in applying AC133, Fair Value adjustments may affect either equity or earnings. This

includes credit impairments against advances, or the provisions for bad debts, which always affect bank earnings significantly. Classifications of provisions are also liable to change markedly (Financial Mail, 2003).

2] Cost of living index

Scoring effectively is about being able to calculate the affordability of individuals by tracing their payment profiles over-time. All variables chosen are proxy points to assist in determining affordability. Cell phones, gambling and lotteries are additional competitive spendings that are often overlooked and should be accounted for in the index (Muller & Trupp, 2003). Within the calculation, the authors have regular, or committed, outgoings, together with irregular, or uncommitted, outgoings. A common method for distinguishing between these two types is the debit method, where outgoings are paid by direct debit each month. The high-level equation is therefore: additional monthly repayment=average income, less total regular outgoings, less a portion of irregular outgoings (Muller & Trupp, 2003).

3] Customer profile analysis

New behavioural scoring techniques can show which client portfolios fall into the same risk class, e.g. sole proprietor ratings correlate with personal profile ratings and therefore by categorising these risk groups, specific software packages can be used. This betters the ’one size fits all’ approach, since one is able to look at the strategic intent of the business first, before offering any form of lending. (G. Muller, personal communication, 22 June 2003.)

Banks with leverage have technology developments which allow the various sales, products and support divisions to interact on an ’anytime, anywhere, anyhow’ basis. This gives customer integration of all products and services, while the banks integrate all client details, giving a snapshot view of every product or service used by a customer (Sunday Times, 2003).

4] Interest rate proxies

Interest rates impact on payment profile directly (cost of credit) and indirectly (knock-on effect) – fluctuations in interest rates must therefore be accounted for, as Banks’ profits are directly affected (P. Muthui, personal communication, 12 August 2003).

5] Product pricing

Success in the non-prime market is largely determined by underwriting expertise, and micro-lending practitioners assess each application individually without credit-scoring, allowing them to offer a competitive product at the right price to reflect the level of risk. In contrast, standard lending remains largely single priced, or in the form of a 'one product, one price' model (Retail Banker International, 2001).

Real-time pricing, according to J. Ridderstrale and K. Nordstrom (2002), is not necessarily tied to the Internet. In financial markets, one could design one's own risk level, by using a range of instruments such as *options.* Generally, prices are set in real-time, so one does not know what one is going to pay. To handle the risk, one buys an option of the underlying asset, that *x*-months ahead will allow one to acquire the underlying asset at a fixed price. Sixty days before exercising the option, one of three things may happen: the asset may cost just as much as the fixed price plus the option price (at-the-money), or it may cost more (in-the-money), or less (out-of-the-money).

6] Portfolio risk management

Improvements to the risk assessment process is the first step required; but the next breakthrough is expected to come from a coupling with market activities, cross-selling, and portfolio risk management (M2 Communications Ltd, 2003). Muller and Trupp (2003) state that a focused product suite may be offered, rather than one single product, allowing the customer to choose the product most suited to their needs. This will reduce portfolio risk and require a group marketing initiative, with buy-ins from all parties.

1.3 Accuracy/'Goodness' of System Performance

1] Gini-coefficient

When a scorecard is first developed, the focus is primarily on the Gini-coefficient, a measure of predictive power, to rate whether or not the development is acceptable (A. Knoesen, personal communication, 10 May 2003).

2] Performance monitoring

It is possible that the good:bad odds for certain scorecards are incorrectly calculated, which can result in inaccurate loss provisioning calculations and incorrect accept/reject

decisions being made on transactions (Muller & Trupp, 2003). Snyder (2000) advises that strong underwriting and making quick tactful collections remain the twin pillars of managing commercial credit risk, whether banking or extending credit on goods and services.

3] Statistical analysis

Banks using credit model (or another system that uses a public rating agency, i.e. ITC credit bureau) default or transition information should demonstrate how their ratings are equivalent to agency ratings (Business Credit, 2003).

The advantage of an expert system is undermined, especially if there is actually an absence of relevant expertise. None of the expert systems take into account AC133, as it has not yet been built into them. Some might argue that the human factor in an expert system would pick up the issue of AC133, but this depends on the general awareness of the subject. Neither a rating system nor a credit-scoring system would fare any better. Rating systems generally include factors such as business credit, assets, debt capacity and management. Credit-scoring systems pre-identify a number of key factors that could indicate the probability of a default and use them to create a credit score, equating either to a default probability or classification scheme. What neither does is take into account unpredictability. They only operate on the basis of known factors (Foulkes, 2001).

4] Logistic regression

For credit-scoring systems explicitly tied to statistical probabilities, banks should be able to show that credits with more severe ratings exhibit higher defaults and losses.

The default and loss levels should be explicitly defined in this type of rating system, the system should rank-order risk and should aggregate pools of similarly risky loans, using an objective measurement of risk (The Nation, 2003).

2] ORGANISATIONAL MEASURES

2.1 System Acceptance/Cultural Fit

1] Process adherence

The board and management must instill a ’credit culture’, that demands timely recognition of risk and has little tolerance for rating inaccuracy. Unless the board and senior management meet these responsibilities, their ability to oversee the loan portfolio can be severely hampered (The Nation, 2003).

2] User satisfaction

The best and most important control over credit risk ratings is a well-trained and properly motivated staff. Personnel who rate credits should be proficient in the bank's rating system and in credit analysis techniques. These skills should be part of the bank's performance management system for credit professionals. Credit staff should be evaluated on, among other things, the accuracy and timeliness of their risk ratings (The Nation, 2003).

2.2 Organisational Impact

1] Referral rates

The board and senior management must ensure that a suitable framework exists to identify, measure, monitor and control credit risk. Board-approved policies and procedures should guide the risk rating process. These policies and procedures should establish the responsibilities of various departments and personnel and by doing so, such policy rules can be effectively integrated with the scoring system and hence reduce the number of referral rates occurring in the process. The ultimate test of any rating process is whether it is accurate and effective (The Nation, 2003).

2] Credit lending strategy, namely acceptance by score

Conventional scoring systems that rely on externally developed, generic scoring models, use only a minor part of customer information specific to the Bank’s operations, and do not take advantage of the specialist knowledge held by the Bank's experts regarding the specific risks facing the business (M2 Communications Ltd, 2003).

Today's product set, in many instances, reflects a 'silo' mindset, whereby customers have a separate purchase card, T&E card, fleet card and others. Customers pick and choose, comparing what the product offers against their needs. There will have to be

innovation on the interest rate structures as well, again reflecting the sentiments and the affordability of this segment (Cards International, 1999)

2.3 Organisational Benefits

1] Process efficiency

The principal of customer level 'credit limit management' (Muller & Trupp, 2003) is that the bank knows the customer's total income and outgoings and as such, the appropriate level of credit can be controlled. Managing the customer allows the calculation of credit or lending limits for all banking products, which can reduce overhead costs by automating credit-granting decisions.

Muller and Trupp (2003) go on to explain that, once the bank's 'credit limit' setting policy is driven by customer calculated affordability measures, significant improvements can be made in the reduction of overhead costs, reduction in manual decisions and labour; improved customer service, speed of decisions, processing and product offerings; and the reduction of bad debt, due to consistent risk based policies.

2] Increase in interest bearing income

It is important to manage risk as this has a direct impact on the Holding Cost of Capital, which is a stipulated amount in terms of the Banking regulations and comes directly off the bottom line (ROI) (G. Muller, personal communication, 22 June 2003).

3] Reduction in bad debt

Uncleared effects can also be calculated via a central customer 'credit limit management' programme. The calculation of these limits is a combination of the strategy tree and limit formula, using all customer transactions and products. The stated purpose of calculating these limits is to automate decision-making, effectively control exposure, and increase revenue from the limit decisions made on accounts, all of which reduces accumulated bad debt (Muller & Trupp, 2003).

3] INDUSTRY MEASURES

3.1 Regulatory Requirements

1] Basel II

In January 2001 the Basel Committee on Banking Supervision issued a proposal for a New Basel Capital Accord that, once finalised, will replace the current 1988 Capital Accord. The proposal is based on three mutually reinforcing pillars that allow banks and supervisors to evaluate properly the various risks that banks face. The New Basel Capital Accord focuses on:

- **minimum capital requirements**, which seek to refine the measurement framework set out in the 1988 Accord
- **supervisory review** of an institution's capital adequacy and internal assessment process
- **market discipline** through effective disclosure to encourage safe and sound banking practices

Policy and governance impacts on credit risk and with the enforcement of Basel II in 2006, the banks will need to meet the following criteria where credit-scoring systems can be of fundamental help:

1 Loss Given Default (LGD) - measures the proportion of the exposure that will be lost if a default occurs;
2 Probability of Default (PD) - measures the likelihood that the borrower will default over a given time horizon;
3 Exposure at Default (EAD) - for loan commitments, measures the amount of the facility that is likely to be drawn if a default occurs.

(Bank for International Settlements, 2003)

2] AC133

SA is the first country globally to adopt the provisions of the international accounting standard AC133 / IAS 39 (Europe), which provides for a global standard of accounting for financial instruments (Finance Week, September 2003).

The added benefit of implementing AC133, is that many of the changes being made by the banks specifically have overlaps that they need to make, to be compliant with the requirements of the Basel II Accord on banking regulations. Information required under AC133 can therefore assist management in understanding, identifying, monitoring and effectively managing their risks, as well as in taking long-term, strategic decisions (Business Brief, September 2003).

