Information Technology Audit: Systems Alignment and Effectiveness Measures

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Declaration

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which to a substantial extent has been accepted for the qualification of any other degree or diploma of a University or other institution of higher learning, except where due acknowledgement is made in the acknowledgements.

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Signature

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Abstract

Information technology audit has proven to be a relatively new, less researched and rapidly expanding field among large, medium and even small businesses (commercial and non-commercial organisations). The implementation rate has grown rapidly and presents a huge growth market for audit consultants due to the need for transparency and compliance with regulation (for example: Sarbanes Oxley Act) and the need to be competitive in the marketplace. The audit process is being conducted mainly by consultants following a traditional process but using different proprietary approaches and mostly done manually. The purpose of this study is to present a scientific method to attach a purely measurement focus to the auditing process so as to provide an auditing as well as a quantitative outcome of the performance to the various IS entities that are audited using a novel automated method that can save organisations considerable resources in terms of time, cost and effort.

The nature of the topic directed the researcher to three domains of information system (IS) namely studies on IS measurement, IT governance and software engineering. These areas provided information on the nature of IS measurement and the models used; the process of auditing/measurement and the corresponding frameworks used; the principles and methodology of measurement of IS entities; and measurement models used both in the software engineering and information systems domain. The review of the literature gave rise to the research question and the COBIT-GQM (Control Objectives for Information Technology Audit) – Goal Question Metrics) model. The research question that had emerged out of the four propositions "How can an IT audit or governance framework be used to measure the effectiveness of IS entities in a scientific manner using customised and goal oriented metrics" along with the nature of data sought (positivist), guided the researcher to qualitative research using multiple case studies to test the theoretical model (grounded theory) that had emerged out of the literature review.

The theoretical model was automated (with a front end interface and a back-end database) and initially tested for usability issues. Then the common COBIT control objective that was obtained through an initial survey was entered into the database along with a set of questions and metrics (developed by the researcher by following the given GQM guidelines). This application that was demonstrated, and given for evaluation in four organisations gave rise to expected and surprising results. While the respondents expressed their desire to incorporate a customised and goal oriented measurement perspective to their IT audit/performance functions, that would save them time, effort and cost, numerous suggestions were provided that need to be incorporated into the model to make it fully functional. Notable among them are the need to embed a multiple contextual qualifying layer, incorporating benchmarking feature to the model, and the need to link this with the maturity model. These were incorporated into the model and a comprehensive model incorporating all the suggestions was created.

The qualitative case study method being used here more to evaluate a theory, provided a sound base for future studies to generate hypothesis that can be evaluated using quantitative survey methods for the model to be generalised. IT auditing being a relatively new, less researched, conventional and high growth oriented field, the use of an innovative, comprehensive, automated and scientific method of audit and measurement method will satisfy the implied need for organisations to incorporate the diverse audit/measurement/ control/standards into one comprehensive method and this research is a major step in this direction. Since the new model is comprehensive and can be automated organisations can economise in terms of time, cost and effort. Irrespective of the nature of economic cycle the need for economising in terms of cost, time and effort is universal for all organisations.

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List of Abbreviations

AICPA	:	American Institute of Certified Public Accountants
AT&T	:	American Telephone and Telegraphs, Inc
AUT	:	Auckland University of Technology
BS	:	British Standards
BSC	:	Balanced Score Card
CMM	:	Capability Maturity Model
CO	:	Control Objectives
COBIT	:	Control Objectives for Information Technology Audit
COCO	:	Chartered Accountant Criteria on Control
COSO	:	Committee of Sponsoring Organisation
CSF	:	Critical Success Factors
DCO	:	Detailed Control Objective
DP	:	Data Processing
ERP	:	Enterprise Resource Planning
eSAC	:	electronic Systems Assurance and Control
FISCAM	:	Federal Information System Controls Audit Manual
GAPP	:	Generally Accepted Accounting Principles
GASSP	:	Generally Accepted System Security Principles Committee
GQM	:	The Goal Question Metric model
HLCO	:	High Level Control Objectives
HP ITP	:	Hewlett Packard
HP	:	Hewlett Packard
IBM	:	International Business Machines
IEC	:	The Electro technical Commission
IEEE	:	Institute of Electrical and Electronics Engineers, Inc
IIARF	:	The Institute of Internal Auditors Research Foundation
IS	:	Information System
ISACA	:	Information Systems Audit and Control Association
ISO	:	International Organisation for Standardisation

IT	: Information Technology
ITCG	: Information Technology Control Guidelines
ITG	: Information Technology Governance
ITGI	: IT Governance Institute
ITIL	: The IT Infrastructure Library
ITSM	: IT Service Management
KGI	: Key Goal Indicators
KI	: Key Issues
KPI	: Key Performance Indicators
MIS	: Management Information System
MM	: Maturity Model
NASA	: National Aeronautic and Space Administration
NOREA	: Dutch Association of Registered EDP-Auditors
NZ	: New Zealand
NZPSAA	: New Zealand Postgraduate Study Abroad Awards
PRINCE	: PRojects IN Controlled Environments
PWC	: Price Waterhouse Coopers
ROI	: Return On Investment
SAS	: Statement on Auditing Standards
SE	: Software Engineering
SMU	: Singapore Management University
SOX	: Sarbanes Oxley Act
SSE-CMM	: Soft Systems Engineering- Capability Maturity Model
SWEBOK	: Software Engineering Body of Knowledge
TQM	: Total Quality Management
US	: United States

Chapter – 1

Introduction

1.0   INTRODUCTION

The focus of this research is onto a set of IT control frameworks that have been popularised during the 1990s in response to growing concerns at the cost of IT projects and the expectation gap between promise and delivery. The demand for IT audit for example has surged and with this various non-engineering control models have been popularise for business IT control. Various reasons contribute to this trend and some major reasons cited are the promulgation of the Sarbanes Oxley Act of July 30, 2002 in the United States in the wake of the Enron scam (Brown and Kelly, 2005; Damianides, 2004); the requirements by the Securities and Exchange Commission, UK on the fulfilling the requirements of the Combined Code and Turnbull Guidance and the Australian standards AS 8015:2005 (ITGI Ltd, 2005); the increased threat to information through hacking and information theft from within the organisation and external to the organisation (Solms, 2005a); the need to effectively manage risks through IT governance framework (Lainhart, 2001); the increasing need for organisations to seek ways to align the IT goals with business goals (Van Grembergen, Haes & Moons, 2005); and the inadequate view of how IT is performing (Sraeel, 2004).

This research addresses the concern that the new wave of IT business control models tell what is to be done to rectify the perceived problems in the IT – business relationship but never say how to do it. In part the new approach reflects the accounting / audit (not engineering) origins of the models and also the business belief that knowledge is power and hence knowing what is not only necessary, but also sufficient for success. This research adopts a different view that may be seen as a moderate position between the worlds of software engineering and corporate audit to work out a practical model for measuring dynamic information systems entities in any organisation using customised goal oriented metrics balanced towards an IT audit perspective. The moderating point is that a long standing software engineering model

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is to be adapted to best fit a new wave IT control model. The expected outcome is a demonstration of how information systems business performance can be measured.

It is the contention of this thesis that the set of possible measurement models for information systems is incomplete (explained in section 2.1.5) and that there is still room for the adaption and adoption of alternative effective measurement models. Systematically managed information systems in an organisation can be a powerful strategic business enabler (Dodds, 2004). Keeping the score provides the data for decision making and without data from measurement it is like practicing and not playing. The establishment and monitoring of performance measures provides the fundamental information resource for strategic alignment, risk management, IT value delivery and IT resource management (Kordel, 2004).

1.1   STUDIES ON IS MEASUREMENT

Studies have been done to find out the key issues emanating from information systems in organisations (Powers and Dickson, 1973; Dickson, Leitheiser, Wetherbe & Nechis, 1984; Hartog and Herbert, 1986; Brancheau and Wetherbe, 1987; Moynihan, 1990; Neiderman, Brancheau & Wetherbe, 1991; Moores, 1996; Gottschalk et al. 2000), and the critical success factors for IS success (Martin, 1982; Magal, Carr & Watson, 1988). IS effectiveness evaluation and measurement was a major issue in these studies. There have been numerous efforts to directly research and evaluate IS benefits (Jurison, 1996); user satisfaction (Ives, Olson, & Baroudi, 1983); performance (Chang & King, 2005; Lucas, 1975; Saunders & Jones, 1992; Singleton, McLean, & Altman, 1988); productivity (Brynjolfsson & Yang, 1996.; Jurison, 1996; Scudder & Kucic, 1991); effectiveness (Evans, Bailey, Moor, & Roberts, 1988; Miller & Doyle, 1987; Pather & Remenyi, 2004; Yuthas & Young, 1998) IS success (Ballantine, Boner, Levy, Martin, Munro & Powell, 1996; DeLone & McLean, 1992; Ishman, 1996; Saarinen, 1996).

The measurement of information systems can be achieved from different perspectives and has provided numerous information systems measurement models. Among them are the information systems production model of Kriebel and Raviv, (1980), the six dimensional model of DeLone and McLean (1992), the three

dimensional model of Ballantine, et al., (1996), the expanded instrument framework of Saarinen (1996), the two dimensional model by Seddon, et al., (1999), and the functional scorecard of Chang and King, (2005). While these models provided much needed frameworks for evaluating IS effectiveness, the finer aspect of measurement (the methodology concept of assigning metrics) using metrics has not been adequately addressed. Singleton et al., (1988, p. 325) remarked that the question of the performance of the information systems department is a difficult one to answer for both the IS professional and the top management. Hence there is a greater "need to answer the question in a more exact manner."

1.2   GAPS IN THE RELEVANT KNOWLEDGE AREAS

The various models used in information systems research (reviewed in section 1.1) provide a framework for categorising and evaluating information systems effectiveness. However, there are a few areas not adequately addressed by the past studies. Seddon, et al., (1999, p. 2) notes that "a large number of IS effectiveness measures can be found in the IS literature. What is not clear in the literature is what measures are appropriate in a particular context." Measures are required to measure the information systems entities and it was observed that a metrics generation model is lacking in this field. The lack of metrics in measuring information systems performance has prompted Zahedi, (1997, p. 792) to comment that "Although millions of dollars are spent on developing information systems, little attention has been paid to formal metrics of information system performance." Most of the studies in IS measurement have not focussed on "directly addressing the comprehensive evaluation of the IS function. No one has developed a validated metric" (Chang and King, 2005, p. 88). Hence while reviewing the information systems measurement frameworks, the researcher located wide gaps in knowledge and problem areas for current theory with respect to metric generation model usage.

1.3   OPERATIONALISING THE RESEARCH

The review of the IS measurement literature identified issues and problem areas for business best practice. In particular the definition of 'how to do' in current

measurement frameworks has left unanswered the finer aspects of doing the measurement activity. Consequently, the research question: **How can an IT audit or governance framework be used to measure the effectiveness of IS entities in a scientific manner using customised and goal aligned metrics? (see section 3.1)** was selected that define the contemporary need to measure IS performance from an audit perspective (Here the term "customised' refer to the context for which the metrics are generated). The rationale for taking an IT audit perspective of IS performance measurement was prompted by the presence of well developed measures, tools and procedures in some of the IT audit frameworks reviewed and the practical use of these tools by the organisations with an IT audit framework.

The research question drives the researcher to three areas of information systems. First the research started in the field of information systems measurement and the concepts and principles of IS measurement before moving to the core IT governance field. Finally the review targeted the software engineering filed for principles and models of scientific measurement (since measurement using metrics have taken root in this field for over 50 years). The ensuring research questions directed the researcher to qualitative analysis using case studies [see section 3.2]. A software prototype was built for evaluation, it is tested in business practice, and end-user feedback collected for model improvement.

1.4 EXPECTED RESEARCH OUTCOMES

The intention of the research is to answer the question relating to "How" to measure information systems in the specific field of IT. As a consequence it is expected that a number of research outcomes are possible. In the first instance it is expected to learn from the practitioners in the field study the limitations of the prototype and hence the starting points for further development. The intention is to build the working prototype from the principles and concepts contained in the literature and then to have up to six practitioners use the software model. These practitioners will have time to evaluate and report their views of capability and applicability in practice of the prototype. The expected outcome of this research is a comprehensive tool for the practitioners of IT governance and audit implementation. The predominance of

literature that prescribes "What" to do in the matters of measurement and metrics is most often the literature that has been written from a business perspective. In this literature the specification of "What" is considered sufficient. However in the current world of flat management structures and pragmatic philosophy automated solutions have closed the gap between "What" and "How". It is expected to find variation between what is prescribed in governance and control framework literature and how effective implementation occurs. In section 2.2.1 for example it is shown what is prescribed in the metrics guidance for the COBIT 4.1 control framework is at variance with best management practice. There are also errors and omissions that are consistent with inadequate articulation of theory and demonstrated understanding of the task of theory in relation to practice.

The overall impact of this research has expected implications for users and also for those who develop theory and theoretical control frameworks (such as COBIT, ITIL, Val IT, and so on). The potential for commercialising automation software for the implementation of organisational control objectives is advanced in this proposed research. One of the key concerns in audit and quality control of systems is the excessive messaging and documentation associated with process control. Similarly at the higher level of enterprise governance standardisation in communication and reporting is a mammoth task. One expected contribution of this research is tactical knowledge for the building of software automation tools for the efficient measurement of enterprise wide goal oriented metrics.

1.5   POSITIONING OF THE STUDY

The measurement of performance is just one aspect of IT audit which is a sub set of IT governance. For the purpose of illustrating (figure 1.2) the positioning of the study in relation to the broad IT governance framework a search on IT governance literature shows a holistic and integrated IT governance framework where measurement is viewed as one of the two operating functions of IT governance (Dahlberg & Kivijarvi, 2006). The topic of study concerns IT audit and systems alignment, and from the figure it is evident that the IT governance process starts with business-IT alignment in the planning phase that have a guiding impact on the operating phase.