AC133 requires a number of new steps and disclosures in financial statements. Key among these is marking assets and liabilities to present market value, also known as Fair Value Accounting. It also forces companies to be far more transparent in their derivative hedging positions (Finance Week, September 2003).

Benefits will accrue to those who embrace the standard and invest in systems and skills to generate better information to help them manage their risks and lower their cost of capital.

3.2 Socio-Economic Effects of the System

Banks are considered Deposit Taking Institutions (DTIs) and therefore scoring models must be designed to protect the depositor, according to the Banking Supervision Department, so as not to put them at risk, while socio-economic effects of these scoring models must be considered, e.g. uncleared effects (G. Muller, personal communication, 22 June 2003).

3.3 Customer Fit

1] Applicant profile comparison

Systems that quantify risk ratings in terms of default probabilities or expected loss should be back-tested. Back-tests should show that the definitions' default probabilities and expected loss rates are largely confirmed by experience/historical data (The Nation, 2003).

2] Customer retention rates

Most credit-scoring systems to date are not customer specific, as most often practitioners' base IT investment decisions on the success of previous projects and use the same vendors, which may not necessarily make good business sense; or Credit Exco will make a subjective decision based on how best the system can upsell the books or decrease the credit risk at the best price. This will be reflected in poor customer retention rates, directly affecting the bottom line (G. Muller, personal communication, 22 June 2003).

6.3 The Delphi measures

Socio-economic effects

The measure most commented on by the panellists was socio-economic effects. This was seen to be a judgmental measure, with a variety of ways to measure it. Some respondents saw it in terms of unemployment, displacement and job insecurity, while others saw it as differentiating on risk using the scorecard to determine who and how to treat the clients. Here socio-economic effects would be brand equity and the value of the brand in the mind of the consumer, where one would want to know if one could provide credit to socio-economic groups who do not qualify for credit. Also, another effect would be if there is some way of uplifting an impact on these communities in some way that the bank will get its money back.

A way to measure socio-economic effects could be the number of complaints received by the credit bureaus of the banking council. The other variable would be the credit granted to the under-banked, or number of new loans and the relative collection rates against that, also the Gini income disparity between employees or the financial services group. One respondent mentioned the legislation, which is coming out to provide banking services to the under-banked, so his question was, “how do I best ensure my interests as a provider of credit?” Credit scoring is one of the ways one can measure other variables of credit worthiness, apart from income. Income is the source of one’s ability to pay one’s loan, but the under-banked do not have income per se, so how does a bank know they will be repaid? One would look at length of employment, number of years the client has lived at a fixed address, and other stability factors, rather than purely financial factors.

The respondents generally agreed that these variables can only be measured over time and it is difficult to measure and remains theoretical in the main. Other than the financial services charter, the majority of respondents felt that this measure was not of concern for organisations from a credit-scoring perspective.

User satisfaction

It was felt that user satisfaction should be complemented with override rates, as this is a true reflection of user satisfaction. Over time, one might find that fewer people are

questioning the system – this will result partially from education and partially from time and getting used to the system.

Customer retention

Customer retention was thought of as a vague measure, which was confused with the retention scorecard that predicts the likelihood of a person leaving or staying. Customer retention has nothing to do with risk, whereas behavioural and application scorecards are built for risk. These are used to drive part of the business and this is done by measuring what the scorecard is predicting. It is imperative to look at population shift through the measurements of how strong the characteristics are. One can then pick up what factors caused the population shift and make the changes.

The question the respondents asked was “is the population through the door the same as what our scorecard was built on?” If that population shift becomes too great, one would have to build a new scorecard. If the scorecard is not working it will affect the delinquency rates, i.e. approval/decline rates.

Cost of living index

The cost of living index was thought to be an important measure, especially in the home loans market. Property prices must be traced along with inflation, as this has a big impact and there are a few different measures associated to this measure. The cost of living index must not be confused with the economic measures of Consumer Price Index and the like.

Product pricing and portfolio management

It was brought to the researcher’s notice that different role players in an organisation look at different measures and there might be more than one point of view. Products and Retail individuals would look at product pricing and portfolio management in terms of specifying how successful the scorecards are in generating revenue. From a Technology and Operations perspective, their role is to implement it and reduce the costs. From this perspective one would measure the success of the scorecard itself by using the following measures:

a) Improved turnaround times – from two points of view: the man in the street, and the customer who is receiving the scorecard as it has been delivered.

b) Reduction in bad debt – balance related measure done six months after implementation.
c) Odds scoring – this is a quick and easy way of seeing if the scorecard worked by the ratio of good:bad prior to implementation and afterwards.

The Basel II measures and cost of living index, as well as product pricing and portfolio risk management, are specific product-driven measures in terms of success.

It is important to bear in mind the difference between asset base lending, e.g. home loans and non-asset base lending, e.g. credit cards, when considering the product pricing measure.

Portfolio management without the 'risk' would be a more appropriate measure. Risk would involve growing turnover through the accounts and asset balances, thus portfolio risk management would form a subset of portfolio management. Typically, when you look at portfolio risk management, the biggest thing is the loss rates, where probability of default is a measure.

6.4 The literature measures

Expert turnover

It was noted that this measure does not necessarily apply, as the user is the person in the frontline. Rather, experts are a subset of users. The experts are the individuals who build the scorecards and some banks do not build their own scorecards, so there are no experts in these banks. This was not a consistent figure, as it looks at too small a population. The respondents suggested, "what you would try and do is grow that knowledge, so that you want different experts coming through to help tweak the base product and move away from having all that knowledge vested in one or two separate individuals". Although this might be a good measure theoretically, the respondents generally agreed that the question would be how to identify the experts and this could be a difficult measure from a practical point of view.

Human Resource Costing and Accounting (HRCA)

Financial Services is currently the most capital-intensive industry in the world, measured on asset value per employee. HRCA correlates to capital intensity and picks up on the replacement of tasks with high human input, but low contribution. If individuals could add value with new technology and be more efficient, then HRCA would be higher. HRCA applies to many Delphi measures, not just turnaround times. This measure can only be used within the organisation and not inter-organisational, as one must look at the bottom-line profits to determine whether outsourcing, or having fixed salaried staff, is more profitable. However, this measure could be skewed, according to the respondents. “If one were just measuring HR and not profits as well, then this figure would be skewed” stated a respondent, “also analysts look at revenue per person and try to control the headcount.” HRCA can be manipulated to have the cost balance within the firm. In a bank, one might look at a balance sheet more than the intellectual capital and there is no consensus as to what unit one is using to get “contribution of human assets held by the company”.

Tobin’s Q

This is closely related to Market-to-Book Value (MBV), which gives a rand value as opposed to a ratio value. This is a valid measure, which can apply across the board to many Delphi measures. This measure would be used in any due diligence or internal approach. It does, however, have a lot of external influences to it, as many things could affect the stock market value, so one might ask, “does this mean underlying credit is different?” The response would be that “that would certainly affect the ‘Q’”. However, since markets are theoretically efficient, this balances out, as this measure is taken over the long-term, when eventually the markets do come up to date.

Market-to-Book Value

If you increase profits, that will increase the MBV ratio. Business Banking is mainly interested in getting all the information needed to assess risk and once the risk is better known, capital can be adjusted and used as extra cash. Credit-scoring Models have to be implemented by 1 January 2004 and there is a 3-year period by the end of which the bank has to prove that their risk models work and show what the risk measures are. This figure can also be seen as the cost-to-income base, which for banks was in the 70^{th} percentile and is now down to the 50^{th} percentile. Or the MBV could be seen as a utilisation measure, where one would have *x* book value which turns over *y* debt. The

respondents agreed that a standard would have to be put in place to prove this measure.

Revenues from new products

One would need a credit history to develop these products. Products are areas working towards a hurdle rate, the question is, are they meeting this hurdle rate relative to capital employed? With credit-scoring models one can understand how much each product costs and the risk of each product and as long as the hurdle rate is reached whilst keeping customers and increasing customer satisfaction one can build new products. This is a useful measure, however, consistent product definitions are needed to make useful comparisons.

Revenues from new products should be done as a matter of course and are only for products that are credit-scored, as opposed to a current account which is not credit-scored if income is over R5000. The respondents generally did not agree that one should measure this in terms of profits from new products, as one could still make an annuity loss on these products. However, it was agreed that it is easier to be innovative if one understands existing products well, both risk-wise and cost-wise, and this could be used in developing new products, since credit-scoring is used for product analysis.

Market and account share

This measure should be done as a matter of course. However, this could be a double-edged sword, as one could be writing bad business and getting the wrong part of the market. As a respondent put it, “you might have 80% of market share but be getting 90% of the bad debts”. Yet movement in market share is important and the reasons for this must be known. Credit scoring should allow lenders to become more aggressive in their lending, due to better risk discrimination. Yet, at the same time, this growth causes a problem, because the new business taken on will take some time to show its colours.

Revenue growth

With performance monitoring, both risk and growth would be monitored. Revenue growth is a very broad term and since scoring has an impact on both the balance sheet and income statement, one would look at balanced growth as a definitive measure. There is a leap in this measure, as it is typically through either balance or transaction fees, or other elements, that revenue is made up. Once revenue growth has been

calculated, it is, according to the respondents, necessary to establish whether the growth is in line with expectations, or if not, why this is so.

Intangible asset monitor

This can also be referred to as the four R's: risk (reduction), revenue (utilisation), retention (renewal) and response (growth). This is a very useful measure as risk, revenue and retention are profit drivers. Revenue from assets employed is similar to earnings per share and should be more financial. A respondent noted however that, "the whole implementation decision is automation, which is not a decision to be taken lightly, due to the huge capital investment and, in order to get the value, one would need to get some repayment or IRR (internal rate of return) on the capital employed." This return figure is needed, which is not seen here. This measure will have some effect, as in certain situations like corporate scoring the intellectual capital is very high and there are more intangibles, so one is able to measure the strength of the scoring, as opposed to these other intangibles. This measure can be compared to the balanced scorecard and looks across different products, assessing both profit drivers and cost reducers, however, the respondents agreed it may be highly theoretical and difficult to score in practice.

6.5. Comment on the model

The working model

Basel II requires a post-implementation review within the three years granted (2004-2007) to prove the models are working. In the end, one needs some sort of output to tell if the model is actually working and for that, this model is excellent. The risk without it is that the focus would only be on one or two values. This is a holistic model with measures across the board and the chances are if one did not look at all the areas in the model, something important could be missed.

Inter-organisational comparisons

A lot of the model is comparisons across organisations, but to what extent is one able to use this in monitoring effectiveness from one year to the next? This is uncertain. This model has to do with the broader organisation, but can one necessarily make the link back to credit scores? The model does, however, fulfil the purpose of inter-organisational comparisons, as the use of technology is already known and now one

wants to look at whether this shows up in the numbers. It is easier to pick up a pattern/relationship between decision automation and its use in strategy and pricing and other things and draw up a conclusion when it is inter-organisational – otherwise there are too many other variables and interdependencies.

Translation and interpretation

The model is not a simple model, which is good. Grouping the theoretical literature measures next to the practical Delphi measures is important, as this gives an overall understanding of the bigger picture. However, once the quantitative work is done, there will still be a certain amount of subjectivity. The situation will never arise in credit scoring, where it punches out a number and a computer can do it. There is a need for a certain amount of intellectual capital to translate the information into something that is valuable. “This model gives one the framework to do it in, but there will still be a certain amount of translation and interpretation of the information that comes through. The framework will eliminate the error, but the final translation requires some intuition.” One would need insight into what these measures are, as there are lots of factors thrown in and it is not as simple as just crunching out ratios.

Due diligence

This is how someone on the outside of the firm, who does not have access to what is going on inside, would look to evaluate things, i.e. an outside assessment or due diligence. As a pre-investment decision, one could use this model and look at what the competitors are doing. This would be used to keep abreast of competitors and to assess if something more sophisticated is done, whether it would benefit the company and give a competitive advantage, which will impact the bottom-line.

Definitive drivers of success

While there are two axes to determine the measures on, there should be within these high proportionate drivers, i.e. the 80:20 rule. So, when success is being measured, one measure on each axis would be picked, because unless there is a big team with a lot of resources at one’s command and the infrastructure to support these, there will be no budget to source all of the measures and complete the puzzle. One must see what data is available for each measure and use that, i.e. the one you can get the most value out of in the shortest time and at the lowest cost. Proxies could be used instead of the actual measure. While the model is complete, in terms of saying if one did all of this one

would get a good view of how successful or unsuccessful credit-scoring systems are; in a practical environment one would not source all of them. Success should rather be reflected on one or two variables.

Difficulty of the model

It was generally agreed that the model might be difficult to implement, since in theory it looks good, but in practice it is more difficult. Whilst the functionality measures would work well as they are standard, the industry and organisational measures are not as easy to align to scoring, as one is looking at the company itself as opposed to the effect of the scoring. These measures are not as clear-cut.

6.6 The literature suggests using qualitative measures – why is the model a quantitative development?

All respondents agreed that there is a drive similar to the balanced scorecard approach where, even if the measures are qualitative, people are looking for some type of measure somewhere that can act as a surrogate for a quantitative measure. Quantitative numbers are easier to assess something with, as they can be ranked and compared easily. One must look at what the impact on the bottom-line is, not just now, but in the future. Even though one may be on the qualitative side of things, one is always looking for a quantitative measure. There is always a push to a quantitative outcome, even though it is a qualitative measure – it is the only way you can link it to past performance.

Also, personality profiles of individuals tend to get involved in this type of area. The model is more quantitative due to historical reasons; in other words, the people who do these things tend to be number crunchers. Second is the type of person one is reporting to. This type of person would want to know the hard facts, delivered by using very real measurable measures, which can show over time whether one has been successful or unsuccessful. Quantitative measures are preferred as they are objective, reliable, valid, rational and logical. Quantitative measures progress the scoring, i.e. give a better version of outgoing work. This gives an objective way of measuring success. The qualitative view is a nice way of providing more information, giving one a narrative about how successful something was, but in the end one would distil this back to numbers.

The matrix is the quantitative side, while the qualitative side is the interpretation of the matrix. The importance is how everything is interrelated. The quantitative measures are where one would go to first and these measures would be the ones chosen from a list of measures to score. However, when it comes to interpretation, it is very important that the qualitative measures get added on top and the ability to do this comes with experience. The qualitative side is the bigger picture, how the general market is, and the interrelationship between the measures.

Most qualitative measures can be expressed as quantitative measures. However, if one has something that cannot be measured, or if it is just too difficult, that would be more judgmental scoring. Hard evidence and proof is always sought and it is the numbers that gives one these facts and the objective evidence. This is factual, non-disputable proof. With credit-scoring models, one would want to get away from the subjectivity of credit risk and get rid of the subjectivity in the model and hence in the evaluation of the model as well.

In the model it is the functionality measures and the regulatory requirement measures that are more quantitative, whereas the other industry and organisational measures are more qualitative. One could have the same scorecard, but get different answers on the softer issues with many variables. If one is trying to measure how well the scorecard is working, then qualitative measures will not help much in predicting this, since there are so many other variables that can affect it. The measurement is essentially on a very high-level figure, which is therefore not a scorecard measure, as there is a lot of variance.

CHAPTER 7. DELPHI ANALYSIS – PROPOSITIONS

7.1 Introduction

Chapter 7 presents an interpretation of the results, which are evaluated with respect to the research propositions and existing literature. In this chapter the results are tested against the four broad propositions formulated on going into the research. More specifically, these four propositions are tested against the findings of Chapter 5 and 6: namely; Delphi Analysis Round Two and Three. The conclusion and areas for future research follow these findings. The propositions are predominantly centred on insights gained from the evaluations and discussion of the results.

Based on the experts' ratings of which measures are deemed most important and their validation of the inductive credit-scoring model, the researcher is able to evaluate the following propositions:

1) CBA methods are still dominant in IT evaluation and account for the majority of post-implementation techniques used in practice.

2) The majority of evaluation methods used assess only the functional performance and financial cost benefit of the systems, while failing to address implementation issues such as culture and strategy.

3) Many methods are theoretical rather than realistic and are therefore of limited practical use.

4) A universal IT evaluation process for financial expert systems does not exist. A holistic model can therefore be proposed whose value lies in its ability to optimise the evaluation process for credit-scoring systems.

7.2 Propositions

Proposition 1 & 2

Eight out of the fourteen measures rated by the Delphi panel as the most important were system measures, half of which focused on functionality. These were seen to be:

1) Product pricing
2) Portfolio risk management
3) Odds scoring
4) Profit drivers by score

5) MIS integration
6) Numerical ratings
7) Debt-to-income ratio
8) Gini-coefficient

Therefore, the propositions that,
a) CBA methods are still dominant in IT evaluation and account for the majority of post-implementation techniques used in practice, and
b) The majority of evaluation methods used assess only the functional performance and financial cost benefit of the systems, while failing to address implementation issues such as culture and strategy, can be said to be true.

Proposition 3

The third proposition that, “many methods are theoretical rather than realistic and are therefore of limited practical use”, is supported by the Delphi panel, whose opinion was that the model is a theoretical construct which would be difficult to apply in practice. There was a disparity between the quantitative functionality measures , which could be applied quite easily, and the qualitative organisational and industry measures, which are, according to one respondent, “not as easy to align to scoring as one is looking at the company itself as opposed to the effect of the scoring”.

Proposition 4

The final proposition that “a universal IT evaluation process for financial expert systems does not exist. A holistic model can therefore be proposed whose value lies in its ability to optimise the evaluation process for credit-scoring systems” can be said to be disputed in the main, since the model as a holistic assessment tool was thought to be too theoretical. The model did, however, prove valid as it was felt that the measures, which stretched across the board, were all-encompassing and prevented the chance of anything being missed. The model was also said to fulfil the purpose of inter-organisational comparisons and could be used as a due diligence or external assessment. Finally, the model was thought to give a framework to translate the information into something that is valuable and the framework eliminated the error where the final translation required some intuition.

Therefore, based on the findings in Chapter 5 and 6, all the first three propositions gleaned from the literature review were supported, with the final proposition being disputed. It is important to note that the strength of the support was unanimous and the findings brought to light additional supporting examples not present in the literature review.

This is discussed as follows: The 80:20 rule states that 80% of the assessment for credit-scoring could be based on one single measure and 20% of the assessment would be gleaned from the rest of the measures. So when success is being measured, one measure on each axis would be picked because, unless there is a big team with a lot of resources at one's command and the infrastructure to support these, there will be no budget to source all of the measures. This finding is pertinent to proposition number four, i.e. "a universal IT evaluation process for financial expert systems does not exist. A holistic model can therefore be proposed whose value lies in its ability to optimise the evaluation process for credit-scoring systems", and will be further discussed in the conclusion since, by taking remedial action, this proposition could in turn be supported.