In this phase the monitoring of it resources, risks and management is impacted by the monitoring of IT performance measurement. The ultimately affect is the benefits, costs, opportunities and risks. Hence measurement is seen as one of the inevitable component in the IT governance process.
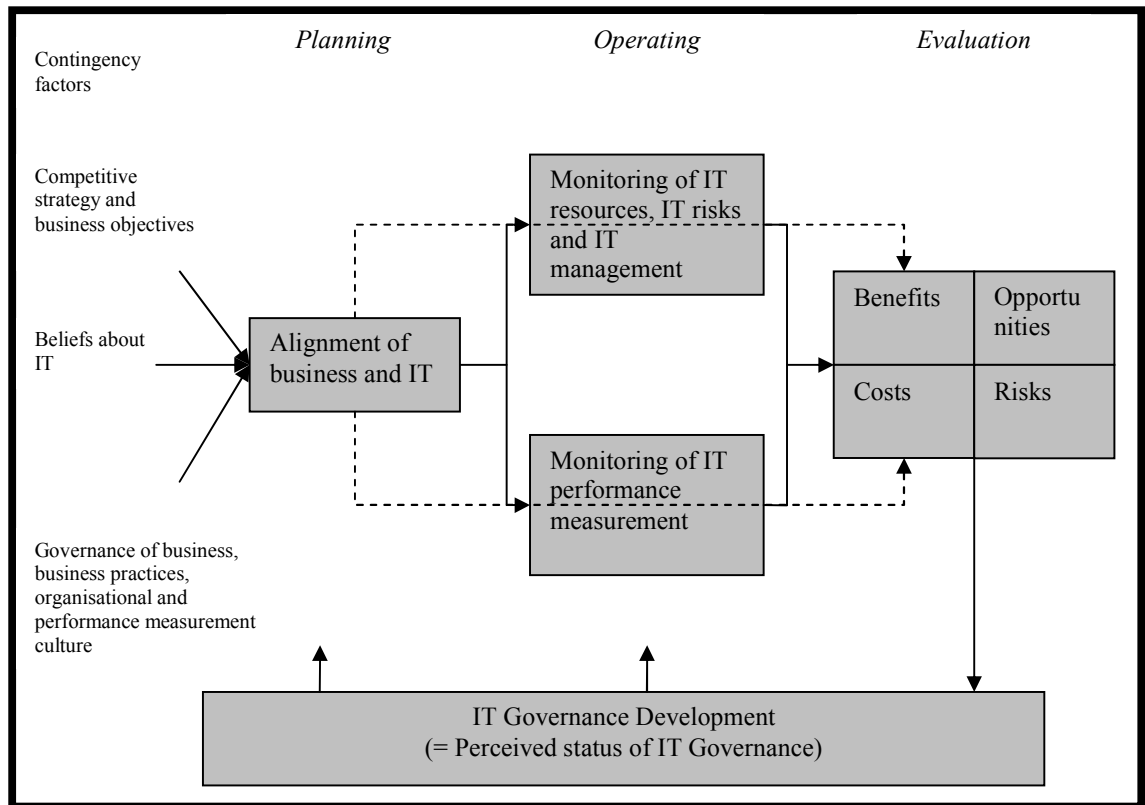
Figure 1.1: Integrated IT Governance framework (Dahlberg & Kivijarvi, 2006)

1.6   STRUCTURE OF THE THESIS

The thesis is structured into six main sections (five leading chapters apart from the chapter on introduction and conclusion). Chapter two that starts with the literature review, includes the research on the three domains of IS namely IS measurement, IT governance and software engineering. Section two is included in the same chapter itself as a separate distinct section (2.4). This section present the theoretical model that have been generated through the analysis of the literature review of the three IS domains. Section three (chapter 3) outlines the methodology of conducting the empirical research and the rationale for doing so. Section four (chapter 4) uses the first two steps of LeCompte (2000) to present an initial analysis into the primary data.

The fifth section (chapter 5) involves a deep analysis of the data using the last three steps of LeCompte, to arrive at the final evaluation of the automated theoretical model. The end result of this section is the comprehensive model that is the result of the theoretical and empirical research. The flow of the sections are graphically represented in the figure below.

Figure 1.2: Structure of the thesis

1.7   CONCLUSION

Even though *IT audit* is a sub set of IT governance, the nature of research ('*systems alignment*') encompass the core concept of IT governance and '*effectiveness measures*' is an integral part of it. Thus a confluence of these three reveals that the purpose of this research is to identify and analyse an approach/model/method that provides a scientific and quantitative measurement perspective to the domain of IT governance and audit for better alignment of not only the business goals with the IT goals, but also the alignment of the IS goals with the metrics. The quest for this starts with the research on the first of the three overlapping domains and related domain (IS measurement) then moving into the core domain (IT governance) for further answers where an overlap was seen between this domain and software engineering. These three domains not only identified the gaps in the literature but also provided a guideline for IS measurement in the form of various models and principles. The fact that the IT audit process involves considerable effort in terms of time and cost, the research can also aid in economising the scarce resources (human resource and money) of the organisation. Moreover considering the relative recent arrival of IT governance and IT audit, a study of this nature is also sure to shed much valuable insight into the different aspects of IT governance and audit.

Chapter – 2
Literature Review

2.0   INTRODUCTION

Performance measurement research had a surge of interest over the last two decades (see section 1.1). The purpose of this study is to propose a method of measuring information systems in a 'more exact' manner using customised goal oriented metrics. Three related areas in the information systems discipline are targeted for research, namely information systems effectiveness measurement, IT governance, and software engineering (SE) metrics. A comprehensive inquiry is hence proposed to search, analyse, evaluate and propose an integration model for these three subsets of the field of information systems. Numerous studies have been done on evaluating and measuring information systems effectiveness from different perspectives and models have been proposed for the purpose. An analysis of these studies can show the methodologies of IS/SE measurement, the models used and proposed, the various perspectives of IS/SE measurement, their strength and weakness, the challenges faced, and areas for future research.

The literature reviewed in this chapter is evaluated from an IT audit perspective. The perspective is a relatively new field of information systems studies that has matured in the second half of the last decade. Regulations and compliance requirements such as the Sarbanes-Oxley Act, Turnbull Guidance, and Basel-II hastened the process of adoption of IT audit and control frameworks in organisations. The field of software engineering has provided principles, concepts and models for measuring the software development process in a 'more exact' manner and some of these concepts have subsequently made their way into IT governance frameworks.

This chapter is divided into five content sections. The first section (2.1) reviews the literature on the measurement of IS effectiveness. It is divided into six sub sections that respectively review the requirement of IS effectiveness, the challenges of IS measurement, the various perspectives of IS success, measurement principles, measurement model reviews, the evaluation of

measurement models, and a brief review of the commonalities in IT Governance and IS measurement. Section 2.2 concentrates on a select literature from IS measurement and IT Governance. In five sub sections and subsequent divisions the claims of the frameworks are critically reviewed and mappings made between. This is the first of two exploratory sections that seek to define specific problem areas in current advocacy and theories for potential further investigation. Section 2.3 continues the exploratory analysis from literature by reviewing software engineering frameworks for measurement. Critically, metric generation models are identified and presented as comparative critiques. In section 2.4 the problem of integrating different metric models is addressed and the potential of moving towards a working model described. A plausible construct is modelled and theoretically demonstrated. The final content section 2.5 summarises the investigative review of literature by tabulating a set of propositions that have potential for researching.

2.1 MEASUREMENT OF IS EFFECTIVENESS

The measurement of IS effectiveness is a contested area of research. The current understanding is that effectiveness can be measured from control objectives and also from stakeholder perspectives. As a consequence there is no one way to measure effectiveness. In the following sections and sub sections the motivation for measurement is reviewed (2.1.1) and then the sub sections review the dimensions of perspective, IS approaches, SE approaches, and CSF approaches. Section 2.1.2 reviews the challenges faced by researchers attempting to measure IS. Section 2.1.3 furthers the perspectives debate by drilling down into the IS literature on effectiveness. Section 2.1.4 reviews published measurement principles and looks at the different ways the principles are applied. Section 2.1.5 reviews 18 measurement models used in different fields of study to identify the model/models that have similar characteristics and applicability to the measurement of IS effectiveness. Section 2.1.6 then reviews the overlap between IT audit and IS measurement concepts.

2.1.1 The Need For Measuring IS Effectiveness

The motivation to measure IS effectiveness has been driven by the increasingly dominant role computers have played in enterprise systems. Researchers and

managers have been trying to find out ways to make computers effective and to gauge the usefulness in organisations. Hence a holistic view of the relevance of measuring IS effectiveness has been taken from the entire IS domain, including the software engineering field. In the light of the innumerable risks involved and the enormous investments in IT, the need to measure IS effectiveness or to assure IS services has prompted organisations to give a greater emphasis on IS audit and measurement. In a study done by PricewaterhouseCoopers (PWC, 2003) on the strategic value of IT governance (on a sample of 7000 respondents from various organisations), it was found out that one of the top 10 IT- related problems cited by these respondents is the inadequate view of how well IT is performing. Hence in the light of the strategic value placed on information systems, it is expected looking at the relevance of measurement from both the information systems and software engineering perspective.

2.1.1.1 Measurement relevance – an IS perspective

In the 1970s McLean (1973, cited in Singleton, et al., 1988) pointed out that information systems should be measured like any other part of business. In fact measurement of information systems success is one of the most enduring research topics in information systems (Markus, et al., 2000) and is critical to the understanding of the value and efficacy of information systems (DeLone & McLean, 2003). Measurement of information systems success has long been a topic of interest among researchers in MIS (Sanders & Garrity, 1996). It has been observed that measurement drives performance and thus not only monitored measures get high visibility within an organisation, but people strive to achieve high performance with respect to these measures (Suleiman, et al., 2005).

From a financial perspective, measurement of IT resources has gained greater importance due to the high risk of IT investments and the effort spent on information systems measurement. This is evident from the fact that over 20% of the corporate IT budget, which is in the US $500 billion, does not achieve its objective (Knowledge@Wharton, 2005). Moreover it had been estimated that an average organisation spends 25,000 person days on performance measurement and planning for every US $ 1 billion worth of sales (Neely & Bourne, 2000). The adoption of enterprise systems and Internet saw expenditure on information systems growing rapidly. In the early part of the 1990s, Saunders and Jones (1992,

p. 64) not only emphasised that "the annual investment in IS and related technology represents approximately one-third of total corporate capital spending" but also states that "given an environment of escalating IS expenditures, along with expanding dependence on IS for maintaining organisational performance, evaluating IS function performance becomes increasingly important." From an assurance point of view, the need for assurance on information systems will be double or triple that of a normal financial accounting procedure (Elliot & Pallais, 1997).

2.1.1.2 Measurement relevance – an SE perspective

The relevance of measurement in the engineering discipline was defined by Basili, et al., (1994) by stating that 'measurement is a mechanism for creating a corporate memory as it helps (during the course of a project) to assess its progress, take corrective action based on the assessment, and to evaluate the impact of such action'. Information systems being a super set of the SE discipline, this statement has much relevance. Measurement of any information systems entity starts with evaluating the attributes of that entity. The importance of attribute measurement was highlighted by Finkelstein, (1982, cited in Fenton & Pfleeger, 1997, p. 7) when he stated that "one of the aims of science is to find ways to measure attributes of things in which we are interested". The importance of measurement in software project management was emphasised by (Ince, et al., 1993, p. 59) by stating that "once something can be measured, you move away from the world of opinion towards the world of fact". Thus he differentiated subjective measurement from objective measurement and commented on the present state of existing measurement by stating that "most measures of project progress are informal, and hence open to interpretation". The need for a robust measurement system for measuring information systems projects was argued to have financial benefit as "the careful use of numerical measures can introduce precision and clarity to the process" (ibid).

2.1.1.3 Key issues in IS

Apart from the relevance of IS measurement deductively given by researchers and the financial importance it had gained, it is worthwhile to view it from research conducted in the last two and half decades. The research shows how measurement

is positioned in the stakeholder's mind, the different perspectives involved, and the changes in perspectives over time. Numerous studies have been conducted in the 1980s, 1990s and in the twenty first century on the key issues (Brancheau & Wetherbe, 1987; Dickson, Leitheiser, Wetherbe, & Nechis, 1984; Gottschalk, Watson, & Christensen, 2000; Hartog & Herbert, 1986; Moores, 1996; Moynihan, 1990; Niederman, Brancheau, & Wetherbee, 1991; Powers & Dickson, 1973) in IS, and the critical success factors for IS success (Magal, Carr, & Watson, 1988; Martin, 1982). In this section the key issues (KI) will be analysed first followed by studies on the critical success factors (CSF). This will certainly shed much light on the IS measurement issues facing organisations worldwide.

Measuring and improving IS effectiveness/productivity was of great concern during the beginning of the 1980s as it ranked fifth among the ten key information systems management issues (Dickson, et.al., 1984) of the 1980s. But in a subsequent study conducted on MIS managers (Hartog & Herbert, 1986) this aspect slipped to the fourteenth rank with a different perspective termed as 'measuring productivity' of IS. Two new major issues were 'MIS planning and alignment', and 'controlling the technological and management pressures created by end-user computing'. These studies gave further impetus for similar studies and in another study done by Brancheau and Wetherbe (1987) on the key issues in MIS, they found that measuring IS effectiveness was ranked ninth (by IS managers, but ranked fourth rank from the general manager's perspective) among the list of the top twenty factors. But one notable feature of the study was the presence of new factors that are related to information systems effectiveness and control namely strategic planning (first rank), competitive advantage (second rank), IS' role and contribution (fourth rank) and alignment in organisation (fifth rank) among the first five factors. It can be seen that these factors are all directly or indirectly related to IS effectiveness.

Studies conducted during the 1990s presented a different perspective of the importance of IS measurement probably due to the widespread adoption of ERP systems and the Internet. In an industry wide stratified study using Delphi technique by Niederman, et.al. (1991) on the key information issues facing the 1990s, 'measuring IS effectiveness and productivity' ranked sixteenth while 'developing an information architecture' (as mentioned earlier ERP and internet contributed to this trend) took the top position. The years following gave great

change due to Internet and the emergence of the concept of IT governance. A notable study (Watson, et.al., 1997) conducted just after the mid 1990s is critical to the understanding of the top global issues. The top five issues (out of 27) were corporate related namely 'developing an information architecture', 'making effective use of the data resources', 'improving IS strategic planning', 'using IS for competitive advantage' and 'aligning the IS organisation with the enterprise'. Although some similarities can be seen in the results of the study with the previous two studies conducted in the 1990s, it is interesting to note that 'measuring IS effectiveness and productivity' is still in the top 20 (ranked 14th). Similarly a global study (Gottschalk, et al., 2000) conducted at the end of the twentieth century revealed that 'improving links between IS strategy and business strategy' as the number one concern of the study among the top ten issues, while 'IS measurement' took a different perspective in the form of 'IS' role and contribution' coming in the tenth place. The study did not show that the relevance of the issue had gone down. It only emphasised the dynamic nature of IS where many issues change perspective in due course of time, as is evident from the fact that the first issue of concern in the studies from the mid 1980s closely relate to the concept of IT Governance (which is explained in section 2.1.6).

2.1.1.4 Critical success factors (CSF) in IS success

CSFs can be viewed as a different approach to IS measurement and as the term implies these are factors necessary for the success of IS in an organisation. CSF focus attention on areas where things must go right for organisational units to be successful (Rockhart 1979, cited in Magal, Carr, & Watson, 1988). A early 1980s study was conducted by Martin (1982) on CSFs via a survey of top executives of IS in organisations with the objective of finding the CSFs for a successful MIS/DP department. The results presented 'systems development' as the most important one out of the seven given, while 'management control of the MIS/DP organisation' ranked fourth on the list, and 'support of the objectives and priorities of the parent organization' ranked sixth. The significance of the result is that the last two CSFs are more related to IT governance and audit concepts rather than measurement. Similarly in another study (Magal, et al., 1988) it was observed that the topmost CSF (among the 26 listed) was 'competent staff' while other audit oriented CSF like the 'control procedures to ensure standards, policies',

were included in the list of 26. Only one CSF was related to IS measurement, stated in the form of 'system performance.'

2.1.2   Challenges of Measuring IS Effectiveness

Measurement of information systems success has long been a topic of interest among researchers in MIS (Sanders and Garrity, 1996), and one of the most enduring research topics in information systems (Markus, et al., 2000). Although it is critical to the understanding of the value and efficacy of information systems (DeLone and McLean, 2003), "measuring the effectiveness of information systems activity is a difficult task" (Miller and Doyle, 1987, p. 107) and a major challenge to information systems managers (Jurison, 1996). The issue remains current today – "assessing the information systems function's performance has long been an important issue to IS executives" (Chang and King, 2005, p. 86).

Evaluating IS effectiveness can be a challenge as well as critical for managers. According to Jurison (1996, p. 75) much of the work done to date on the assessment of the impact of information systems "have produced mixed or even conflicting results". Moreover "many senior managers are dissatisfied with their capabilities for evaluating IS impact on organisational performance" thus implying that there is no effective method to evaluate IS effectiveness. The author further cites the work of Steers (1976) who emphasised the need for a contingent and continuous process of evaluation rather than an end-state or static outcome. This suggests the need for an instrument, framework or a model that can evaluate IS effectiveness on a continual basis.