CHAPTER 8. CONCLUSION

The intention of this report is to provide the necessary analysis required for the induction of a descriptive evaluation model, which pinpoints the critical factors inherent in financial expert system investments.

Functionalist and interpretive constructs

In this report, different approaches to the evaluation of financial expert systems used in practice were discussed. It was clear that a functionalist approach to evaluation was used where quantitative measures were preferred to the more qualitative, interpretive kind. The model itself was predominantly quantitative since it was induced from the Delphi panel. Quantitative numbers were felt to be easier to assess as they can be ranked and compared easily. The impact on the bottom-line is always sought and quantitative measures are preferred, as they are objective, reliable, valid, rational and logical. Although this was a unanimous finding, the qualitative/interpretive paradigm was not completely left out. Since the qualitative side formed the interpretation of the matrix, it was thought to be essential for a holistic view of the model to be taken. As one respondent said, “the qualitative side is the bigger picture, how the general market is, and the interrelationship between the measures”.

Limitations in evaluating expert systems

Insight was gained into how experts are evaluating financial expert system investments and what current shortcomings should be overcome. The functionalist approach brought with it limitations in evaluating expert systems and raised the need for a holistic approach to evaluating these investments. Evidence by Yan Tam (1992) and Ballantine and Stray (1998) supports the view that organisations keep using evaluation methods, which are improper for IT evaluation, despite the development of an extensive list of IT-specific evaluation methods (Renkema & Berghout, 1997).

The Delphi panel commented on those Delphi measures thought to be problematic and it was the literature measures that mitigated the lack of robustness of the Delphi measures. It is these gaps that arose between theory and practice that were addressed in this research report.

Testing assumptions

The researcher adopted a high level approach when developing the credit-scoring evaluation model. This was due to the fact that corporate scoring and retail scoring were thought to be significantly different to each other. However, on testing this assumption to see if it was valid, it was found not to be the truth. The assumption that retail scoring and corporate scoring cannot be studied in unison was tested against a statistical correlation between the Delphi panellists, half corporate and half retail. A strong positive correlation at a 95% confidence level resulted between both retail and corporate panellists. Therefore, the finding that there is a significant overlap between post-implementation evaluation methods, and hence corporate and retail credit-scoring systems, could be concluded.

Adding to the body of knowledge

Due to the complex multidisciplinary and multi-faceted nature of IT evaluation, the aim of researchers to develop a comprehensive, yet testable and normative method of expert system evaluation, is not yet fully achieved (Turnbull, 1999) This research report should add to the current, underdeveloped body of knowledge in the expert systems' field of Knowledge Management, since a holistic approach to evaluation was proposed as an inductive credit-scoring model.

This research aims to assist South African banks to create and maintain their own, company-specific credit-scoring profiles and better determine their risk drivers, by use of the intangible asset monitor and the like, as required for an internal rating based risk assessment in Basel II.

The process

Based on the findings by Ruggles, (1997), Angus and Patel, (1998), Jackson, (1999), Wensley, (2000) and Savory (2001), the need for IS to be appropriately valued is blatantly evident. Essentially, IS evaluation must combine both quantitative and qualitative measures if the true benefits of IS are to be assessed. In this research report the author proposed to develop a holistic model by means of an exploratory research methodology using the Delphi technique. This model was supplemented by the latest techniques available in this field of research by extracting the evaluation metrics appropriate to post-implementation of credit-scoring systems. The model was then

consolidated based on Symons' (1991) broader conceptualisation entailing linkages between context, content and process: the 'why', 'what' and 'how' of evaluation, namely:

A] INDUSTRY (Context)

7 factor measures + 1 literature measure

B] ORGANISATIONAL (Content)

2 factor measures + 3 literature measures

C] SYSTEM (Process)

7 factor measures + 4 literature measures

Total measures=23 statistically based credit-scoring measures.

Risk management

Today, companies involved in business credit follow a process to approve credit. It may be a formal model, an informal set of procedures, or a combination of the two. These procedures usually establish a set of quantitative and subjective hurdles designed to weed out risky buyers. Some credit systems go further and attempt to minimise the overall risk of company portfolios while maximising profitability.

Subjective considerations

Although quantitative factors drive most credit-scoring models, credit managers layer various subjective considerations into final credit decisions and procedures. They must balance multiple, and sometimes conflicting business objectives, such as minimising costs per applicant, reducing the risk of bad debt and maximising the companies' profits (Business Credit, 2003).

Recommendations

The formal model proposed by the author has its value in its ability to optimise the evaluation process for credit-scoring systems. However, many methods, which were theoretical rather than realistic, were of limited practical use and a useful recommendation, extracted together with refining the model, would be to use the 80:20 rule and definitive drivers of success. An area for improvement would be to formulate the definitive drivers of success which has a foundation based on the 80:20 rule. This would require a relative ranking of all the measures which would show by how much each measure drives success, i.e.10% by Tobin's Q, 20% by Loss Given Default and others. From a measurement perspective, the model as it stands has diminishing

marginal returns at a point in time, so one could actually measure it to death to determine success. By using definitive drivers the model can get the most value out of those measures which are most successful in the shortest time and at the lowest cost. This would make the model less theoretical and more practical to use, as only one or two key variables would be sourced according to those with the highest percentiles. By applying this concept the fourth proposition, namely, “a universal IT evaluation process for financial expert systems does not exist. A holistic model can therefore be proposed whose value lies in its ability to optimise the evaluation process for credit-scoring systems”, would be supported.

Automation

A final thought on credit-scoring systems considers that automated credit scoring may never really replace the human component in credit granting decisions, but models will automate an increasing percentage of the credit determination process over time. Automated credit-scoring is destined to play an increasingly larger role in credit decision-making, requiring the credit manager not only to be versed in the business and analytical requirements of the job, but also to understand the data and methodology of credit modelling (Business Credit, 2003).

Contribution

Therefore, the author has made a contribution in the following areas:

- The most recent market developments in financial expert system evaluation have been investigated
- The literature has been assessed and opportunities for current and future practitioners have been identified
- A descriptive model has been devised as a benchmark evaluation methodology
- A perspective has been articulated that will assist organisations to make IT investments in concert with their business activities
- Some useful areas for future research will be extracted in the section to follow.

8.1 Areas for Future Research

The research presented in this report offers a broad view of credit scoring. From this research a number of areas for future research were identified.

Outsourcing credit-scoring systems

Should companies develop credit-scoring systems in-house or use an outsource provider? The challenges that credit managers face ahead in developing in-house systems lie in building adept models with limited resources. It is proposed that adaptive credit-scoring systems offer an attractive solution, utilising a broad range of data and proven scientific methodologies on an outsourced basis. An area for future research would investigate the appropriateness of keeping ones credit scoring systems in house versus outsourcing them.

The sub-prime lending market

The increased competition from nonbanks, combined with the lure of wider spreads, is inducing more big-bank players to investigate sub-prime lending. In the mortgage industry, sub-prime lending has become a mechanism for pumping up volume during those years when regular lending turns lean (Bank technology News, 1996).

The so-called sub-prime, or non-conforming market, is comprised of customers unable to meet mainstream lenders' credit-scoring systems. However, the segment is comprised not only of those with impaired or sub-prime credit histories, but also of the recently self-employed, independent contractors, as well as those who have retired and live on investment income, for example. It is probably more accurate to call this sector 'non-conforming complex' since it is also made up of consumers who pose a very low credit risk but who just do not fit the traditional credit-scoring model. High barriers to entry - namely the difficulty of acquiring underwriting expertise - will lead to a spate of mergers and acquisitions, both among non-conforming lenders and from traditional lenders attracted to the high margins in this niche (Retail Banker International, 2001) A possible area of future research would investigate the factors which would be used by a credit-scoring or expert system aimed at meeting the unique challenges faced by the sub prime lending market.

Neural networks and artificial intelligence

Another tool coming to market, a multidimensional sub-prime scoring model, uses a combination of artificial intelligence technologies to pinpoint diamonds in the rough. Neuristics Corp., Baltimore, MD, uses case-based reasoning, neural networks, statistical pattern recognition and rule induction to determine the rules and relationships that drive different groups of applicants (Bank technology News, 1996). Future research would investigate how this new generation technology could be best utilised in optimising the credit scoring process.

Impact of cyber world

The cyber world is a very different environment to contend with and one in which we are already witnessing several major industry players positioning themselves. The transacting customers and the needs of this customer base are quite different to the ones in the physical world. It is vital, therefore, that these needs are understood or learned in an incremental manner prior to embarking on this journey. The need here is for an exclusive offering for the cyber medium that is created, used and sustained exclusively in the cyber world (Cards International, 1999).

Pre-Implementation evaluation in the Retail market

The Retail market has become a serious player in the credit lending market. The pre-implementation investment decision is critical in determining the business outcome of these much needed systems. The propositions could be that CBA methods are still dominant in IT evaluation and account for the majority of pre-implementation techniques used in practice, and many methods are theoretical rather than realistic and are therefore of limited practical use.

REFERENCES

Abdolmohammadi, M.J., Greenlay, L., & Poole, D. (1999). *Accounting methods for measuring intellectual capital* [Online]. Available: http://www.round.table.com/scholars/articles/acctg-intellectual-capital.html [accessed 16 November 2002].

Accenture. (2003). Banking on Basel II – Seizing advantage from unavoidable investments, *The Point*, January.

American Banker. (2000):. Credit Scoring catching on with Small Business Lenders, *OneSource,* August 24.

Andersen, R., & McLean, R. (2000):. *Accounting for the Creation of Value.* Ongoing research project sponsored by the Canadian Institute of Chartered Accountants.

Andriessen, J., & Tiessen, L. (2000). *Weightless Weight – Find your real value in a future of intangible assets.* London: Pearson Education.

Angus, J. & Patel, J. (1998). Knowledge Management Cosmology, *InformationWeek,* March, pp. 13-23.

Anonymous. (2002). Technology must be aimed at the bottom line, *Sunday Times,* December 03.

Bank for International Settlements. (2003). *Overview of the new Basel Capital Accord, Basel Committee on Banking Supervision* [Online]. Available: http://www.bis.org [accessed 30 June 2003].

Balderston, J. Birnbaum, P. Goodman, P., & Stahl, M. (1984). *Modern Management Techniques in Engineering and R&D.* New York: Van Nostrand Reinhold Company.

Ballantine, J., & Stray, S. (1998) Financial appraisal and the IS/IT investment decision making process, *Journal of Information Technology,* Vol. 13, pp.3-14.

Bank Marketing International (2003). US concerns about credit rating accountability, *One Source,* January 01.

Bank Technology News. (1996). Credit Scoring New Markets, *One Source,* July 01.

Bendixen, M. (1996). A Practical Guide to the Use of Correspondence Analysis in Marketing Research, *Marketing Research On-Line*, Vol. 1.

Bontis, N. (2000). Assessing knowledge assets: A review of the models used to measure intellectual capital, *Management Research Centre for Knowledge-Based Enterprises* [Online]. Available: http://www.business.queensu.ca/kbe [accessed 22 October 2002].

Bornemann, M. (1999). *Empirical analysis of the intellectual potential of value systems in Austria according to the VAIC™ method* [Online]. Available: http://www.measuringip.at/Opapers/Bornemann/Empirical/EmpiricalAnalysisAustria.html, [accessed 12 December 2002].

Bravo, G. & Pontvin, L. (1991). Estimating the Reliability of Continuous Measures with Cronbach's Alpha or the Intraclass Correlation Coefficient: Toward the Integration of Two Traditions*, J. Clin. Epidemiol*, Vol. 44, No. 4/5, pp. 381-390.

Brooking, A. (1996). *Intellectual Capital: Core Assets for the Third Millennium Enterprise.* London: Thomson Business Press.

Brynjolfsson, E., & Hitt, L. (1991). *IS Information Systems Spending Productive? New Evidence and New Results*, Sloan School of Management, Massachusetts Institute of Technology.

Business Credit. (2003). Credit Scoring Basics, *OneSource,* March 31.

Business Process Resource Centre [BPRC] (2001). *Defining Knowledge Management*, Warwick Business School [Online]. Available: http://bprc.warwick.ac.uk [accessed 5 December 2002].

Cards International. (1999). The Next Innovation, *OneSource,* August 20.

Campbell, D.J. (2000). Legitimacy theory or managerial reality construction? Corporate social disclosure in Marks and Spencer Plc corporate reports, *Accounting Forum*, Vol. 24 No.1, pp. 80-100.

Celemi Monitor (1999). *Analysis of intangible assets* [Online]. Available: http://www.sveiby.com/articles/celemimonitor99.htm [accessed 20 November 2002].

Churchill, G.A. (1995). *Marketing Research: Methodological Foundations.* New York: Dryden Press.

Colostate University (2003). *An introduction to content analysis* [Online]. Available: http://writing.colostate.edu/references/index.cfm [accessed 25 November 2003].

Critcher, C., & Gladstone, B. (1998). Utilizing the Delphi Technique in policy discussion: A case study of a privatised utility in Britain, *Public Administration*, Vol. 76, pp. 431-449.

Da Vinci, L. (2002). *The Delphi Technique* [Online]. Available: www.consorzio.com [accessed 10 November 2002].

Dameri, R. (2002). *Classification and Evaluation of Business Information Systems: Analysis and Definition of a Taxonomy,* University of Genova, Faculty of Economics.

Dearlove, D. (1998). *Business the Bill Gates way* Oxford: Capstone.

De Salvo, D. & Liebowitz, J. (1990). *Managing artificial intelligence and expert systems.* New York: Yourion press computing series.

DeKlerk, V. (2002). Unprecedented Equity Slaughter, *Finance Week*, October 16, pp. 20.

Doswell, A., & Reid, V. (2000). *An empirical study of knowledge and organisations, Information Resources Management Association*, 11th International Conference, Anchorage, Alaska, May 21-24.

Edvinsson, L., & Malone, M. (1997). *Intellectual Capital: Realizing your Company's True Value by Finding Its Hidden Brainpower.* New York: Harper Business.

Fairchild, A. (2002). *IT investment in KM: creating scorecard perspectives*, Greiner International, Inc. Boechout, Belgium, Vesalius College: Vrije Universiteit Brussels.

FairIsaac. (Undated): *Decision Technology Capabilities* [Online]. Available" www.fairIsaac.com [accessed 27 December 2002].

Farbey, B., Land, F., & Target, P. (1999). Moving IS evaluation forward: learning themes and research issues, *Journal of Strategic Information System,* Vol. 8 No. 2, pp. 189-207.

Financial Times. (1998). Datastream/ICV, *FTSE International*, December 08.

Firestone, J. (1998). Knowledge Management metrics development: A technical approach, *Executive Information Systems*, Inc. White Paper no. 10 [Online]. Available: http://www.dkms.com/KMMeasurement.html [accessed 2 October 2002].

Fitz-Enz Jac (1994). *How to Measure Human resource Management:* McGraw-Hill.

Fitzgerald, B., & Howcroft, D. (1998). Towards dissolution of the IS research debate: from polarization to polarity, *Journal of Information Technology*, Vol. 13, pp. 313-326.

Foulkes, T. (2003): AC133-does it affect you?, *OneSource*, September 30.

Halal, W.H. (1998). *The Infinite Resource: Creating and Leading the Knowledge Enterprise*. San Francisco: Jossey-Bass Business and Management Series.

Harris, K., Austin, T., Fenn, J., Hayward S., & Cushman, A. (1999). The Impact of Knowledge Management on Enterprise Architecture, *GartnerGroup Strategic Analysis Report*, October 25.

Harrison, H. (2003). A tough new accounting standard, *Business Brief,* August/September, Vol.8, No.4.

Hiltz, S. & Turoff, M. (1978). *Computer based Delphi processes* [Online]. Available: http://eies.njit.edu/~turoff/papers/delphi3.html [accessed 12 November 2002].

Hines, A. (1995). A Checklist for Evaluating Forecasts, *Futurist*, Vol. 29 No. 6, 20-25.

Jackson, C. (1999) Process to Product, *Creating tools for Knowledge Management*, Conference in Lisbon, Portugal.

Jayaraman, V., & Srivastava, R. (1996). Expert Systems in production and operations management: Current applications and future prospects. *International Journal of Operations and Production Management*, Vol. 16, No. 12, pp. 27-44.

Johansson, J. (1996). *Human Resource Costing and Accounting* [Online]. Available: http://IntangAss/OECDartUlfjoh.htm [accessed 2 January 2003].

Kaplan, R., & Norton, D. (1996). *The balanced scorecard – translating strategy into action*, Boston: Harvard Business School, xi, 322pp.

Kaplan, R., & Norton, D. (1992). The balanced scorecard measures that drive performance, *Harvard Business Review,* January-February, pp. 71-79.

King, D. (1993). *Knowledge acquisition in intelligent decision support systems: A case for natural language,* Transactions of Seventh International Conference on Decision Support Systems, San Francisco, pp. 115-117.

Leedy, P.D., & Ormrod, J. E. (2001). *Practical Research: Planning and Design.* New Jersey: Merrill Prentice Hall.

Lev B. (2002). *Intangibles: Management, Measurement and Reporting.* Washington: Brookings Institution.

Lev, B. (1999). Seeing is Believing - A Better Approach To Estimating Knowledge Capital, *CFO magazine* [Online]. Available: http://207.87.9.12/html/charts/99FEseei-2.html [accessed 10 January 2003].

Lindstone, H. & Turoff, M. (1975). The Delphi Method: Technique and Applications.

Luthy, D.H. (1998). Intellectual capital and its measurement [Online]. Available: http://www3.bus.osaka-cu.ac.jp/apira98/archives/htmls/25.htm [accessed 30 January 2003].

M2 Communications Ltd. (2003). DataDistilleries launches new capabilities for improved credit scoring, *OneSource,* May 07.

Magrassi, P. (2002). A Taxonomy of Intellectual Capital, *GartnerGroup Strategic Analysis Report,* July 18.

Mahoney, J. (2002). The new focus of IT value: Externalising agile business, *GartnerGroup Strategic Analysis Report*, July 17.

Makridakis, S., & Wheelwright, R. (1998). *Forecasting methods and application.* 3rd edition. New York: Wiley.

McNully, A. (2003). AC 133: Look for the Trend, *Financial Mail*, August 01.