While models provide a framework for categorising and evaluating information systems effectiveness, there are few areas not addressed by the past studies. Seddon, et al., (1999, p. 2) notes that "a large number of IS effectiveness measures can be found in the IS literature. What is not clear in the literature is what measures are appropriate in a particular context." Similarly while these models provided much needed frameworks for evaluating IS effectiveness, the finer aspect of measurement using metrics has not been addressed. When Singleton et al., (1988, p. 325) remarked that the question of performance of the information systems department is a difficult one to answer for both the IS professional and the top management he was referring to a narrow domain. Hence there is a greater "need to answer the question in a more exact manner."

Measures are required to measure the information systems entities and it was noted that a metrics generation model is lacking in this field. The lack of metrics in measuring information systems performance has prompted Zahedi, (1997, p. 792) to comment that "although millions of dollars are spent on developing information systems, little attention has been paid to formal metrics of information system performance." Most of the studies in IS measurement have not focussed on "directly addressing the comprehensive evaluation of the IS function. No one has developed a validated metric" Chang and King (2005, p. 86 - 88). They also stated that "while there exists metrics and instruments to assess specific IS sub functions and specific IS sub areas, such as data centre performance, productivity and data quality, typically these measures cannot be aggregated in any meaningful way". Thus there is a need to aggregate the metrics or to trace the metrics to the object. Hence while reviewing the information systems measurement frameworks, the researcher located large gaps in knowledge and problem areas for current theory with respect to metric generation model adoption for aligning the metrics with the goals.

2.1.3   Perspectives of Research on IS Effectiveness

Measurement of information systems being a complex domain it is not easy to classify the literature on IS measurement into different perspectives, because of two factors. First of all, the concept of "measurement mean different things to different people in different contexts" (Pedhazur & Pedhazur-Schmelkin, 1991, p.15) and secondly IS performance measurement is a complex task (Scudder & Kucic, 1991). Hence different approaches have been followed by researchers in analysing this topic. A review of literature on IS measurement studies have driven the researcher to focus on the studies that measure one or a few aspect/s of IS effectiveness, studies that attempt to measure IS entities from various perspectives, studies done on IS success measures, and studies done on the most important issues in IS.

2.1.3.1 Uni-dimensional nature of IS measurement studies

Studies have focussed on evaluating just one aspect of IS, namely IS contribution to sales force performance (Lucas, 1975), measuring the effectiveness of a single domain (e-commerce) within IS (Pather, Erwin, & Remenyi, 2003), measuring the

key dimensions of information systems development project (Xia & Lee, 2005), and, measuring IS performance concentrating on IS service (Singleton, McLean, & Altman, 1988). There are other studies that have tried to measure from a financial point of view namely cost-benefit analysis (Knutsen & Nolan, 1974) and productivity of computer systems (Knutsen & Nolan, 1974; Kriebel & Raviv, 1980). While frameworks and models have been postulated for IS measurement, the concern with these studies (with respect to the proposed study) is that there is not much evidence of metrics and/or goal oriented measurement. In addition, the models presented cannot be generalised into other perspectives.

2.1.3.2 Broad studies on IS measurement

Taking a broad view of IS, there are studies conducted to measure the overall IS effectiveness (without using any models) based on seven performance factors (Miller & Doyle, 1987). Even though Miller and Doyle's method of using a seven point Likert scale to measure the 76 attributes of a computer based information system, gives a more quantitative approach to IS measurement, it did not consider all the dimensions of IS, like IS security and planning. Moreover there is no evidence of a goal-oriented focus on measurement, nor customised metrics. Similarly a method of measuring the performance of the information systems function using specific measures on ten dimensions of the IS function by Saunders and Jones (1992), did not cover the entire IS domain and neither provides any subjective or objective metrics for the identified measures.

Considering the measurement of IS from a comprehensive, quantitative and functional perspective two models stand out. An 'expanded instrument for evaluating information system success, by Saarinen (1996) and a 'functional scorecard for measuring the performance of IS by Chang and King (2005). These two models are described and analysed in detail in section 2.1.5. While all of the above mentioned methods, models and frameworks have viewed IS measurement from various perspectives, the researcher could not locate a model that is multidimensional and that generates goals oriented metrics.

2.1.3.3 Dimensions of IS success measurement

While IS measurement is a critical aspect of studies done on IS success, they lack a measurement focus (Havelka, Sutton, & Arnold, 1998). Thus IS system

performance measurement and evaluation of system effectiveness or success are considered to be different (Alter, 1999). One of the earliest studies on information system success was done by Powers and Dickson during the first half of the 1970s. In their study focussing on the factors affecting information systems success (based on four criteria namely time, cost, user satisfaction and computer operations) they found out that each criteria of success was measuring a different dimension of MIS project success (Powers & Dickson, 1973). Thus a notable observation from this study is the acceptance of the concept of multidimensional aspect of information systems success which has been further researched and proved in a noteworthy study by DeLone and McLean (1992). Even though the motive of this widely quoted study was to create a 'well defined outcome measure' for MIS effectiveness, it doesn't tell how to measure the IS entities. The authors state that a well-defined outcome measure (or measures) is essential if information systems research is to make a practical contribution to the IS field.

Thus the concept of multi-dimensional view of IS success have given rise to many IS measurement models/frameworks. This aspect of IS success received widespread attention mainly through the six dimensional model of DeLone and McLean (1992), followed by the three dimensional model of Ballantine, et al., (1996), and the two dimensional model by Seddon, et al., (1999). While there have been numerous subsequent modifications on the DeLone and McLean Model, this research is not going deeper into it, as these studies are more concentrated on providing a classification of IS effectiveness measures than measurement, and serve more as a platform to built IS measurement frameworks. Among research on IS success, a notable one was conducted by DeLone and McLean's 1992 that "provides a scheme for classifying the multitude of IS success measures that have been used in the literature, into six categories" (Seddon, 1997, p. 240). Hence the main contribution of these studies is that they have provided a robust system of segregating IS domain into different dimensions that makes IS measurement easy to implement.

2.1.4 Measurement Principles - IS Perspective

While a critical analysis of these studies done in IS measurement would present the areas for further research and identifies the gaps in measurement (from the research topic perspective), it is worthwhile to analyse the contributions of these

studies (1) to the researcher's topic and, (2) to the information systems measurement in general. Unlike the field of software engineering, where there exists measurement concepts and principles, a set of scientific principles on measurement is lacking in the generic IS field. Hence in this section the researcher is taking a prescriptive and a deductive approach to come up with a set of principles for IS measurement. A prescriptive approach takes into account the studies done in the IS field that will aggregate the prescriptive views of the researchers on the best approach/advise to follow regarding IS measurement. In the deductive approach the researcher takes into account those studies done in the field in the last 25 years, and based on the techniques the researchers have used to measure or attempted to measure or provided a model to measure, a set of concepts or method of IS effectiveness measurement is arrived at.

2.1.4.1 Dimensions of IS success

'Success' from an information systems point of view have been described as "satisfaction with the system; systems effectiveness in meeting needs; value of benefits as compared to costs; and system utlilisation" (Conrath & Sharma, 1993, p. 268). Hence it is not easy to measure IS from a single dimension. Lucas's (1975) study that demonstrated a weak link between sales personnel performance and information systems indicated that measuring effectiveness of information systems uni-dimensionally may not produce an appropriate result. While Lucas's study made the reader to assume that a multidimensional approach for IS measurement is required, Miller and Doyle (1987) in their study indirectly stated the need for such an approach for IS measurement. This approach got a boost when, DeLone & McLean (1992, p. 60) published their seminal paper on dimensions of IS success, providing "six major dimensions or categories of IS success" thus emphasising the need to look at IS success from different perspectives. This model has been used for measuring information systems (Chang & King, 2005; Ishman, 1996; Saarinen, 1996) and subsequently modified by researchers (Ballantine et al., 1996; Pitt, Watson, & Kavan, 1995; Seddon, 1997).

2.1.4.2 Functional measurement of IS

A functional approach to IS has been recommend by Chang and King (2005) for measuring IS performance. According to Saunders & Jones (1992) an IS function

include all IS groups and departments within an organisation, while Seddon, et al., (1999, p. 6) describes IS function as "a system for making IT resources more readily available to other parts of the organisation". This also encompasses "various structures for the IS function, from centralised to distributed, yet specific enough to include only the formal IS function that can be readily identified" (Chang & King, 2005, p. 86).   Based on these definitions an IS functional level performance imply the measurement of the finer IS entities as opposed to a broader focus like 'IS efficiency' 'IS effectiveness' and 'IS success'. Thus a functional performance becomes a necessity for viewing 'IS efficiency' 'IS effectiveness' and 'IS success.' Even though the concept of functionality is highly subjective (as it is not easy to describe what comprise 'all IS groups' or 'various structures' in IS), a few studies have measured IS from a functional perspective (Dominic, 1987; Evans, Bailey, Moor, & Roberts, 1988; Malik & Goyal, 2001; Miller & Doyle, 1987; Saarinen, 1996; Saunders & Jones, 1992)

2.1.4.3 Objective (Goal Oriented) and subjective measurement

Hamilton and Chervany (1981) took a two pronged approach by proposing a goal centred view and a systems resource view for evaluating systems effectiveness. The interaction between IT and organisation being very complex and influenced by many mediating factors (Rosenkranz & Holten, 2007), it was seemed appropriate to have a multiple view of IS measurement. Hamilton and Chervany (2007) state that even though the two approaches have been used to evaluate system effectiveness, in practice the two should converge to get a real measure of effectiveness or system success.

Table 2.1 Summative & formative views of systems findings (Adapted from Hamilton and Chervany, 1981)

SYSTEM EFFECTIVENESS	
Summative view	**Formative view**
Goal centred view	System resource view
Asses the accomplishment of goals	Assess system quality
Objective	Subjective
Comparing performance to objectives	Standards for good practice
Effectiveness in terms of task objectives	Effectiveness in terms of resource viability
Provides information on the outcome	Provides information throughout the process
Helps to support decisions to continue or end	Helps in improving the means or process

The two pronged approach of IS measurement is summarised by the author in table 2.1.

A similar view was also put forward by Kriebel and Raviv (1980) who differentiated the quality characteristics or attributes of IS from the objective measure of the characteristic by defining the quality characteristics into timeliness, convenience, accuracy or precision, reliability or availability, flexibility of adaptability, and relevance or selectivity. The significance of these two studies lies in its separation of measurement into subjective and objective measures that can be seen in current measurement frameworks while some of the above mentioned summative and formative views are evident in software measurement (Boehm and McCall, 1977, cited in Fenton & Pfleeger, 1997) and in the IS audit framework COBIT IV (ITGI, 2005). Apart from this, Kriebel and Raviv proposed the idea of using or defining a goal/ performance standard/organisational function for the purpose of measurement. This is used by the software engineering model, GQM (Basili & Rombach, 1988) and the IT audit frameworks namely COSO, ITIL and COBIT.

2.1.4.4 Use of measures/metrics/scales

Researchers have used two approaches in this area. One set of studies divided the IS domain into separate, similar dimensions/entities, produced a set of measures for each of the dimensions and used rating scales (Chang & King, 2005; Saunders & Jones, 1992) for measuring IS performance. The second set of studies used similar dimensions/questionnaire and used rating scale/semantic differential scale without going through the process of defining the measures or metrics (Jurison, 1996; Malik & Goyal, 2001; Miller & Doyle, 1987; Saarinen, 1996). Hence IS measurement have been done using measures or metrics, and also by bypassing the metrics generation process. In these studies, it was observed that Likert scale is a common method for evaluating functional level performance followed by semantic differential scale (Chang & King, 2005; Doll & Torkzadeh, 1988; Evans, Bailey, Moor, & Roberts, 1988; Ishman, 1996; Malik & Goyal, 2001; Miller & Doyle, 1987; Pitt, Watson, & Kavan, 1995; Saarinen, 1996).

2.1.4.5 Performance oriented measurement

Although 'performance' is a common term associated with IS effectiveness measurement and success, different researchers view it differently. While at the

operational level the measures are efficiency and productivity (equating to performance), at the managerial level 'effectiveness' is the key and 'competitiveness' is the term associated with the strategic level (Anthony 1965, cited in Singleton, McLean, & Altman, 1988). In his effort to evaluate information systems, Lucas (1975) proposed the need to consider the relationship between the use of the system and performance. While Yuthas and Young (1998) identified four types of performance measurement in one functional area, Miller and Doyle (1987) isolated seven performance factors implying that IS success correlates with the perceived performance and importance of these seven factors. Thus there is a need to monitor information systems by organisations (Dominic, 1987), but it is not easy to measure the performance of IS in an organisation (Singleton, et al.,).

2.1.5 Models Evaluation

The purpose of this section is to identify the model that best conform or nearly fits into the proposed measurement concept being developed in this study (table 2.2). Out of the eighteen models evaluated, four models have at least 4 characteristics of a common measurement system and hence these models are further analysed to target potential adoptions. Out of these four models the models of Hamilton & Chervany, (1981) cannot be taken for analysis as the dimensions are not comprehensive enough to measure IS (unlike that of Saarinen, 1996). Likewise in the case of Saunders and Jones (1992) the ten dimensions mentioned do not give a comprehensive view of IS. The model of Chang and King (2005) is a model based on an input output performance model using three dimensions (systems performance, information effectiveness, service performance) where these three dimensions give rise to 42, 36 and 32 measures. These were in turn measured using a 5-point Likert scale. The strength of this model lies in the fact that the methodology used is robust, but since it follows an input-output model, the dimensions are too narrow to represent a typical IS domain. For example there are 36 measures for information and 32 for service and these measures are statements measured using Likert scales and thus do not represent the term 'metrics'. Hence measurement using attributes are missing.

Table 2.2   An evaluation of the various IS measurement models from different IS perspectives

	Multi-dimensions of IS success/ IS category	Performance oriented	Functional level	Goal oriented	Metrics/ measures	Use of scales	Metris systematically derived from goals
(Lucas, 1975)	x	√	x	x	√	x	x
(Knutsen & Nolan, 1974)	x	x	x	x	x	x	x
(Hamilton & Chervany, 1981)	√	√	x	√	√	x	x
(Dickmeyer, 1983)	x	x	√	x	x	x	x
(Ives, Olson, & Baroudi, 1983)	x	x	√	x	x	√	x
(Dominic, 1987)	√		√	x	x	x	x
(Miller & Doyle, 1987)	x	√	√	x	x	√	x
(Evans, Bailey, Moor, & Roberts, 1988)	x	x	√	x	x	√	x
(Doll & Torkzadeh, 1988)	x	x	√	x	x	√	x
(Scudder & Kucic, 1991)	x	x	√	x	√	√	x
(Conrath & Sharma, 1993)	√	x	x	x	x	√	x
(Saunders & Jones, 1992)	√	x	√	x	√	√	x
(Pitt, Watson, & Kavan, 1995)	√	x	x	x	x	√	x
(Saarinen, 1996)	√	√	√	x	?	√	x
(Jurison, 1996)	x		x	x	x	√	x
(Ishman, 1996)	√		?		x	√	x
(Malik & Goyal, 2001)	√	√	?	x	?	√	x
(Chang & King, 2005)	√	√	√	x	?	√	x

Taking the third model, it was observed that the author has given a comprehensive view of IS success. In an effort to develop an instrument for evaluating information system success, Saarinen (1996, p. 106) reduced the dimensions of success to four "consisting of the success of the development process, success of the use process, quality of the IS product, and impact of the IS on the organisation." He further subdivided each of these four categories into 16 subcategories and these sub categories are further divided into 52 measurable process or entities that are inherent in an information systems domain of an organisation. These 52 end units are then measured using a seven-point interval scale to find out the information systems success. The most notable feature of this

study is the demonstration of the instrument in explaining not only the 'what' aspect of information systems to measure, but also the 'how' aspect of measurement. Although the instrument does give a comprehensive measure of IS success, no metrics were used to measure the 52 entities/process, as the scale was not derived from any measures or metrics. For example, taking one entity/aspect/process namely 'accuracy' under the sub category 'information quality' coming under the dimensions 'quality of the product' Saarinen used a seven-point scale to measure this aspect. But it is to be noted that accuracy depends on a lot of factors and a more meaningful measure can be produced only if a set of metrics are developed in a systematic way that can measure 'accuracy'. A comparison of Saarinen's model with the popular IT controls like COBIT, COSO, SAC, and SAS 55 (Colbert & Bowen, 1996) revealed that it had more or less similar structure and methodology to COBIT.