McPherson, P., & Pike, S. (2001). Accounting, empirical measurement and intellectual capital, *Journal of Intellectual Capital*, Vol. 2, No. 3, pp.246-255.

Micklewait, J. & Wooldridge, A. (1996). *The witchdoctors – making sense of the management gurus.* New York: Times Book Random House,.

MITSloan. (2003). *Business Models and IT Investment* [Online]. Available: http://sloanserver.mit.edu/cisr/2003_Projects/2003_projects.html [accessed 24 September 2003].

Neilson, R. (2000). Commentary by Dr. Robert E. Neilson, CKO & Professor at the Information Resources Management College (IRMC) of the National Defence University [Online]. Available: www.chips.navy.mil.htm [accessed 2 January 2003].

Nijland, M. (2002). *IT cost benefit management improvement from a critical perspective,* Research in Progress, Department of Information Systems: London School of Economics.

O'Leary, D. (1990). International auditing and expert systems. In: *Expert systems in business and finance*, Watkins, P., Eliot, L. (Eds.). University of Southern California, Los Angeles, USA, pp 209-211.

Ono, R. & Wedemeyer, D. J. (1994). Assessing the Validity of the Delphi Technique, *Futures*, Vol. 26, No. 3, pp. 289-304.

Parker, M.M., Trainor, H.E., & Benson, R.J. (1989). *Information strategy and Economics.* New Jersey: Prentice-Hall.

Passing, D. (1996). Imen-Delphi: A Delphi Variant Procedure for Emergence, *Human Organisation,* Vol. 56, pp 53-63.

Poe, J. (2002). Keeping the wheels turning*, Convergence*, Vol. 3 No. 3, pp 74-75.

Porter, M. (1985). *Competitive advantage.* New York: Free Press.

Pulic, A. (2000). *An accounting tool for IC management* [Online]. Available: http://www.measuring-ip.at/Papers/ham99txt.htm [accessed 31 December 2002].

Remenyi, D., Sherwood-Smith, M., & White, T. (1997). *Achieving maximum value from Information Systems: a process approach.* Chichester: Wiley.

Renkema, T.J.W., & Berghout, E.W. (1997). Methodologies for information systems investment evaluation at the proposal stage: a comparative review, *Information and Software Technology*, Elsevier Science B.V., pp.1-13.

Retail Banker International. (2001). Higher Risk, Higher Margins, *OneSource,* May 14.

Ridderstrale, J. & Nordstrom, K. (2002). *Funky Business*. Stockholm: Bookhouse Publishing AB.

Roberts, J. (2002). The Elusive Business Value of IT, *GartnerGroup Strategic Analysis Report,* August 1.

Roos, J., Roos, G., Dragonetti, N.C., & Edvinsson, L. (1997). *Intellectual Capital: Navigating in the New Business Landscape.* Houndsmills, Basingtoke: Macmillan.

Rowe, G., & Wright, G. (1999). The Delphi technique as a forecasting tool: issues and analysis, *International Journal of Forecasting,* Vol. 15, pp. 353-375.

Ruggles, R. (1997). *Knowledge Management Tools*, Oxford: Butterworth-Heinemann.

Savory, C. (2001). *Co-operative Inquiry as a basis for Evaluation of Knowledge Management Tools,* Centre for Complexity and Change, Technology faculty: The Open University.

Seddon, P., Graesaer, V., & Willcocks, L. (2001). *IT Evaluation Revisited: Plus ca Change: Department of Information Systems.* Australia: University of Melbourne.

Serafeimidis, V., & Smithson, S. (2000). Information systems evaluation in practice: a case study of organisational change, *Journal of Information Technology*, Vol. 15 No. 2, pp 93-105.

Skandia Insurance Company (1995-2000). *Visualizing Intellectual Capital in Skandia: Supplements to Skandia Annual Reports 1994-2000.* Stockholm: Skandia Insurance Company.

Skyrme, D., & Associates (2000b). *Measuring intellectual capital – A plethora of methods* [Online]. Available: http://www.skyrme.com/insights/24kmeas.htm#meas [accessed 3 October 2000].

Snyder, J. (2000). Weighing commercial credit quality, *OneSource,* May 01.

Standfield, K. (1998). *Extending the Intellectual Capital Framework* [Online]. Available: http://www.knowcorp.com/article075.htm [accessed 24 August 2002].

Stewart, T.A. (1997). *Intellectual Capital: The New Wealth of Organisations.* New York: Doubleday/Currency.

Story, V., Hurdley, L., Smith, G., & Saker, J. (2001). Methodological and Practical Implications of Delphi Technique in Marketing Decision-Making: A Re-Assessment, *The Marketing Review*, Vol. 1, pp. 487-504.

Sullivan P. (2000). *Value-driven Intellectual Capital. How to convert intangible corporate assets into market value:* Wiley.

Sveiby, K.E. (1997). The New Organisational Wealth: Managing and Measuring Knowledge Based Assets, *Berrett Koehler*, San Francisco [Online]. Available: http://www.sveiby.com/articles/MeasureIntangibleAssets.html [accessed 2 August 2002].

Sveiby, K.E. (2001). *Methods for measuring intangible assets* [Online]. Available: http://www.sveiby.com.au/intangiblemethods [accessed 2 November 2002].

Symons, V.J. (1991). A review of information systems evaluation: content, context and process, *Journal of Information Systems*, Vol. 1, No. 3, pp. 205-212.

The Nation (2003). A tool for managing credit risk, *OneSource,* May 12.

Turban, E., McLean, E., & Wetherbe, J. (1999). *Information Technology for Management.* New York: Wiley.

Turnbull, P. (1999). Business-to-business marketing: organisational buying behaviour, *The marketing book*, Croom Helm, pp. 217235.

UM-C. (Undated). *Researched shortcomings of the Delphi Technique* [Online]. Available: http://tiger.coe.Missouri.edu/~is334/projects/Delphi_DL/TechniqueShortcomings.htm [accessed 5 November 2002].

Vermeulen, A. (2003). AC133=RR$% nightmare-says business, *Finance Week*, September 15-19.

Viedge, C. (1999). The Balanced Scorecard: A tool for KM. In: *Leveraging Knowledge for Business Performance,* Duffy, N., Jooste, A., & Whittaker, L. (Eds.). Johannesburg: Graduate School of Business Administration, University of the Witwatersrand, pp. 47-52.

Walsham, G. (1993). *Interpreting information systems in organisations*, Chester, West Sussex, England: Wiley.

Ward, J. (1990). A portfolio approach to evaluating information systems investments and setting priorities, *Journal of Information Technology*, Vol. 5, pp. 222-231.

Ward, P, Davies, B.J., & Wright, H. (1999). The Diffusion of Interactive Technology at the Customer Interface*, International Journal of Technology Management*, Vol. 17, No. 1/2, pp. 84-108.

Wensley, A. (2000). *Tools for Knowledge Management,* BPRC Conference on Knowledge Management: Concepts and Controversies, University of Warwick, Coventry, February 2000, 10-11.

Wiig, K. (1999). KM Must Address Business Direction. In: *Leveraging Knowledge for Business Performance*, Duffy, N., Jooste, A., & Whittaker, L. (Eds.). Johannesburg: Graduate School of Business Administration, University of the Witwatersrand, pp. 1-11.

Willcocks, L.P., & Lester, S. (1999b). In search of Information Technology Productivity: Assessment Issues, in *Beyond the IT Productivity Paradox*, Willcocks, L.P., & Lester, S. (Eds.). Chichester, UK: Wiley, pp. 69-98.

Williams, M. (2000). *Is a company's intellectual capital performance and intellectual capital disclosure practices related?* Paper presented at McMasters Intellectual Capital Conference, Jan 2001, Toronto.

Woudenberg, F. (1991) An Evaluation of Delphi, *Technological Forecasting and Social Change*, Vol. 40, pp. 131-150.

Yan Tam, K. (1992). Capital budgeting in information systems development, *Information and Management*, pp. 345-357.

Appendix A – Celemi Monitor

Celemi Monitor 1999

Tangible Assets		Intangible Assets					
Financial Capital		**Customers** (External Structure)		**Organization** (Internal Structure)		**People** (Competence)	
	1999		1999		1999		1999
(overall rating year)	**56**	(overall rating year)	**110**	(overall rating year)	**82**	(overall rating year)	**100**
Growth/ Renewal		**Growth/ Renewal**		**Growth/ Renewal**		**Growth/ Renewal**	
Equity Growth	-3%	Revenue Growth	22%	Organization Enhancing Customers (5,18	21%	Average Professional Experience (3,9)	9.2
Net Investment Ratio (13,15)	19%	Image Enhancing Customers (5,12)	54%	Revenues from New Products (24)	17%	Competence Enhancing Customers (4,5)	27%
				R&D / Revenues	14%	Professional Competence grwth (11)	38%
				Intang. Investments % Value Added (13)	22%	Experts with Tertiary Degree (6,8)	80%
Efficiency		**Efficiency**		**Efficiency**		**Efficiency**	
Profit Margin (19)	1%	Revenues per Customer (5,26)	367	Proportion of Admin Staff (2,21)	20%	Value Added per Expert SEK '000 (33)	892
Net Return on Equity (16)	8%			Revenues per Admin Staff SEK '000 (25)	9205	Value Added margin (20)	49%
Profit Capacity % Sales (22)	8%						
Stability		**Stability**		**Stability**		**Stability**	
		Customer Satisfaction Index (32)	5.00	Admin Staff Turnover (1,2)	33%	People Satisfaction Index (31)	5.00
Solidity (29)	20%	Repeat Orders (23)	68%	Admin Staff Seniority, Years (2,28)	3.8	Expert Turnover (7,9)	14%
Liquid Reserves No Days (14)	32	5 Largest Customers (5,10)	29%	Rookie Ratio (17,27)	36%	Expert Seniority, years (9,28)	4.0
						Median Age all Employees, Years (17)	37

Definitions

1 Administrative Staff turnover: Number of admin staff leaving ,divided by number of admin staff at beginning of year.

2 Administrative staff: Employees other than experts.

3 Average professional experience: Experts' average professional experience in number of years.

4 Competence enhancing customers: Share of revenues from customers with projects that Celemi's experts learn from.

5 Customers: categorised under three headings. Number excludes book customers.

6 Education level: Employees at year end with Primary education (’Grundskola’, calculated as =1), Secondary (’Gymnasium’ =2) and Tertiary (’Universities’ = 3).

7 Expert turnover: Number of experts leaving divided by number of experts at beginning of year.

8 Experts with tertiary degree: Number of experts with a tertiary degree divided by total number of experts.

9 Experts: Employees working directly with customer projects. Top management is regarded as experts.

10 Five largest customers: Share of revenues from 5 largest customers.

11 Growth in professional competence: Growth over last year in total number of years of professional competence.

12 Image enhancing customers: Share of revenues from customers that improve Celemi's image or gives referrals.

13 Intangible Investments % Value Added: Investments in R&D, Marketing and IT charged as cost in normal P&L, divided by Value Added.

14 Liquid reserves: Cash reserves in number of days, assuming normal business.

15 Net investment Ratio: Investment in tangible fixed assets as % of fixed assets.

16 Net Return on Equity: Profit after 28% tax divided by average equity.

17 Number of employees: Two definitions are used: Average number employed during year for efficiency indicators, year-end numbers for growth/renewal and stability indicators.

18 Organisation enhancing customers: Share of revenues from customers that improve Celemi's organisation, brings R&D or

projects that can be leveraged.

19 Profit Margin: Profit before tax divided by total Revenues

20 Profit/Value added: ’Real’ Profit divided by Value Added.

21 Proportion of admin. Staff: Number of admin. Staff divided by number of total staff at year-end.

22 Profit Capacity: Profit adjusted for R&D charged as cost in normal P&L.

23 Repeat orders: Share of revenues from customers buying from us also last year.

24 Revenues from new products: Share of revenues from products and concepts launched less than 5 years ago.

25 Revenues per admin. Staff: Total revenues divided by average number of admin. Staff.

26 Revenues per customer: Total revenues divided by total number of customers.

27 Rookie ratio: Number of employees with less than 2 years seniority.

28 Seniority: Number of years as Celemi employees.

29 Solidity: Equity divided by Total Assets.

30 Value Added: The value produced by Celemi's employees after payment to all outside vendors.

31 People Satisfaction Index. Scale 1-6 (highest)

32 Customer Satisfaction Index. Scale 1 - 6 (highest)

Appendix B – Parker & Benson's Information Economics

Financial Domain 'Return on Investment'
Organisational Domain 'Strategic Match': the degree to which the IS fits with the strategic goals of the firm. 'Competitive Advantage': the degree to which an investment can contribute to a stronger position in the market. Examples are the changing structure of the company or a company's branch, improving the competitive position, creating and using all strategic possibilities of the IS. 'Management Information': the degree to which the to be implemented IS provides critical information to the executive management on the core activities of the organisation. 'Competitive Response': the degree to which not investing would be a risk and timely implementation would imply an advantage to competitors. 'Project or Organisational Risk': the degree in which the IS to be implemented is dependent on new competencies. Some investments in IS can cause large organisational changes in this way.
Technological Domain 'Strategic IS Architecture': the degree to which the proposed IS matches with the information plan and information architecture. 'Definitional Architecture': the degree to which the need for information from users can be fulfilled adequately. 'Technical Uncertainty': the degree to which investments in an IS demand more investments in the technical infrastructure, and the degree to which the IS-department can support these efforts.

SOURCE: Parker *et al.*. (1989)

Appendix C – An Information System Application Portfolio

STRATEGIC	TURNAROUND OR HIGH POTENTIAL
- applications which are critical to sustaining future business strategy	- applications which may be important in achieving future success
- applications on which the organisation currently depends for success	- applications which are valuable but not critical to success
FACTORY OR KEY OPERATIONAL	**SUPPORT**

SOURCE: Ward (1990).

Appendix D – Correspondence Analysis

Measures	Owen	Ray	Leigh	Gary	James	Jeetesh	Anelda	Stefan	Piers	Walter
syst int	10	10	5	5	10	3	1	5	4	0
num rate	5	10	10	15	20	5	4	2	3	0
debt-to-inc	5	0	5	8	0	5	4	2	8	0
liv index	3	0	5	0	0	0	3	1	6	0
cust prof	0	0	5	0	10	3	3	1	2	0
int rate	0	0	2	0	0	0	3	1	0	0
prod pric	0	5	5	8	0	0	3	2	1	20
port risk	3	10	10	12	5	5	4	2	2	20
data rec	4	5	2	0	5	3	4	2	5	0
gini co-ef	5	10	1	0	5	0	10	7	2	0
odds scor	10	0	2	0	0	5	10	2	2	0
cont-by-score	10	0	2	0	0	5	5	0	3	0
Kol-Smirnov test	5	0	1	0	0	0	10	0	2	0
Kull-Leib dist	0	0	1	0	0	0	0	0	2	0
stud t-test	0	0	1	0	0	0	0	0	2	0
log reg	5	0	1	5	0	0	3	0	4	0
ov rates	5	5	5	12	0	5	3	8	5	0
user's sat	0	10	2	5	5	5	3	10	0	0
ref rates	5	5	1	0	1	10	4	5	2	0
cred strategy	5	10	5	3	0	5	4	5	4	0
turnaround times	0	10	1	2	10	10	3	10	2	0
labour costs	0	5	1	2	5	10	1	10	4	0
int-bear income	0	0	1	0	0	0	1	5	8	0
bad debt	0	5	5	8	20	10	2	5	3	0
LGD	5	0	5	0	1	3	1	1	2	0
PD	5	0	5	15	1	3	2	1	3	60
ED	5	0	2	0	1	3	2	1	3	0
AC133	5	0	5	0	1	2	0	0	2	0
socio-ec effects	0	0	1	0	0	0	3	2	8	0
app profile comp	0	0	1	0	0	0	2	5	4	0
cust ret rates	0	0	2	0	0	0	2	5	2	0
TOTAL	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Correspondence Analysis Report
Database

Variables **Owen to Walter**

Plot Detail Section for Rows

				--------	Axis1	--------	--------	Axis2	--------
Name	**Quality**	**Mass**	**Inertia**	**Factor**	**COR**	**CTR**	**Factor**	**COR**	**CTR**
1 syst int	0.388	0.053	0.018	0.320	0.240	0.010	0.252	0.148	0.013
2 num rate	0.488	0.074	0.038	0.201	0.062	0.006	0.526	0.426	0.081
3 debt-to-inc	0.364	0.037	0.018	0.208	0.069	0.003	-0.431	0.296	0.027
4 liv index	0.676	0.018	0.021	0.384	0.100	0.005	-0.920	0.576	0.060
5 cust prof	0.262	0.024	0.030	0.419	0.112	0.008	0.486	0.151	0.022
6 int rate	0.181	0.006	0.014	0.371	0.048	0.002	-0.619	0.133	0.009
7 prod pric	0.942	0.044	0.060	-1.275	0.941	0.138	0.028	0.000	0.000
8 port risk	0.872	0.073	0.032	-0.674	0.823	0.064	0.165	0.049	0.008
9 data rec	0.509	0.030	0.009	0.438	0.508	0.011	-0.019	0.001	0.000
10 gini co-ef	0.225	0.040	0.028	0.448	0.223	0.015	0.039	0.002	0.000
11 odds scor	0.585	0.031	0.036	0.446	0.135	0.012	-0.812	0.449	0.081
12 cont-by-score	0.573	0.025	0.032	0.429	0.114	0.009	-0.859	0.459	0.073
13 Kol-Smirnov test	0.530	0.018	0.043	0.450	0.067	0.007	-1.180	0.463	0.099
14 Kull-Leib dist	0.240	0.003	0.011	0.381	0.032	0.001	-0.974	0.208	0.011
15 stud t-test	0.240	0.003	0.011	0.381	0.032	0.001	-0.974	0.208	0.011
16 log reg	0.413	0.018	0.019	0.162	0.019	0.001	-0.728	0.394	0.038
17 ov rates	0.065	0.048	0.018	0.177	0.064	0.003	-0.016	0.001	0.000
18 user's sat	0.613	0.040	0.025	0.319	0.127	0.008	0.624	0.486	0.061
19 ref rates	0.253	0.033	0.021	0.452	0.253	0.013	-0.004	0.000	0.000
20 cred strategy	0.245	0.041	0.014	0.325	0.244	0.008	-0.023	0.001	0.000
21 turnaround times	0.774	0.048	0.031	0.423	0.220	0.017	0.672	0.554	0.085
22 labour costs	0.449	0.038	0.027	0.429	0.208	0.013	0.462	0.241	0.032
23 int-bear income	0.231	0.015	0.036	0.517	0.088	0.008	-0.660	0.143	0.026
24 bad debt	0.712	0.058	0.043	0.308	0.101	0.011	0.757	0.610	0.131
25 LGD	0.347	0.018	0.015	0.365	0.129	0.005	-0.476	0.218	0.016
26 PD	0.983	0.095	0.249	-1.802	0.978	0.595	-0.129	0.005	0.006
27 ED	0.642	0.017	0.011	0.431	0.223	0.006	-0.591	0.419	0.023
28 AC133	0.257	0.015	0.019	0.335	0.069	0.003	-0.553	0.188	0.018
29 socio-ec effects	0.390	0.014	0.033	0.497	0.083	0.007	-0.956	0.307	0.051
30 app profile comp	0.227	0.012	0.021	0.511	0.119	0.006	-0.488	0.108	0.011
31 cust ret rates	0.158	0.011	0.018	0.469	0.107	0.005	-0.325	0.051	0.005