2.1.6 Overlap of IT Governance/Audit Concepts with IS Measurement

The purpose of an IT audit is to evaluate IT controls (Mahnic, Klepec, & Zabkar, 2001) and in this section the definitions of 'IT audit' are analysed in order to find out the relationship between IT/IS audit and measurement of information systems. According to Strous (1998, p. 2), "an IT-audit is an independent and impartial assessment of the reliability, security (including privacy), effectiveness and efficiency of automated information systems, the organisation of the automation department and the technical and organisational infrastructure of the automated information processing." According to the Dutch Association of Registered EDP auditors (NOREA) an IT-auditor "assesses and advises on the following aspects of information technology: effectiveness; efficiency; exclusiveness; integrity; auditability; continuity; controllability"(ibid) a different perspective of auditing Hermanson (2006, p. 39) defined internal auditing as "an independent, objective assurance and consulting activity designed to add value and improve an organisation's operations." All the above definitions of the IT audit process have not only a measurement focus but separates the aspects of quality that is audited in an IT audit namely reliability, security, effectiveness and efficiency from the object of audit that are information systems, automation department and infrastructure.

2.1.6.1 Key issues in IS – IT governance perspective

The concept of IT governance emerged and became widely used only at the turn of the century (Grembergen, Haes, & Guldentops, 2004). It is also interesting to note that most of the concepts of ITG have been cited as key issues concerning the stakeholders of the organisation in studies of 1980s and 1990s. The IT audit frameworks enforces the concepts of 'assurance' and the 'alignment of IT goals with business goals' (Grembergen, et al., 2004; ITGI, 2005; Yip, Ray, & Paramesh, 2006). These were two main issues (Hartog & Herbert, 1986) cited among the top ten issues facing MIS managers. Likewise in a study (Magal, Carr, & Watson, 1988) on the critical success factors (CSF) for IS success they identified two factors related to IT governance/audit namely 'control procedures to ensure that standards, policies, are adhered to' and, 'monitor and coordinate end-user applications development.' Monitoring and controlling are vital IT audit process in IT Governance (Dahlberg & Kivijarvi, 2006). In another study on key IS issues by Niederman, Brancheau, & Wetherbee, (1991) it was observed that three issues in the top twenty are related to IT governance namely 'improving IS strategic planning' (3rd), 'aligning the IS organisation with that of the enterprise' (7th), and 'increasing understanding of the role and contribution of IS' (11th). Thus factors that are related to information systems governance/audit have got into the list of key issues.

A look at the top issues in the beginning of the 1980s reveals that the need to 'measure IS effectiveness' was of great concern while in subsequent years this aspect slipped down the list. In the meantime starting from the mid 1980s, ITG issues emerged; during the early 1990s it gradually climbed up the issues list and by the turn of the century took the top place among the top issues. A recent and comprehensive study on the key global issues in IS management was done by Gottschalk, et al. (2000) comparing the key issues in the US and the rest of the world based on 19 studies conducted on the subject in the 1990s. By adopting a Q-method analysis they found out that the highest ranked global key issue was 'improving links between IS strategy and business strategy' (a key objective in IT governance).

Table 2.3   Propositions derived from section 2.1

Propositions that have emerged from this section (2.1)
P 1: There is a need for an instrument/framework/model that can measure/evaluate IS effectiveness on a continual basis
P 2: The metrics for measuring IS entities need to be context based and aligned to the goal or objective or entity that it measures

2.2   IT GOVERNANCE AND IS MEASUREMENT

In the previous section in-depth reviews of literature were undertaken to locate current and evolutionary understandings of IS measurement. In this section the IT governance field is reviewed to locate areas where measurement is done, and to evaluate IT audit models. The methodologies and tools used for implementing IT governance are also reviewed along with the current measures/tools used for performance measurement and benchmarking so as to analyse the link between IS measurement and alignment. Finally sections 2.2.4 & 2.2.5 review the alignment issues and the mapping between COBIT and other IS measurement frameworks.

2.2.1   Measurement in IT Governance

Monitoring of IT performance measurement is one of the two operating phases (the other one is - monitoring of IT resources, IT risks and IT management) in IT governance development (Dahlberg & Kivijarvi, 2006). The motivation for undertaking an audit perspective of IS measurement stems from three reasons. Auditing is a form of control with a measurement perspective and secondly there are established frameworks in this field and thus there is no need to 're-invent the wheel'. Thirdly due to compliance and accountability requirements, the need forIT governance through internal control/IT audit has caught up with organisations. Even though the concept of IT governance did not feature in literature until the late 1990s (Brown & Grant, 2005; Grembergen, et al., 2004), it is an important issue on the agenda of many organisations (Grembergen, et al., 2004; Simonsson, Johnson, & Wijkstrom, 2007). One of the important objectives of IT governance is to align business and information technology strategies effectively and efficiently (Grembergen, et al., 2004; Wessels & Loggerenberg, 2006). The term 'IT governance' gained momentum in recent years and has been the focus of increased attention from both practitioners and researchers (Dahlberg & Kivijarvi, 2006), and has even become law for many companies (Hardy,

2006a). IT governance had been perceived and defined as a concept, set of functions, responsibilities, processes, a system of elements, a control structure, and an area of decision making. It is such a hot and debated topic that no one seems to be sure exactly what it is or how to explain it (Broadbrent, 2003). An analysis of the definitions of IT governance is taken from the literature to assess the role of measurement.

IT governance "refers to the patterns of authority for key IT activities in business firms, including IT infrastructure, IT use, and project management" (Sambamurthy & Zmud, 1999, p. 261). A control oriented definition of IT governance states that "IT governance is about assigning decision rights and creating an accountability framework that encourages desirable behaviour in the use of IT" (Broadbrent, 2003, p. 1) and how those persons entrusted with governance of an entity will consider IT in their supervision, monitoring, control and direction of the entity (ITGI, 2005a). The process nature of IT governance were indirectly implied by Parkinson and Baker (2005, p. 17) by stating that "governance has two equally important aspects – doing the right thing (driving performance) and doing things the right way (ensuring conformance)". A measurement inclusive description of IT governance explains it as "assessing the impact and nature of information systems, technology and communication; the development of the IS/IT skills bases; the consideration of business, legal and other IS/IT related issues" (Kakabadse & Kakabadse, 2001, p. 9).

Viewing IT governance from a control oriented perspective Webb, Pollard, & Ridley (2006, p. 3) explains that "IT control frameworks are any set of processes, procedures and policies that enable an organization to measure, monitor, and evaluate their situation in relation to predefined factors, criteria or benchmarks." The 'policies and procedures' concept of IT governance has also been emphasised by Posthumusa, Solms, & Mandela (2005). IT governance "have appropriate controls for: monitoring IT risks, controlling IT assets, compliance with laws and regulation and records management" (Hamaker, 2003) thus making it an appropriate tool for measuring information systems. A well managed IT governance system can help in ensuring return on investment through the achievement of enterprise's goals by adding value while balancing risk verses return in IT. The utility of IT governance tools and standards was highlighted by Hardy (2006) by stating that COBIT, ITIL and ISO 17799 are useful for the

growth and success of an organisation since an implementation of these ensures better ROI on IT investments, serves a guideline for compliance, reduces risks, optimises costs and helps in benchmarking.

An effective implementation of an IT governance framework delivers benefits to an organization since "IT governance addresses how to design and implement effective organizations by creating flexible IT and information systems structures and processes" (Patel, 2002, p. 33). A similar perspective of IT governance is evident in the statement that "IT governance is an inclusive term that encompasses the variety of elements that interact to provide IT services within an organization" (Bodnar, 2003, p. 27). IT governance in an organization ensures that "the organizational capacity to control the formulation and implementation of IT strategy and guide to proper direction for the purpose of achieving competitive advantage for the corporation" (Grembergen and Saull, 2000, cited in Patel, 2002, p. 34).

Even though the above definitions give a clear concept of IT governance and its functions, Rau (2004) considers it as a 'maligned and misused' term that have multiple meanings in different contexts. Thus there is a lack of consensus on its concept (Simonsson & Ekstedt, 2006) as the definitions of IT governance are broad and ambiguous (Mårten Simonsson & Johnson, 2006). A process and functional view reiterates the role of IT governance council as policy setting, control, performance measurement and reporting (ibid). The various definitions of IT governance taken from the literature and defined in this section (2.2.1) have been summarized and given in table 2.4. From the table a comprehensive definition of ITG can be formulated as IT Governance comprising of [A] does activities [B] targeting the domain of [C] with the functional objective of [D] so as to fulfil the corporate objectives [E] thus ensuring the alignment of IT goals with business goals. From the table it is also evident that measurement and measurement tools are an important aspect of IT governance to ensure the activities in [B] to measure the entities in the domain [C] so as to achieve the functional IT goals in [D] and thus achieving the overall corporate goals [E] so as to ensure the alignment of IT goals with business goals.

Table 2.4 IT governance framework incorporating components, activities, domain and objectives. (Model constructed by the author to summarize the findings)

IT governance Components [A]	Activities [B]	Object of Activities/ IT Domain [C]	IT Functional/ Governance Objectives [D]	Corporate Objectives [E]
-IT governance Policies -IT governance Procedures -IT governance Process -IT governance Functions -Measurement tools -IT governance Strategy -IT governance Guidelines -IT governance Best practice	-Controlling -Monitoring -Measuring -Identifying -Assessing IT -Development of IS -Safeguarding IT -Maintaining quality of IS -Advise on best practice -Maintaining security -Reporting	-IT assets -IT risks -Information -Stakeholders -IT staff and skills -IT procedures -IT process -IT policies	-Risk reduction -Effective utilization of IT resources -Alignment with corporate goals -Accountability -Transparency -Disclosure - Ensuring quality	-Compliance with regulations -Safeguard external stakeholders -Achieving strategic objectives -Ensuring competitive advantage -Benchmarking

2.2.1.1 Systems alignment and effectiveness measures

IT governance covers five major domains namely IT principles, IT architecture, IT infrastructure, business application needs, prioritisation & investments decision (Weill & Ross, 2005a) and is viewed as an approach to fuse business and IT (Grembergen, et al., 2004; Grembergen, Haes, & Moons, 2005; Liu & Ridley, 2005; McGinnis, Pumphrey, Trimmer, & Wiggins, 2004; Wessels & Loggerenberg, 2006). Strategic alignment of IT with the business objectives is a critical success factor for many companies (Bodnar, 2006) and a lack of strategic alignment by Gartner, Inc. has resulted in a drop of its share price from US $ 18 in March 2000 to US $ 6 in 2001 (Hamaker, 2003). Information systems is said "to be strategic if it is aligned with business goals and strategies, and if it has an impact on organisational performance" (Ravenaugh & Papp, 2000, p. 1149). The increased investments in information technology (Gartner Group 2003, cited in Webb, Pollard, & Ridley, 2006) have focussed on the need for business-IT alignment and thus alignment between business and IT has become a key concern for business executives (Luftman & Brier, 1999; PricewaterhouseCoopers, 2006). The link between performance measurement and business strategy is made clearer by Alves, Carmo & Almedia (2006, p. 75) by stating "to measure performance and effectiveness of goal accomplishment, some indicator concepts are currently being adopted by organisations. These indicators enable the evaluation of process alignment with business strategy." Thus strategic alignment of corporate goals

with business goals, IT goals and operational performance is critical for any business.

2.2.2   An Evaluation of IT Control/Audit Frameworks

While there are numerous internal controls and IT audit frameworks, it is challenging to identify a framework that can comply with comprehensive criteria for IS measurement. Since the objective of an IS audit is to evaluate IT controls (Mahnic, et al., 2001) a list of available controls can be evaluated to select context appropriate ones. Here apart from the criteria required, the popularity and the widespread usage are looked at while selecting the IT audit framework. "A control framework is a recognised system of control categories that covers all internal controls expected in an organisation" (IIARF 2002, cited in Liu & Ridley, 2005, p. 2) There are three categories of control frameworks namely business oriented controls like COSO (Committee of Sponsoring Organisation) and SAS (Statement of Auditing Standards); IT focussed controls namely ITIL (The IT Infrastructure Library), ISO/IEC 17799:2000 (The International Organisation for Standardisation/the Electro technical Commission) and the Security Code of Conduct; and a third category of controls that align control over IT with business goals namely, COBIT (ibid). In selecting controls businesses have wide choices namely BS 7799, CoCo, COSO, FISCAM, COBIT, GAPP, GASSP, ITCG, SAC, SSE-CMM, and SysTrust and out of these BS 7799, CoCo, COSO, COBIT, FISCAM, ITCG, SAC and SysTrust are goal oriented (Campbell, 2003) with control objectives for each IS entity (process or object of IS for measurement).

An internal control provides reasonable assurance regarding the achievement of objectives in the area of effectiveness and efficiency of operations, reliability of financial reporting and compliance with regulations (Pathak, 2003). Brown and Nasuti (2005), identified three internal control frameworks for IT governance namely COSO, COBIT and eSAC. According to Ramos and Pathak (2004, 2003, cited in Brown and Nasuti, 2005) COBIT is the generally accepted standard for IT Governance. From Table 2.5, it is evident that COBIT was regarded as a common framework by all the seven authors along with COSO endorsed by five authors, but the problem with COSO is that it provides little guidance regarding general IT controls (Edelstein, 2004). A comparison of COSO and COBIT revealed that both have similar definition of the term 'control'

(Colbert & Bowen, 1996). While COSO divides the IS into 5 components, that are further broken into 16, 80 and 250 sub components, COBIT divides the IS into four domains, 34 high level and 318 low level control objectives (Campbell, 2003). Based on the endorsement by the researchers and practitioners, and the correspondence of the 318 detailed control objectives to goals, the COBIT framework is selected for further mapping. Considering the PCI card industry (https://www.pcisecuritystandards.org/pdfs/pci_dss_saq_instr_guide.pdf) standard and guidelines, while the exists similarity of control objectives, questions and compliance requirements, it cannot be analysed for suitability due to its adherence to compliance, focus on a narrow domain, lack of goal oriented metrics and lack of a comprehensive measurement system.

Table 2.5 List of internal IT controls endorsed by researcher and practitioners

Internal Controls	(Larsen, Pedersen, & Andersen, 2006)	(Campbell, 2003)	(Colbert & Bowen, 1996)	(Deshmukh, 2004)	(W. Brown & Nasuti, 2005)	(Pathak, 2003)	(Carvajal-Vion & Garcia-Menendez,	(Dahlberg & Kivijarvi, 2006)
BS7799		✓						
CoCo		✓						
COSO		✓	✓	✓	✓	✓		
FISCAM		✓						
COBIT	✓	✓	✓	✓	✓	✓	✓	✓
GAPP		✓						
GASSP		✓						
ITCG		✓						
SAC			✓		✓	✓		
SSE-CMM		✓						
SysTrust	✓	✓						
ITIL	✓				✓			✓
SAS	✓		✓					
PPF - IAA				✓				
AICPA				✓				
ASL	✓							
CMMI	✓							
ITS CMM	✓							
ISO 17799	✓						✓	
SOX	✓							
Prince2	✓							

2.2.2.1 The COBIT IV framework

COBIT IV (2005) has been selected for the purpose of research and in this section it is defined and discussed why and how it is used. The term 'framework' is used for addressing COBIT (Colbert & Bowen, 1996; Hussain & Siddiqui, 2005; ITGI, 2005a; Kordel, 2004; Lainhart, 2001; Liu & Ridley, 2005; Myerson, 2006; Salle & Rosenthal, 2005; Simonsson & Johnson, 2006) rather than 'standard' (Allinson, 2003; Flowerday & Solms, 2005), or 'model' (Oliver, 2003), since the term 'framework' is widely used both in the academic and non academic literature to refer to COBIT. COBIT is an IT control framework (Kordel, 2004), and terminologies like 'COBIT framework', COBIT control framework', and 'COBIT IT control framework' will be used interchangeably in this study to mean the same.

COBIT is a comprehensive framework of control objectives based on 41 international source documents, providing a global perspective and a best practice point of view (Lainhart, 2001). It is a set of guidelines for IT auditing consisting of processes, practices and controls (Anthes, 2004). It has divided the IT activities into four domains namely (i) plan and organize, (ii) acquire and implement, (iii) deliver and support, (iii) monitor and evaluate, comprises around 34 high level control objectives (HLCO, also termed as control process) and 318 detailed control objectives (DCO). Since its introduction in 1996, COBIT had been revised thrice and currently 10% of the IT population worldwide use COBIT (ITGI, 2006). Published by the IT Governance Institute it is internationally recognised and accepted as a high level governance and control framework (Gaynor, 2002; Hardy, 2006a) and is a good information technology security and control practice framework (Mahnic, Klepec, & Zabkar, 2001). Since the low level objectives of COBIT is derived from the high level control objectives which in turn reflect the corporate objectives, it, is considered the most appropriate control framework to help the organisation to align its business and IT goals (Ridley, Young, & Carroll, 2004). The exhaustive collection of processes of COBIT focus on the fiduciary, quality and security needs of organisations by providing seven information criteria for evaluation (effectiveness, efficiency, confidentiality, integrity, availability, compliance and reliability) that define the business needs from IT of an organisation (Hardy, 2003). As the terminology of these criteria imply, an evaluation of these criteria necessitates the need for IS measurement.

COBIT is a breakthrough (Lainhart, 2001) multi-purpose business tool that is used worldwide (Gerke & Ridley, 2006; Yan & Makal, 1998) is the most effective and helpful tool for IT audit (Singleton, 2006). It is a trusted and internationally recognised standard that is being used increasingly by a diverse range of organisations throughout the world (Guildentops & Haes, 2002; Hussain & Siddiqui, 2005; Lainhart, 2000; Oliver, 2003; Ridley, Young, & Carroll, 2004; Singleton, 2006). It provides IT controls and IT metrics (Wallhoff, 2004) and is used as a high level governance and control framework (Gaynor, 2002; Hardy, 2006b) with growing acceptance worldwide (Guildentops & Haes, 2002).It is exhaustive (Edelstein, 2004) and encompasses the complete lifecycle of IT investment (Debreceny, 2006). Thus the framework is deemed appropriate for the purpose of research. Moreover since it can be used as a yardstick for gauging management's achievement of goals (Yan & Makal, 1998), this framework gives a measurement perspective.

The stated purpose of COBIT is to provide the business stakeholders with an information system governance model that helps in understanding and managing the risks associated with information technology (Oliver, 2003). The top down structure of COBIT ensures systematic management of the processes and "if each of these 34 processes is managed properly, proper information technology governance will result (Solms, 2005a, p. 100). Measurement of performance against goals is explicit in the COBIT process:

> "First, objectives are set. Set objectives provide direction to the organisation and execution of activities. Then the outcomes of the activities and decisions are measured. The measured performance is then compared to a set of targets and improvement activities may take place if results fall short of the set objectives (Dahlberg & Kivijarvi, 2006, p. 3).

Since COBIT has been viewed as an exhaustive framework, it needs to be mapped with the IT governance domain to see the extent to which COBIT covers IT governance.

2.2.2.2 Mapping of IT Governance domain with COBIT

The identification of the dimensions/domain of IS activity in IT governance is essential to the research in ensuring that the appropriate IT governance framework chosen for study best represents a comprehensive IS domain in any organization. The various definitions of IT governance were helpful in identifying the areas being covered by IT governance, but it is imperative that a more specific boundary needs to be defined to understand the domains that it operates. Domains may include decision areas being covered (Simonsson & Johnson, 2006), spheres of activity, and IT resources covered by IT governance models. Weill and Ross (2005b) have outlined five major decision domains covered by IT governance namely IT principles comprising of high level decisions, IT architecture, IT infrastructure consisting of IT services, business applications needs and prioritization and investment decisions. A similar set of IT domains was given by Sambamurthy and Zmud (1999) in the form of three spheres of activities that are directed, controlled and coordinated through IT governance such as IT infrastructure management, IT use management and project management. Even though these three domains mentioned are viewed from three different perspectives it is evident that the target of control of COBIT covers the entire IT resources (application, information, infrastructure, and people) through the 34 control objectives.

Table 2.6 A comparison of the ITG domain with the IS domain

IT Governance Domain				IS Domain
Weill and Ross (2005a) Decision domains	(Simonsson & Johnson, 2006) ITG domain	Sambamurthy and Zmud (1999) Spheres of activity	ITGI (2005) COBIT - IT Resources	Chang and King (2005) – IT Resources
- IT principles - IT architecture - IT infrastructure - Business applications - Prioritization and investment decisions	- Goal - Technology - People - Process	- IT infrastructure management - IT use management - Project management.	- Application - Information - Infrastructure - People	- Software - Integrated managerial and technical capabilities - Hardware - Human resources

Viewing from an IS measurement models perspective the IT resources of COBIT closely correlates with the resources of Chang and King (2005) than that of Saarinen (1996) thus implying that the target of measurement in IS and ITG are

not different (Saarinen was measuring IS success based on dimensions of IS success, rather than IT resources, and hence not included in the Table 2.6).

2.2.2.3 Mapping of IT Governance and COBIT focus areas

Regarding the focus areas of IT governance Oud (2005) has identified five major areas. These are IT strategic alignment, IT value delivery, risk management, performance management and stakeholder value drivers. The ITGI (2005) describe the focus areas of COBIT as strategic alignment, value delivery, resource management, risk management and performance management thus not implying the close integration of COBIT within IT governance, but displaying the role of 'performance measurement' in the IT governance process.

Table 2.7 Mapping of IT governance with COBIT focus areas

IT Governance (Oud, 2005)	COBIT (ITGI, 2005a)
- IT strategic alignment - IT value delivery - Risk management - Performance management - Stakeholder value drivers	- Strategic alignment - Value delivery - Risk management - Performance management - Resource management

2.2.3 Measurement in COBIT

Performance measurement is an essential part of IT governance and it "includes setting and monitoring measurable objectives of what the IT process need to deliver (process outcome) and how they deliver (process capability and performance)" (ITGI, 2005). This correlates with the measurement theory in the software engineering field which is "about the systematic assignment of numbers to represent some attributes of an object or an event of interest" (Mock and Grove 1979, cited in Saltero, 1998, p. 93). The objective of the measurement focus in COBIT is evident from the statement - "A basic need for every enterprise is to understand the status of its own IT systems and to decide what level of management and control the enterprise should provide" (ITGI 2005, p. 18) and this is a challenging task. Regarding the difficulty of objective measurement in COBIT, ITGI (2005) states that "obtaining an objective view of an enterprise's own performance level is not easy" but still emphasizing the organisations' "need to measure where they are and where improvement is required" (ibid).

COBIT has a structured set of measurement framework consisting of 'key performance indicators' (KPI), 'key goal indicators' (KGI), activity goals, process goals and IT goals (ITGI, 2005). COBIT makes use of the maturity models, for evaluating the maturity levels of the organisation, and the balanced score card helps in performance measurement where the IT balanced scorecard is linked to the business scorecard thus supporting the IT/business governance framework. The measurement framework of COBIT also includes a set of metrics for each of the 34 high level control objectives that correspond to high level information systems process apart from the metrics in the form of KPI, process KGI and IT KGI.

2.2.3.1 Measurement tools in COBIT

Performance measurement in COBIT is done through metrics that measure goals. In all of the 34 higher level control objectives (HLCOs), there are three types of goals namely IT goals (that define what the business expects from IT), process goals (that define what the IT must deliver to support IT objectives), and activity goals (for getting the process under control). Regarding metrics there are two types in COBIT namely goal indicators and performance indicators that measure the activity goals, process goals and IT Goals. Key performance indicators (KPI) "define measures that determine how well the IT process is performing in enabling the goal to be reached", while key goal indicators (KGI) "define measures that tell the management - after the fact – whether an IT process has achieved its business requirements" (ITGI, 2005, p. 23). Figure 2.1 illustrates this with an example from COBIT.

2.2.3.1.1 Issues in measurement using COBIT KPI and KGI

For every category of goal (activity, process and IT goals), there is a generic set of metrics namely KPI, Process KGI and IT KGI respectively. The issue here is that first of all these are generic and secondly it is not easy to trace the metric to the particular goal. Every organisation requires a set of metrics tailored to their needs and COBIT being a flexible (Dawada, 2006) and a generic tool (ITGI, 2005) the goals and metrics needs to be tailored to the environment. Hence there is a need for a method to generate customised and goal oriented metrics as this would greatly aid in the functional measurement aspect of COBIT implementation. This

weakness has been illustrated in an implementation of COBIT in Hewlett Packard where Salle and Rosentall (2005, p. 8) cite two problems namely measurement and automation. They stated that "it is clear that the presented KGIs and KPIs might not be all measured and future work would include selecting the indicators that can be measured in the current instantiation of the HP ITP systems as well as bringing about some degree of automation in the reporting framework".

2.2.3.2 Measurement models in COBIT

ITGI has adapted the Capability Maturity Model of the Software Engineering Institute to suit the COBIT framework mainly for the purpose of benchmarking. For performance measurement they have recommended the balanced scorecard of Kaplan and Norton. An analysis is done on these two models to evaluate whether a goal oriented measurement can be done using customised metrics. Maturity models being benchmarking oriented rather than performance, the analysis will focus more on the BSC rather than the COBIT MM.

2.2.3.2.1 Maturity models in COBIT

The COBIT Maturity Model is used to measure how well developed the management process are with respect to internal controls (Pederiva, 2003) rather than a measurement tool. ITGI (2005) has stated in COBIT IV that capability, performance and control are the three aspects of maturity. Thus benchmarking in COBIT is done through maturity models (MM) for each of the 34 control processes for identifying necessary capability improvements. These MMs with six levels provide a method of scoring where an organisation can grade itself from non-existent to optimized (Guildentops, Grembergen, & Haes, 2002). The COBIT MM derived from the software engineering institute's Capability Maturity Model responds to three requirements for organisational needs, namely to show the relative measure of where the enterprise is; guidance on where the organization need to go; and it acts as a tool for measuring progress against the goal (ITGI, 2005). Evaluation is done from non-existent (0) to optimized (5). It has been emphasised in COBIT that the "COBIT maturity models focus on capability, but not necessarily on performance" as it "is a way of measuring how well developed management process are" (ITGI, p. 21). Being a purely maturity

model, there is no need for a deep analysis into the COBIT MM to find out whether the CIBIT MM can serve as a measurement tool.

2.2.3.2.2 The balanced score card

An evaluation of the IT BSC in COBIT as a performance measurement tool, is undertaken to address the issue of whether this popular tool can be used to scientifically generate customised and goal oriented metrics. The concept of using the score card was emphasised and recommended in COBIT to measure the goals and metrics of the 34 IT process (ITGI, 2005, , 2007a). Unlike the COBIT MM, where a set of maturity models have been given for each of the 34 processes, detailed guidelines are lacking for applying the BSC for these 34 IT processes. External support for using the BSC have been provided by Grembergen (2000) According to him, since the IT goals are derived from business goals, an IT balanced scorecard can be linked to the business balanced score card thus supporting the IT/business alignment process using a cascade of scorecards. Giving the methodology of implementation of the BSC in COBIT, Grembergen, (2000, p. 7), states that "within an IT BSC the cause-and-effect relationships are established and the connections between the two types of measures, outcome measures and performance drivers are clarified" Thus the BSC used in COBIT defines the cause and effect relationships, defines the outcomes and performance drivers, and finally links the scorecard to the financial/business outcome measures. Accordingly the exercise involves translating each of the four perspectives on the IT BSC into corresponding metrics and measures that assess the current situation (ibid). The issue here is 'how' to assign the metrics to the goal and 'how' to generate customised metrics and 'how' to ensure the metrics are aligned with the goals.

In implementations of the BSC (other than in COBIT) the lack of implementation guidelines has seen many failures while implementing the BSC in organisations. Thus while Gartner Group suggests that between 40 and 60 percent of large US firms will have adopted balanced scorecards by 2000, it had been claimed that 70 percent of balanced scorecard implementations fail (Neely & Bourne, 2000). According to Brock, Henricks, Linnell & Smith, (2003, p. 4), the BSC which was originally intended for the management to give a wide angle vision organization, is inadequate for IT project management, due to two main

reasons namely "its theoretical constructs do not explicitly specify which areas or factors must be considered under each of its four high-level perspectives" and the four perspectives in the BSC do not adequately reflect relevant project management focus areas. Information systems domain consists of numerous entities and it would be difficult to categorise these into the four perspectives of the BSC. Another reason why the Balanced Score Card isn't working is that since the four perspectives developed by Kaplan and Norton was modelled on the corporate scorecard of Analog Devices (a highly technology innovation company), it may not fit into all organisations (Kenny, 2003).   Considering the design and implementation of the BSC in organisations, Neely and Bourne, (2000) states that the poor design of the measurement system and the difficulty in implementing it are two reasons for the failure of any measurement process as a proper measurement system should state the methodology and should have proper guidelines for implementation in the form of principles. Professor Claude Lewy (cited in Kersnar, 1999) did a study on BSC implementation in Dutch firms and found that over half of the scorecard implementations fail. The reason for its failure is that the BSC works well for senior management, but is not effective for translating those measures for everyone in the organisation as it doesn't give guidelines on what companies need to do to reach the targets it sets out (Hesselshwerdt, cited in Kersnar, 1999).

2.2.3.3 Issues in COBIT

Much less literature discussing problems has been written about COBIT due to the fact that many of the reviews have been made available though a range of non academic fora, which is not normally accessible by academic researchers (Ridley, Young, & Carroll, 2004). Moreover COBIT being a recent framework (first released in 1996, with the third version in 2000 and the fourth version in 2005) unlike the maturity model has not been subjected to any in depth analysis. This section gives some generic analysis made on COBIT from various sources (academic and non-academic).

While COBIT provides the management with control objectives, detailed control objectives (DCOs), KPI, KGI and metrics, it does not give guidance on how to implement these tools thus forcing organisations to turn to operational IT framework to figure out how best to implement those process (Salle & Rosenthal,

2005). This downside of COBIT was emphasised by Solms (2005a, p. 100) by stating that "it is not always very detailed in terms of 'how' to do certain things. The DCOs are more addressed to the 'what' must be done. In most cases some more detailed guideline for detailing precisely 'how' things must be done will be needed". Apart from the inadequacy of 'how to do it', in the COBIT framework other limitations attributed is that it doesn't provide a roadmap for continuous process improvement (Anthes, 2004) and cannot be considered as a complete solution as it may involve costly procedural re-engineering (Oliver, 2003).