Correspondence Analysis Report
Database
Variables **Owen to Walter**

Plot Detail Section for Rows

				--------	Axis2	--------	--------	Axis3	--------
Name	**Quality**	**Mass**	**Inertia**	**Factor**	**COR**	**CTR**	**Factor**	**COR**	**CTR**
1 syst int	0.255	0.053	0.018	0.252	0.148	0.013	0.214	0.107	0.016
2 num rate	0.544	0.074	0.038	0.526	0.426	0.081	0.277	0.118	0.039
3 debt-to-inc	0.303	0.037	0.018	-0.431	0.296	0.027	-0.069	0.007	0.001
4 liv index	0.621	0.018	0.021	-0.920	0.576	0.060	-0.257	0.045	0.008
5 cust prof	0.177	0.024	0.030	0.486	0.151	0.022	0.202	0.026	0.007
6 int rate	0.133	0.006	0.014	-0.619	0.133	0.009	0.042	0.001	0.000
7 prod pric	0.008	0.044	0.060	0.028	0.000	0.000	-0.116	0.008	0.004
8 port risk	0.060	0.073	0.032	0.165	0.049	0.008	0.077	0.011	0.003
9 data rec	0.009	0.030	0.009	-0.019	0.001	0.000	0.054	0.008	0.001
10 Gini co-ef	0.004	0.040	0.028	0.039	0.002	0.000	0.043	0.002	0.001
11 odds scor	0.688	0.031	0.036	-0.812	0.449	0.081	0.592	0.239	0.074
12 cont-by-score	0.757	0.025	0.032	-0.859	0.459	0.073	0.693	0.298	0.082
13 Kol-Smirnov test	0.579	0.018	0.043	-1.180	0.463	0.099	0.591	0.116	0.043
14 Kull-Leib dist	0.484	0.003	0.011	-0.974	0.208	0.011	-1.120	0.275	0.026
15 stud t-test	0.484	0.003	0.011	-0.974	0.208	0.011	-1.120	0.275	0.026
16 log reg	0.431	0.018	0.019	-0.728	0.394	0.038	0.224	0.037	0.006
17 ov rates	0.051	0.048	0.018	-0.016	0.001	0.000	-0.157	0.051	0.008
18 user's sat	0.551	0.040	0.025	0.624	0.486	0.061	-0.228	0.065	0.014
19 ref rates	0.019	0.033	0.021	-0.004	0.000	0.000	0.123	0.019	0.003
20 cred strategy	0.004	0.041	0.014	-0.023	0.001	0.000	-0.033	0.002	0.000
21 turnaround times	0.587	0.048	0.031	0.672	0.554	0.085	-0.163	0.033	0.009
22 labour costs	0.430	0.038	0.027	0.462	0.241	0.032	-0.409	0.189	0.043
23 int-bear income	0.848	0.015	0.036	-0.660	0.143	0.026	-1.465	0.705	0.219
24 bad debt	0.622	0.058	0.043	0.757	0.610	0.131	0.107	0.012	0.004
25 LGD	0.357	0.018	0.015	-0.476	0.218	0.016	0.379	0.139	0.018
26 PD	0.005	0.095	0.249	-0.129	0.005	0.006	-0.029	0.000	0.001
27 ED	0.525	0.017	0.011	-0.591	0.419	0.023	0.298	0.106	0.010
28 AC133	0.344	0.015	0.019	-0.553	0.188	0.018	0.503	0.156	0.026
29 socio-ec effects	0.733	0.014	0.033	-0.956	0.307	0.051	-1.127	0.426	0.121
30 app profile comp	0.761	0.012	0.021	-0.488	0.108	0.011	-1.197	0.653	0.117
31 cust ret rates	0.507	0.011	0.018	-0.325	0.051	0.005	-0.968	0.455	0.070

Appendix E – Descriptive Statistics Analysis

Descriptive statistics

Measure/Row 26

	1
count	9
mean	10.56
sample variance	362.03
sample standard deviation	19.03
minimum	1
maximum	60
range	59
sum	95.00
sum of squares	3,899.00
deviation sum of squares (SSX)	2,896.22
population sample variance	321.80
population standard deviation	17.94
standard error of the mean	6.34
confidence interval, 95% lower	-4.07
confidence interval, 95% upper	25.18
confidence interval, 99% lower	-10.73
confidence interval, 99% upper	31.84
median	3
mode	5
skewness	2.74
kurtosis	7.71
minimum interval width	8.43
maximum interval width	14.8

Measure/Row 21	*1*
count	8
mean	6.00
sample variance	18.57
sample standard deviation	4.31
minimum	1
maximum	10
range	9
sum	48.00
sum of squares	418.00
deviation sum of squares (SSX)	130.00
population sample variance	16.25
population standard deviation	4.03
standard error of the mean	1.52
confidence interval, 95% lower	2.40
confidence interval, 95% upper	9.60
confidence interval, 99% lower	0.67
confidence interval, 99% upper	11.33
median	6.5
mode	10
skewness	-0.06
kurtosis	-2.67

Descriptive statistics

Measure/Row 18

count	7
mean	5.71
sample variance	9.90
sample standard deviation	3.15
minimum	2
maximum	10
range	8
sum	40.00
sum of squares	288.00
deviation sum of squares (SSX)	59.43
population sample variance	8.49
population standard deviation	2.91
standard error of the mean	1.19
confidence interval, 95% lower	2.80
confidence interval, 95% upper	8.62
confidence interval, 99% lower	1.30
confidence interval, 99% upper	10.12
median	5
mode	5
skewness	0.64
kurtosis	-1.02
minimum interval width	1.14
maximum interval width	2

Measure/Row 24	*1*
count	8
mean	7.25
sample variance	33.07
sample standard deviation	5.75
minimum	2
maximum	20
range	18
sum	58.00
sum of squares	652.00
deviation sum of squares (SSX)	231.50
population sample variance	28.94
population standard deviation	5.38
standard error of the mean	2.03
confidence interval, 95% lower	2.44
confidence interval, 95% upper	12.06
confidence interval, 99% lower	0.13
confidence interval, 99% upper	14.37
median	5
mode	5
skewness	1.84
kurtosis	3.77

Descriptive statistics

Measure/Row 7

count	7
mean	6.29
sample variance	41.90
sample standard deviation	6.47
minimum	1
maximum	20
range	19
sum	44.00
sum of squares	528.00
deviation sum of squares (SSX)	251.43
population sample variance	35.92
population standard deviation	5.99
standard error of the mean	2.45
confidence interval, 95% lower	0.30
confidence interval, 95% upper	12.27
confidence interval, 99% lower	-2.79
confidence interval, 99% upper	15.36
median	5
mode	5
skewness	1.99
kurtosis	4.33
minimum interval width	2.71
maximum interval width	4.75

Measure/Row 8	*1*
count	10
mean	7.30
sample variance	32.68
sample standard deviation	5.72
minimum	2
maximum	20
range	18
sum	73.00
sum of squares	827.00
deviation sum of squares (SSX)	294.10
population sample variance	29.41
population standard deviation	5.42
standard error of the mean	1.81
confidence interval, 95% lower	3.21
confidence interval, 95% upper	11.39
confidence interval, 99% lower	1.43
confidence interval, 99% upper	13.17
median	5
mode	10
skewness	1.30
kurtosis	1.53
minimum interval width	2.57

Descriptive statistics

Measure/Row 11

	1
count	6
mean	5.17
sample variance	15.37
sample standard deviation	3.92
minimum	2
maximum	10
range	8
sum	31.00
sum of squares	237.00
deviation sum of squares (SSX)	76.83
population sample variance	12.81
population standard deviation	3.58
standard error of the mean	1.60
confidence interval, 95% lower	1.05
confidence interval, 95% upper	9.28
confidence interval, 99% lower	-1.29
confidence interval, 99% upper	11.62
median	3.5
mode	2
skewness	0.65
kurtosis	-2.12
minimum interval width	1.14
maximum interval width	2

Measure/Row 12	*1*
count	5
mean	5.00
sample variance	9.50
sample standard deviation	3.08
minimum	2
maximum	10
range	8
sum	25.00
sum of squares	163.00
deviation sum of squares (SSX)	38.00
population sample variance	7.60
population standard deviation	2.76
standard error of the mean	1.38
confidence interval, 95% lower	1.17
confidence interval, 95% upper	8.83
confidence interval, 99% lower	-1.35
confidence interval, 99% upper	11.35
median	5
mode	5
skewness	1.28
kurtosis	2.00
minimum interval width	1.14