2.2.4 Alignment of Metrics with Goals, Control Objectives and Control Process

COBIT is very detailed in describing the objective, process, goals and metrics, but guidelines are lacking in implementation (Anthes, 2004; Salle & Rosenthal, 2005). Secondly it is not easy to trace the metrics to the goal. To illustrate this point with an example (figure 2.2) let us take the first HLCO (AI1):

> "Control over the IT process of identifying automated solutions that satisfies the business requirement for IT of translating business functional and control requirements into an effective and efficient design of automated solutions by focussing on identifying technically feasible and cost effective solutions is achieved by defining business and technical requirements, undertaking feasibility studies as defined in the development standards, approving (or rejecting) requirements and feasibility study results and is measured by number of projects where stated benefits were not achieved due to incorrect feasibility assumptions, percent of feasibility studies signed off by the business process owner, percent of users satisfied with functionality delivered"
> (ITGI, 2005, pp 73 - 75. COBIT IV)

Under AI1 there are four DCOs, followed by eight activities that are in turn broken down into four activity goals, three process goals, and two IT goals. These are measured by two IT KGIs, four process KGIs and two KPIs. The first issue that is discussed here is alignment of the DCO with the activities. In this case it is not easy to trace or link an activity or activities with the DCO. For this specific HLCO (AI 1) there are four DCOs linking to it, but eight activities are derived from these four DCOs. While the linkage is implied between these DCO and

activities is not easy to trace. Similarly proper linkage between the eight activities and the three sets of goals are not evident as it is not easy to trace which goal links to the specific activity or process goal or IT goals. Even though from an IT audit point of view the COBIT framework may work well, but from an IS measurement perspective alignment is required. It would be better to measure the DCO than the activity due to break in linkage between different levels in the framework.

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          ┌─────────────────────────────┐
          │      AI1 - HLCO             │
          │ Identify Automated Solutions│
          │    (with three metrics)     │
          └─────────────────────────────┘
                        │
                        ▼
          ┌─────────────────────────────┐
          │     Four DCOs (AI1.1,       │
          │     AI1.2,AI1.3,AI1.4)      │
          │ (with no specific metrics   │
          │         for any)            │
          └─────────────────────────────┘
                        │
                        ▼
          ┌─────────────────────────────┐
          │        Activities (8)       │
          └─────────────────────────────┘
            │           │            │
            ▼           ▼            ▼
    ┌───────────┐ ┌───────────┐ ┌───────────┐
    │ Activity  │ │ Process   │ │ IT Goals  │
    │ goals (4) │ │ goals (3) │ │   (2)     │
    │measured by│ │measured by│ │measured by│
    └───────────┘ └───────────┘ └───────────┘
          │             │             │
          ▼             ▼             ▼
    ┌───────────┐ ┌───────────┐ ┌───────────┐
    │ IT KGI (2)│ │Process KGI│ │ KPI (2)   │
    │ (metrics) │ │   (4)     │ │ (metrics) │
    │           │ │ (metrics) │ │           │
    └───────────┘ └───────────┘ └───────────┘
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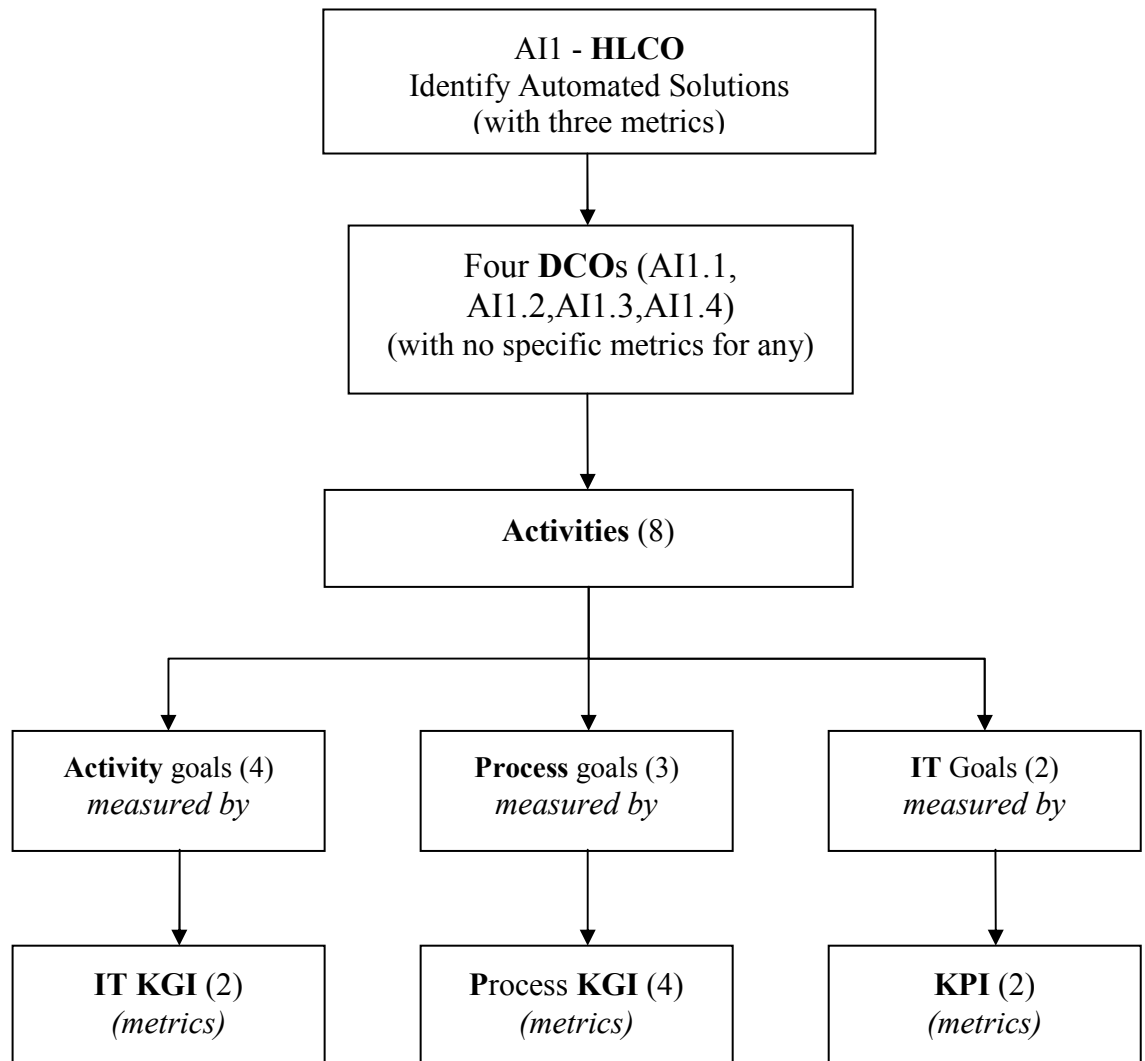
Figure 2.1 The COBIT process

The second issue that is being discussed here is the metrics and alignment of metrics to goals. Considering the metrics aspect, COBIT framework gives two sets of measures/metrics. One for each of the 34 high level control objectives, and a set of the 2 IT KGIs, 4 process KGIs, and 2 KPUIs are given to measure the three types of goals (4 activity goals, 3 process goals and 2 IT goals). The

problem with the first set of metrics is that the HLCO, AI 1 being too broadly stated, it may not be possible to be evaluated with a few metrics, and the basis of choosing the metrics is not given. Secondly, it is not easy to trace the metrics to the goals, and measurement without context can be quite misleading (Jeffrey & Berry, 1993).

Considering the above two issues of alignment and tracing the metrics to the goals it is obvious that a metric generation model would greatly solve the measurement and alignment problem regarding metrics. Further more to maintain alignment with the HLCO, it is recommended to measure the DCO rather than the given set of goals (for the purpose of this proposed research).

2.2.5 COBIT as a Measurement Process Framework

An effective measurement program ensures that a well defined measurement framework can emerge along with defined measures and meaningful data (Offen & Jeffrey, 1997). In this section COBIT is taken and compared with two measurement frameworks from software engineering (SE) literature in order to observe, identify and analyse the similarities and differences. The purpose of this exercise is to evaluate whether COBIT follows any SE measurement models, and if not, to find out the deviations/gaps and methods to re specify the model so as to give it a measurement focus as well. While selecting the measurement model/process from the software engineering discipline, care has been taken to ensure that the models/process are broad enough to apply in the IS domain rather than focussed on software development. Two such models have been selected for the purpose of mapping with COBIT. The first one is the model developed by Ashley (1995) and the other is a set of steps/process outlined by Offen and Jeffrey (1997) for setting up an IS measurement program (based on their Model, Measure, Manage paradigm). These two models are illustrated and compared with COBIT, in the subsequent section to evaluate whether COBIT can be taken as a measurement framework for the purpose of this proposed research.

2.2.5.1 Mapping of COBIT with the measurement model of Ashley

It can be observed that some of the phases in Ashley's model can be matched with COBIT (figure 2.2). The objective is to identify the similarities and differences so that if these differences can be bridged, then COBIT can also be used as a

measurement tool for information systems, apart from its main use as an effective IT governance/audit tool. An effective implementation of COBIT in an organisation incorporates most of the phases mentioned in the above model.

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┌─────────────────────────────────────────┐
│ 1. Appoint an executive sponsor and obtain backing │
│    from senior management (evident in COBIT) │
└─────────────────────────────────────────┘
                    │
                    ▼
        ┌─────────────────────────┐
        │ 2. Establish scope and goals │
        │    (evident in COBIT)    │
        └─────────────────────────┘
                    │
                    ▼
        ┌─────────────────────────┐
        │ 3. Define KPIs, measures and │
        │    models (evident in COBIT) │
        └─────────────────────────┘
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┌──────────────┐   ┌──────────────────┐   ┌──────────────┐
│ 5. Explain the │   │ 4. Set up data collection │   │ 6. Devise success │
│ program (evident in │   │ infrastructure (evident in │   │ criteria (evident in │
│ COBIT) │   │ COBIT) │   │ COBIT) │
└──────────────┘   └──────────────────┘   └──────────────┘

┌──────────────────────────────────┐
│ 7. Set baseline and targets for KPIs (not │
│   evident in COBIT) │
└──────────────────────────────────┘

┌──────────────────────────────────┐
│ 8. Develop a feedback mechanism (not │
│   evident in COBIT) │
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        ╭─────────────────────╮
        │ Management reports  │
        │ (can be generated using │
        │      COBIT)         │
        ╰─────────────────────╯
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Figure 2.2 Process for setting up a measurement program

(Ashley, 1995, p. 5)

Considering the first phase, it is evident that since implementing COBIT is a rigorous exercise involving all levels of management unless there is an executive sponsor and backing from senior management it could not be implemented. This is evident from the COBIT guidelines and in actual implementation. ITGI (2005, p. 8) states in COBIT IV that "The COBIT process model has been mapped to the

IT governance focus areas providing a bridge between what operational managers need to execute and what executives wish to govern". In an implementation of COBIT in Curtin University (that took two years) the adoption of COBIT was decided by the top management (ITGI, 2007b).

The second phase of the measurement framework involves establishing goals and objectives. COBIT has a well structured set of goals addressing various levels of IS functions consists of High level control objectives (HLCO), detailed control objectives, activity goals, process goals and IT Goals. These cover "a broad spectrum of duties in IT management. COBIT includes all significant parts of IT management, including those covered by other standards" (ITGI, 2004, p. 9).

COBIT includes "a comprehensive framework of control objectives based on 41 international source documents, providing a global perspective and best practice point of view" (Lainhart, 2001, p. 191).

Regarding KPI, measures and models measurement of the goals in COBIT are achieved through the KPI, process KGI and ITKGI, while benchmarking can be done by the COBIT MM where the slightly revised maturity model is also "used to evaluate an organisation's relative level of achievement of IT governance" (Bodnar, 2003, p. 28). The only difference in COBIT from the above model is that Ashley (Ashley, 1995, p. 24) proposed a model for generating metrics namely the GQM model that derive "a set of measures to monitor the performance of the IS department against the KPI", while in COBIT there are KPI, and KGI which does not use any model for generating metrics. Thus COBIT is not specific in giving guidelines on tracing the set of KPIs and KGIs to the specific detailed control objectives. The KPIs and KGI are defined, but not defined specifically as has been prescribed by Ashley (1995) in the above framework.

Phase four, which is setting up a data collection infrastructure consisting of data collection plans, procedures, guidelines, checklists, forms, structure and database (Ashley, 1995) are set up by the COBIT implementation teams that can be internal of external. IT governance Implementation Guide of COBIT has a set of implementation tools namely documentation and reporting tools, IT governance implementation tools, and information and presentation tools (Kordel, 2004) that serves as a data collection infrastructure.

Phase five involves explaining the program in the form of conducting workshops for the COBIT users. Normally COBIT is implemented by external consultants, but there are also specialised firms that conduct COBIT workshops (ITG Ltd, 2006) for a fee of £1300 – £ 1500 per person. Workshops/training programs are also conducted by the organisers of International IT governance conferences, and by ISACA.

Phase six involves devising "a set of objective criteria to assess the success of the measurement program" (Ashley, 1995, p. 10) after it had been running for an year. The objective is to evaluate the measurement framework's effectiveness, to provide information to managers and provide a quantifiable outcome. This is a bottom up approach that provides valuable feedback on the program. Since COBIT is a relatively recently introduced framework, there is no set framework to evaluate the success, apart from customised surveys being conducted by the respective organisation regarding the success of the program' and usage surveys (ITGI, 2006) conducted by the ITGI. COBIT does not have in itself a mechanism to evaluate its effectiveness, but is prescriptive regarding the success of the outcome by providing a set of success factors namely the 'critical success factors' that comes under the Management Guidelines (in COBIT III). Critical success factors "define the most important issues and actions for management to address for achieving control over and within its IT processes. These COBIT CSFs are management-oriented guidelines that identify the most important things to do strategically, technically, organisationally or procedurally" (Lainhart, 2001).

Regarding phase seven which is to 'set baseline and targets for KPI' Ashley (1995, p. 49) states that the main principles of this phase for setting targets involve defining the targets in measurable terms, related to time that can be validated, achievable, communicated and revised. The KPIs and KGIs in COBIT have to be refined further to confirm to these principles. COBIT, being an audit and assurance tool rather than a measurement framework focuses primarily on compliance than on measurement and hence this aspect is not clearly evident. In the measurement model of Ashley, the GQM model developed by Basili and Rombach in 1998 was used to monitor the performance of the information systems department against the KPIs, COBIT presently does not use any models for generating metrics, but it can be transformed into an effective measurement if a model like GQM or similar models can be used to generate metrics for the goals

or the KPIs. While a feedback mechanism is not evident in COBIT, the ultimate purpose of measurement is to give a tangible report to the management in the form of reports which can be generated using COBIT. COBIT has provided a set of templates for the purpose of measurement outputs that can be downloaded from the ISACA website.

A mapping of COBIT with the model thus reveals the need for metrics generation model as this aspect is not present in COBIT as the primary purpose of COBIT was to provide internal control to IS activities and measurement is only one aspect of this control and compliance. While Ashley had suggested a model called GQM (developed by Basili and Rombach in 1988), an attempt will be made in section 2.4 to analyse this model and find out whether this model can be used with COBIT for measurement.

2.2.5.2 Mapping of COBIT with Offen and Jeffrey's Measurement Process

Even though Offen and Jeffrey (1997) takes a software engineering perspective in their proposed measurement process, the reason for taking this model for mapping with COBIT is its comprehensiveness. It includes the wider business context in the measurement process as is evident from the first two stages of the process. It is based on the GQM model and it is called a 'meta model' as it "counters a contributing factor commonly seen in failed measurement programs, namely the lack of well-defined links between the numerical data and the surrounding development and business contexts, by coupling technical, business, and organizational issues into a given measurement program context" (ibid, p. 46).

The figure, (2.3) which is self-explanatory, shows the similarity of COBIT with six of the eight processes. The basis for Offen and Jeffrey (1997, p. 46) to propose their model was to establish an effective software measurement program. In the mapping it was also evident that if COBIT is be used as a measurement framework for seamlessly linking the metrics to the immediate goal and finally to the business goal, there needs to be a metric generation method or model. Hence the review of literature has necessitated a need to search the software engineering field for an appropriate metrics generation model that can seamlessly integrate with COBIT.

1. Understand business strategy	←	Alignment of IT with the business strategy is a key process under the Planning and Organising domain of COBIT (ITGI, 2005)
2. Identify business goals	←	IT goals are derived from business goals in COBIT (ITGI, 2005)
3. Determine Critical Success Factors (CSF)	←	CSF are outlined in COBIT (ITGI, 2005)
4. Define software development goals	←	COBIT has 34 high level and 316 low level objectives that equate with goals
5. Pose questions	←	Not addressed in COBIT
6. Identify measures (The authors prefer to use the term 'measure' than 'metrics')	←	Measures are evident in COBIT in the form of KPI and KGI but cannot be traced to the goals
7. Set up the program	←	Normally done by external consultants
8. Review the program	←	Not evident in COBIT

Figure 2.3 Model by Offen and Jeffrey (1997) mapped with COBIT

Table 2.8   Propositions derived from section 2.2

Propositions that have emerged from this section (2.2)
P 3: There is a need to automate the IS audit and measurement process
P 4: There is a need to align and trace the metrics to the goals in IS audit and measurement
P 5: A metric generation model would greatly solve the measurement and alignment problem regarding metrics in IS auditing process
P 6: The control objectives of the COBIT framework can be used to start the measurement process from an IS audit perspective.

2.3 MEASUREMENT IN SOFTWARE ENGINEERING

While the motive for researching this domain is due to the overlap of SE principles in IT governance, the use of GQM by Ashley (2.2.5.1), and to select an appropriate metric generation model to fill the gap identified in COBIT for its use as a measurement model. This involves analysing the measurement principles in SE in terms of metrics and object of measurement, finding out any commonality between SE and IS regarding metrics, evaluate the relevance of using metrics, examine the challenges in software measurement and finally select a metrics generation model that conforms to the measurement principles. Since the IEEE Computer Society provides information regarding measurement principles in the form of Software Engineering Body of Knowledge (SWEBOK) and relevant IEEE standards (1061 – 1992), an initial research into the area is done mainly to extract the principles of measurement from the SE perspective (if any). Software engineering is "the application of a systematic, disciplined, quantifiable approach to the development, operation, and maintenance of software" (IEEE-Computer-Society, 2004, p. 11). It is one of the six sub areas of software management, which again is one of the ten SWEBOK knowledge areas. Since critics (Sellami, Suryn, Abran, Bourque & Laport, 2003) have complained that metrology has not been properly addressed in SWEBOK, other relevant research papers in software measurement are taken into consideration for the purpose of extracting measurement principles.

2.3.1 Measurement Principles in Software Engineering

From a software development perspective, Cantone and Donzelli (1999) states that to successfully apply a measurement plan, it has to specify the "why" (the underlying reasons), the "what" (attributes to measure), the "how" (data collection procedures and involved personnel) of the corresponding measurement activities. To start the process of measurement, it is necessary to look at the fundamental concepts of 'measurement' and 'metrics' in software engineering so as to understand the principles, concepts and theories behind the process. The reason for taking a deeper look at the software engineering discipline is because measurement in information systems started in the field of software engineering as earlier than IS with numerous research papers that view measurement in terms

of 'measurement', 'management', 'reliability', and 'software quality assurance' (Curtis, 1980; Goodenough & McGowan, 1980; Musa, 1980). According to Zuse (1995) the groundwork for software measures and software measurement was established in the 1960s and 1970s, and from these works, results have emerged in later years.

2.3.1.1   Metrics in software engineering

Metrics help managers to know what is happening to a measured entity (Manas-Argemi, 2005). In software engineering the term 'metrics' have been associated more with 'software quality' and 'productivity'; and has been equated with 'measures' (IEEE-Computer-Society, 2004; Offen & Jeffrey, 1997) as metrics is more technically oriented. Measurement is defined as "the act or process of measuring, figure, extend, or amount obtained by measuring"; a process metric as "a metric used to measure characteristics of the methods, techniques, and tools employed in developing, implementing, and maintaining the software system"; a product metric as "a metric used to measure the characteristics of the documentation and code"; a metric framework as "a tool used for organising, selecting, communicating, and evaluating the required quality attributes for a software system" (IEEE-Computer-Society, 1993, p. 2). Like in IS, both product and process metrics are used for software measurement. Apart from the fact that 'metrics' have been defined, nothing much has been stated as to whether it can be used outside the software engineering field. A word search on 'metrics' in SWEBOK also could not reveal any definitions. Goals have been referred to as the overall high level objectives of the software. Also concerns have been raised (in SWEBOK) regarding the vague definition of goals and hence it was advised in SWEBOK to pay particular attention to goal definition.

Since the definitions are purely focussed on software quality, it becomes necessary to turn to research papers to see if and how the concept of 'metrics' can be transposed into the IS field. Regarding metrics program success, Jeffrey & Berry (1993) have identified four factors namely context, inputs, process, and products with 34 questions and some of the concern that have a parallel with IS measurement are the 'alignment of measurement program goals with the business goals'; 'clear definition of goals and objectives'; 'the tailoring of the measurement program with the needs of the organisation'; 'automation of data collection';

'integration of the measurement into the organisational process'; and 'deriving the measures from the goals' (goal aligned metrics). Since a similar set of principles, have already been identified in the IS and IT audit field, it can be hypothesised that a model from this field can be transposed into the IS or IT audit field. Moreover there is also a need for a continuous metrics programs where if metric data is made available to software project managers on a frequent basis, corrective actions can be made to the project plan to increase the probability of successful completion of the project (Anderson, 1990).

2.3.1.2 The object of measurement

Since software engineering is a field where the topic of measurement is in a relatively advanced stage, a look into this field for the objects of measurement can give valuable insights into the common objects for measurement. In software engineering the object of measurement has been identified as products like deliverables, documents specifications, designs programs (nouns); processes namely specifying, designing, testing, interviewing (verb); and resources like hardware, software, personnel, office space (Basili, Caldiera, & Rombach, 1994). Talking about the object of measurement Fenton and Pfleegar (1997, p. 5) states that "measurement captures information about the attributes of entities". They define an entity as an object or an event in the real world while an attribute is a feature or property of an entity. Hence measurement becomes the process of assigning numbers or symbols to attributes and scientifically speaking the authors state that when we measure something it is the attribute of the entity that we measure and not the entity itself. For example if IT auditors want to measure an entity like an IT security plan, in fact they have to measure the attributes of the plan such as effectiveness, accuracy, usability and reliability. Hence metrics have to be tailored to these attributes rather than the entities. Based on the above measurement concept all of the components of an information systems domain can be called as entities namely hardware, software, process, procedures, networks, information, people, and events. While each of these categories need to be assigned attributes for the purpose of measurement. Since attributes are not clearly specified for the entities of COBIT this is a concern that has to be addressed for the purpose of measurement.

2.3.2 Application of Software Metrics to the IS Domain

From an SE perspective an application of measurement involves "assigning numbers to represent the different states of a property belonging to the object under study. Relationships among these different states determine the type of measurement scale which should be employed in assigning numbers" (Curtis, 1980, p. 1145 - 1146). Software engineering is described as "the collection of techniques that apply an engineering approach to the construction and support of software products. Software engineering activities include managing, costing, planning, modelling, analysing, specifying, designing, implementing, testing, and maintaining" (Fenton & Pfleeger, 1997, p. 9). Since a similar set of activities can be seen in the information systems domain can be hypothesised that the concept of 'metrics' and its associated environment of software engineering can be used in an information systems environment with similar success. Since "a metrics program builds on measures, which provide quantitative indications of the extent, amount, dimensions, capacity, or size of some attributes of a software product or process" (Pressman, 2000, cited in Fredericksen & Mathiassen, 2005, p. 350), a similar metrics program suited to information systems can provide quantitative indications of the same attributes to the entities of information systems.

Regarding the purpose of measurement metrics in the software engineering discipline they have been successfully used also for improving software quality and productivity (Moller & Paulish, 1993). A similar statement on the quality aspect of software metrics was echoed by Fenton and Neil, (1999, p. 149) when they stated that it (software metrics program) not only includes a "wide range of activities concerned with measurement in software engineering" but, also "includes quantitative aspects of quality control and assurance – and this covers activities like recording and monitoring defects during development and testing". Claims have even been made that software 'metrics' have been generalised to include the entire business organisation (Du, Ngolah, & Thornton, 2003).

Software metrics, which was concerned with software development broadened its role as software engineering discipline became dynamic encompassing a range of activities. Fenton and Pfleeger , (1997, p. 15-16) described the scope of software metrics that "embraces many activities, all of

which involve some degree of software measurement" such as "cost and effort estimation, productivity measures and models, data collection, quality models and measures, reliability models, performance evaluation and models, structural and complexity metrics, capability-maturity assessment, management by metrics, and evaluation of methods and tools." Such activities are not alien to the field of IT audit also.

Moller and Paulish, (1993) further broadened the field of activity of software metrics to include a lot of aspects that are normally seen in information systems or even organisational systems by viewing then from a utility perspective. According to them the six primary uses of metrics include goal setting, improving quality and productivity, project planning, managing and improving customer service.

Table 2.9 Purpose of software metric mapped with COBIT measurement system

Purpose of a software (quality) metric (IEEE-Computer-Society, 1993)	Purpose/aspects of COBIT's measurement system (ITGI, 2005)
Achieve quality goals	"Organisations should satisfy the quality, fiduciary and security requirements for their information, as for all assets" (p. 6) COBIT is a tool that ensure this objective
Establish quality requirements for a system at its outset	"To satisfy business objectives, information needs to conform to certain control criteria, which COBIT refers to as business requirements for information. Based on the broader quality, fiduciary and security requirements, seven distinct, certainly overlapping, information criteria are defined as follows: effectiveness, efficiency, confidentiality, integrity, availability, compliance, reliability" (p.12)
Establish acceptance criteria and standards	"COBIT has been aligned and harmonised with other, more detailed, IT standards and best practices" (p. 6)
Evaluate the level of quality achieved against the established requirements	Benchmarking is done by using the modified maturity model of COBIT
Detect anomalies or point to potential problems in the system	COBIT's good practices will help optimise IT-enabled investments, ensure service delivery and provide a measure against which to judge when things do go wrong. (p. 6)
Predict the level of quality that will be achieved in the future	*Not explicitly stated in COBIT*
Monitor changes in quality when software is modified	Since COBIT is not much concerned with software a similar objective can be taken from one of the high level control objective that is - "All IT processes need to be regularly assessed over time for their quality and compliance with control requirements" (p. 15)
Assess the ease of change to the system during product evolution	*Not explicitly stated in COBIT*
Normalise, scale, calibrate, or validate a metric	*Not explicitly stated in COBIT*

This broad use of metrics have been further emphasised by Feigenbaum, (1983) when he stated that metric data is useful for establishing quantitative improvement objectives for company management; to measure the current productivity; can be used in conjunction with a corporate quality improvement program like Total Quality Management, and for managing and monitoring software projects. While the literature on software metrics reveals that it can be used in the wider context as it operates on similar principles it would be also worthwhile to evaluate the purpose of metrics from a SE perspective with the purpose in COBIT.

The purpose of measurement from an SE perspective is quite similar to that of IS. According to Basili, Caldiera, & Rombach, (1994) measurement is a mechanism for creating a corporate memory. It supports project planning, helps the organisation to determine the strengths and weakness of the current process and products, provides a rationale for adopting/refining techniques, helps in evaluating the quality of specific process and products, helps during the course of a project to assess its progress, to take corrective action based on this assessment; and to evaluate the impact of such action (ibid). Brown and Goldenson (2004) echoed a similar statement regarding the use of measures from a management's perspective when they said that there are many instances where measurement has been used effectively to inform management due to the fact that a proper measurement framework ensures that technical decisions based on facts and objective evidence is made available from a measurement framework. The above view of measurement takes a broad dashboard view of measurement (stated in COBIT using performance indicators). Measurement is a form of dashboard and feedback to the users and stakeholders as "monitored measures get high visibility within an organisation, and people strive to achieve high performance with respect to these measures" (Abu-Suleiman, Boardman, & Priest, 2005). A combination of COBIT with the proposed metrics generation model can provide a dashboard view of IS performance.

2.3.3 Relevance of Measurement in SE

The importance of attribute measurement was highlighted by Finkelstein, (1982, cited in Fenton & Pfleeger, 1997, p. 7) when they stated that "one of the aims of science is to find ways to measure attributes of things in which we are interested". With an annual global expenditure of over one trillion dollars in IT, and growing

at 10% compounded annually (Seddon, et al., 1999) it is little wonder that the information systems department has attracted widespread attention among the stakeholders of the organisation. Taking a subset view of information systems (as software project management is a part of IS) the importance and the state of measurement in software project management was emphasised by Ince, et al., (1993, p. 59) by stating that "once something can be measured, you move away from the world of opinion towards the world of fact" and "most measures of project progress are informal, and hence open to interpretation" thus emphasising the need for a robust measurement system for measuring information systems projects. He further stated, "the careful use of numerical measures can introduce precision and clarity to the process." Thus he not only emphasised the use of subjective as well as objective measurement but also emphasised the need to perform in a careful and systematic manner to get the desired results. Metrics have been classified into subjective metrics and objective metrics. Commenting on the nature of subjective and objective metrics, Moller and Paulish (1993) remarked that while subjective metrics takes into account the opinion of users on the goodness of quality, objective metrics takes a negative view of identifying what is wrong with the product or process such as the number of faults or errors.

Even though metrics programs are difficult to introduce and maintain, it was found out that "an increase in the use of metrics information in decision making leads to higher organisational performance and similarly, an increase in the use organisational performance is associated with an increase in the use of metrics information in decision making" (Gopal, Krishnan, Mukhopadhyay & Goldenstein, 2002, p. 10). Commenting on the benefits of a good metrics program Anderson, (1990) states that if metric data is made available to software project managers on a frequent basis, corrective actions can be made to the project plan to increase the probability of successful completion of the project. A similar control benefit can be attributed to the benefit of reporting on an IT audit and control framework where ITGI (2000, cited in Hussain & Siddiqui, 2005, p. 158) states that "the purpose of COBIT framework is to provide the management with an IT governance model that helps them control and manage the information and related technology." Moreover a "successful metrics program will ultimately result in higher quality software system products which will in turn increase customer satisfaction" (Moller & Paulish, 1993, pp. 25-27).

Measurement of software quality using metrics also provides a balanced performance management system such that the use of metrics in software engineering can be viewed from an economic point of view. Viewing software quality measurement from a financial point of view, in term of return on investment calculation, Jones (1996, p. 36) states that "software quality measurements provide one of the highest ROIs of any technology and are far easier to get started than a full reusability program." If using metrics can improve quality as well as improve the ROI, then it can be done with a similar success rate in measuring information systems resources provided the metrics are developed and suited to the components of the numerous IS dimensions. To prove his point he further cited the success of IBM's use of quality measures during the 1970s and beyond to such an extend that IBM was used as a standard for computer architecture that made the company dominate the personal computer hardware market for a long time.

2.3.4 Challenges in Software Measurement

There are a large number of metrics for software measurement, but computer scientists and software engineers cannot agree on what is important to measure, how to measure, or why we are measuring (Gray, 1999). Even though software metrics have been used successfully in the field of software engineering, there are reported cases of failures. It has been reported that up to 78% of metrics programs fail (Dekkers 1999, cited in Fredericksen & Mathiassen, 2005). Success in software metrics program has been defined at various levels. Fenton and Neil (Fenton & Neil, 1999, p. 149) states that "if we judge the entire software metrics subject area by the extent to which the level of metric activity has increased in industry then it has been a great success." Here success was correlated with the quantity of metrics generated in the software industry rather than in improving the quality of relevant metrics. The authors cites two reasons for this gap; one is the irrelevance in scope where metrics developed can be applied to only small programs and the other is the irrelevance in content where more metrics were developed for detailed code rather than for process improvement. While talking about measurement programs, Offen and Jeffrey (1997), states that a contributory factor seen in failed measurement programs is the lack of well defined links between the numerical data and the surrounding development and business

contexts and the solution to this problem according to them is to combine technical, business and organisational issue into a given measurement program context by implementing the measurement program in an orderly manner. In this research the researcher will be addressing the above concern. A systematic approach to measurement framework is needed to make any measurement program a success (Goldenson et al., 2003a; Goldenson et al., 2003b; cited in Brown & Goldenson, 2004) so that decisions can be taken based on factual evidence.

In order to succeed in any organisational activity researchers have come up with critical success factors that if followed can ensure success in that particular activity. And much has been written on the critical success factors for a successful measurement program in the SE field. Hall and Fenton (1997) identified eleven consensuses on requirements for metric program success, but according to Niessink and Vliet (1999) the problem with success factors is that they tend to focus on the internal aspects of the measurement program. They advocate a broad organisational level perspective where the measurement program adds value to the organisation and attention to be given to proper mapping of identifiable organisational problems into the measurement program. Taking into account the suggestions, the researcher's proposed work aims to look at the larger picture where the entire information systems domain can be measured; the objectives of these domains being derived from corporate and organisational goals ensure a tight link between organisation and the finer aspects of information systems.

Discussing the determinants/variables of success in software measurement programs in an organisation, Goldenson, Gopal, & Mukhopadhyay (1999) states that success not only include longevity and persistence of the measurement program, but also the extend to which the measurement program was able to inform management and technical decision making, the extend to which improvements in the organisation's measurement program can be attributed to the use of measurement program, and the level of alignment of the measurement program with the business and technical goals of the organisation. The above given guidelines necessitate a systematic, goal aligned and well structured measurement system. Even in a focused process like software measurement, many organisations find, software measurement to be a complex and difficult task

(Gopal, et al., 2002). The severity of failures in metric programs is evident in the studies which reveal that only 10% of the metrics programs are positive and two out of three metrics program do not last beyond two years (Daskalantonakis, 1992, Pfleeger, 1993, cited in Gopal, et al., 2002).

2.3.5 Metrics Generation Models

Six criteria were used to choose a goal oriented metrics generation model (table 2.10). In the literature review (section 2.2.5.1) Ashley has recommend the use of the GQM model for rectifying the shortcoming in a measurement model. Since a recommendation cannot be taken for granted other five factors to consider are the recommendation of researchers in the SE domain, the popularity of the model, its use in reputable organisations, to see any attempt have been made to fit the metrics generation model with any business process or model from the IS field, and whether data can be traced to the goals and vice versa.

Regarding the work on the mechanics of implementing metrics there are two works in this respect. The first such work is the one developed by Grady and Caswell in 1987 which is an extensive experience report of a companywide software metrics program and, secondly the model developed by Basili, Rombach and colleagues from borrowed ideas of TQM called the GQM Model which is a top down approach for quantifying metrics from goals (Fenton & Neil, 1999). The Goal Question Metric (GQM) approach that was originally used to evaluate defects for a set of projects in the NASA Goddard Space Flight Centre is based on the premise that an effective measurement system should have specified goals, and metrics can be developed for these goals (Basili & Rombach, 1988). Numerous organisations like NASA, Eriksson, Bosch, Schlumberger, Motorola, HP, AT & T and Digital have applied this model successfully for developing metrics for software engineering (Latum, Solingen, Hoisl, Rombach & Ruhe, 1998; Mendonca & Basili, 2000; VTTElectronicsLtd, 1999). The model has also been modified and used successfully for measuring software development (Kilpi, 2001).

Table 2.10 Criteria for selecting a metrics generation model

Criteria used for selecting a metric generation model (GQM)	Evidence
Recommendation from literature review on COBIT mapping with measurement model	Ashley (1995) has proposed the GQM model for generating metrics and while mapping COBIT with the measurement framework the GQM model was deemed appropriate
Recommendation from literature review regarding its application to business process	(Aversano, Bodhuin, Canfora, & Tortorella, 2004)
Used by large organisations worldwide	NASA, Eriksson, Bosch, Schlumberger, Motorola, HP, AT & T and Digital, (Mendonca & Basili, 2000; VTT Electronics Ltd, 1999)
Very popular approach	(Birk, Haman, Pfahl, Jarvianen, Oivo & vierimaa, 1999; Birk, Solingen, & Jarvinen, 1998)
Model had been combined with measurement methods/models/frameworks from the IS or business domain	The GQM model has been combined with the balanced Score Card (Aversano, Bodhuin, Canfora, & Tortorella, 2004; Becker & Bostelman, 1999)
Data can be traced to the goals	(Anacletto, Punter, & Wangenheim, 2003)

2.3.5.1 The GQM model

The GQM (Goal/Question/Metric) model is a well-known, widely used (Birk et al., 1999), popular and an efficient means of selecting software metrics based on organizational goals (Gray & MacDonell, 1997) and a powerful method (Solingen & Berghout, 1997) for defining and executing goal oriented measurement programs. According to Buglione & Abran (2005) there are two generic types of approach to process improvement. The first type are analytical models that are open, goal-oriented, measurement driven and bottom-up-driven using quantitative evidence in determining where an improvement is needed like the plan-do-check-act. Prescriptive models come under the second category that is closed, staged, assessment-based and top-down-vision driven like the Capability Maturity Model (CMM). The GQM model which is a top down model for defining goals, and bottom up approach for interpretation comes under the analytical category. A top-down approach to measurement using metrics derived from organisational goals ensure the alignment of goal with metrics (Woodings & Bundell, 2001).

The *Goal/Question/Metric* paradigm has been proposed as a goal-oriented approach for the measurement of products and processes in software development (Basili, et al.,1994; Basili & Rombach, 1988). It can be applied to any business process and supporting software system (Aversano, et al., 2004) and is seen as an approach to choosing metrics (Differding, et al., 1996). It is based upon the

assumption that for an organization to measure in a purposeful way it must not only identify and precisely specify the organizational and project-specific goals, but also these goals have to be traced to the data that are intended to define the goals operationally and thus provide a framework for analyzing and interpreting the data with respect to the stated goals (Anacletto, et al., 2003).

The GQM approach is a systematic way to tailor and integrate an organization's objectives into measurement goals and refine them into measurable values and aims to create information that will help people understand, monitor, evaluate, predict, control, and improve software development (Latum et al., 1998). GQM is a method of cascading from business goals to decisions needing information, to determining what to measure to supply that information (Rifkin, 2001). GQM derives the project's assessment metrics from goals and not from a predetermined, possibly misaligned, set of criteria (Becker & Bostelman, 1999, p. 48) and GQM goals help clarify what needs to be studied, why, and where (Morasca, 2001). The advantage of the GQM is that through this method "only useful data is gathered, leading to more cost-effective studies than if a large amount of data is gathered without a clear purpose or use" (Olsson & Runeson, 2001, p. 236). Moreover "without a comprehensive software measurement system support, it is really a challenge for practitioners to figure out what metrics are needed, and how the measurement data are collected, managed and interpreted" (Wang & He, 2003, p. 1329). The Goal-Question-Metric (GQM) method not only gives a measurement framework that applicators can take and develop a metrics program, but it also helps gives detailed guidelines on the 'how' of implementation (Sirvio, Parvianen, & Ronkainen, 2001) which is a major advantage of the GQM.

2.3.5.1.1 Critical evaluation of the GQM model

There has been numerous criticisms of the GQM model with the result that it has been modified to rectify the areas that the critics have mentioned. In this review, the researcher decided to use the 1994 GQM version (Basili, Caldiera, & Rombach, 1994) since it was improved from the 1988 one, but the guidelines for defining goals, quantifying questions and generating metrics are taken from the 1988 version as the 1994 one doesn't have the guidelines. Table 2.11 list the views of the critics and the relevant measures/solutions related to the research.

Table 2.11 Critical evaluation of the GQM model and the measures taken by the researcher in the proposed study

Weakness of the GQM model	How these are addressed wherever relevant to the research
It involves a series of well defined, interrelated stages, phases and activities, that are not so easy to understand and apply, in real environment, by software engineering professionals and people from organizations that are involved in software quality measurement programs (Abib & Kirner, 1999)	GQM requires expert involvement especially during the first year (Solingen & Berghout, 1997) It is true that an expert is required to implement the model. Hence the researcher will be briefing the respondents fully before the model is given to them
Establishing a GQM-based measurement program, performing the measurements, and collecting and analyzing data is a complex process (as it involves a number of steps) It is not yet defined in a fully precise and detailed way and subject to changes and modifications (Fuggetta, Lavazza, Morasca, Cinti, Oldano, & Orazi, 1998)	Critical success factors for (1) for initial application of GQM and (2) for routine application of GQM have been given by Birk, et al., (1998) The original GQM comes with a set of guidelines; GQM have been subsequently modified by the original authors and other researchers
Moreover the process is non-repeatable, non-terminating and not practical (Card 1993, cited in Fuggetta et al., 1998)	These criticisms have been addressed in Basili [1994] and Weiss [1994]
GQM often leaves important environmental and measurement issues implicit rather than explicit—such as how the top-level goals relate to business imperatives (Rosenberg & Hyatt, 1996)	This is addressed by combining GQM with COBIT
GQM cannot cope with high level corporate goals, application of the GQM requires expert involvement especially during the first year (Solingen & Berghout, 1997)	For this purpose the researcher is taking the lower level goals of COBIT for measurement.
GQM does not provide any guidelines or methods for identifying problems and goals as perceived by key members of the software project (Bell, Cooper, Jenkins, Minocha, & Weetman, 1999)	This is addressed by combining GQM with COBIT where the goals are provided by COBIT. Hence there is no need to generate a goal from nothing

2.4.5.1.2 The GQM approach

The GQM model is an effective approach to selecting and implementing metrics (Fenton & Pfleeger, 1997). An understanding and application of the GQM model involves knowing the three levels of GQM process, namely the *conceptual level* where the goals are determined for a set of products or process, the *operational level* where a set of questions that characterize the object of the measurement are asked, and at the *quantitative level* where a set of objective or subjective data is associated with every question (Basili, et al., 1994) giving rise to metrics. The GQM paradigm is a top-down approach for defining metrics, but the interpretation

of data is bottom-up (Solingen & Berghout, 1997). Basili and Rombach (1988, p. 760) asserts that "the measurement process must be top-down rather than bottom up in order to define a set of operational goals, specify the appropriate metrics, permit valid contextual interpretation and analysis, and provide feedback for tailorability and tractability.

At a conceptual level a goal is defined for an object, for a variety of reasons, with respect to various models of quality or productivity, from various points of view (like the CIO, CEO), relative to a particular environment (like the department or division or company) (Basili et al, 1994). Objects of measurement can be products, process or resources. The operational level consists of a set of questions that characterise the way the goal can be achieved with respect to a selected quality issue and to determine its quality from the selected viewpoint. The last level is the quantitative level where a set of data (which can be objective or subjective) is associated with every question so as to answer the question in a quantitative manner giving rise to metrics. In the guidelines for metrics, data collection and interpretation Basili and Rombach (1988, pp.762) states "the choice of metrics is determined by the quantifiable questions. The guidelines for questions acknowledge the need for generally more than one metric for objective and subjective metrics, and for associating interpretations with metrics. The goals, questions and metrics provide for tractability of the (top-down) definitional quantification process, they also provide for the interpretation context (bottom-up)." A demonstration of the application of the GQM model to generate metrics for a COBIT objective is given in section 2.5.

Table 2.12 Propositions derived from the section on software engineering

Propositions that have emerged from this section (2.3)
P 7: There is a need for a systematic, goal aligned and well structured measurement system for successful IS measurement
P 8: GQM model can be used for generating metrics for IS entities

2.4 INTEGRATING GQM INTO COBIT

This is a design section where the model of IT audit COBIT is theoretically integrated with the GQM model to give rise to a potential novel IS measurement model (section 2.2.5 has provided the rationale for fusing these two models while table 2.13 provides the criteria taken into consideration). This model is demonstrated by taking a detailed control objective (DCO) from COBIT to generate metrics to evaluate whether metrics can be generated/traced from/to DCO in a systematic and aligned manner. Moreover steps are also taken to see how the model can be empirically tested. Measures are also taken to automate the model for efficiency in measurement and for empirical testing.

Table 2.13 Criteria to look for when formulating the proposed model

Areas where the criteria has evolved	Criteria
Information systems measurement (Section 2.1); IS governance (2.2)	(1) Comprehensive view of IS entities (2) Performance oriented measurement, (3) Customised measures (4) Goal aligned/oriented metrics. (5) Multidimensional view of measurement (6) Use of rating scales
Software engineering (Section 2.3)	(7) Metrics derived systematically from goals (8) Measurement of attributes (using questions for goals)

2.4.1 The COBIT-GQM Model

An analysis of the literature on IT governance presented the COBIT framework while the software engineering literature gave the GQM model. This section looks at the possibility of integrating the two different entities to give a systematic approach for generating and assigning metrics for measuring IS entities. It is hoped that this fusion would give rise to a sound, complete, lean and consistent IS measurement model.

A "measurement framework is *sound* when its metrics and measurement models are valid in the environment where they are used. A measurement framework is *complete* when it measures everything that its users need to achieve their goals. A measurement framework is *lean* when it measures what is needed and nothing else. A measurement framework is *consistent* when its metrics are consistent with the user goals" (Mendonca & Basili, 2000, p. 484 - 485).

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COBIT and the GQM model are two different but similar entities where one is a comprehensive IT audit framework while the other is a metrics generation model. COBIT version IV divides the entire information systems domain into four distinct categories called 'domains', that are subdivided unequally into 34 high level control objective (also called control processes) and these are further subdivided into 318 detailed control objectives (DCO). It is considered as a top down (Oliver, 2003) goal definition structure where high level control objectives are broken down into objectives/goals at the lower level. A similar top-down approach is evident in the GQM model where Solingen and Bergout (1997, p. 2) describes that "measurement goals are defined on the basis of high level corporate goals, and refined into metrics. The GQM paradigm provides a method for top-down metric definition and bottom –up data interpretation."

Even though the COBIT and the GQM models are two separate entities coming from different but similar fields of information systems, it can be observed that in these two top down models, the DCOs of COBIT overlaps and integrates with the goal definition phase of GQM thus ensuring tight integration. A diagrammatic representation of the fusion of the two models is given in the figure 2.4. Theoretical testing of the model involves taking a DCO from COBIT, defining it in terms of the guidelines for goal definition in GQM, formulating a set of quantifiable questions, and generating metrics for that particular DCO/goal. Unlike in a real GQM implementation where brainstorming session is used for the GQM process in the theoretical testing the metrics generation process is done deductively by the researcher.

For the purpose of illustrating the generation of metrics from COBIT, DCO using the GQM model the GQM model guidelines given by Basili, et al., (1994) is followed (1994 is an improved version). Also the basic principles and guidelines outlined in the original TAME project (Basili and Rombach, 1988) for goal definition, product related questions, process related questions, and for metrics, data collection, and interpretation are followed as guidelines. While there are many variations of the basic GQM model, the principles of the basic model is taken for the exercise. Secondly instead of putting all the GQM steps in one table the author has separated the stages into three tables (2.14 – 2.16) to give a clearer picture of the metrics generation process.
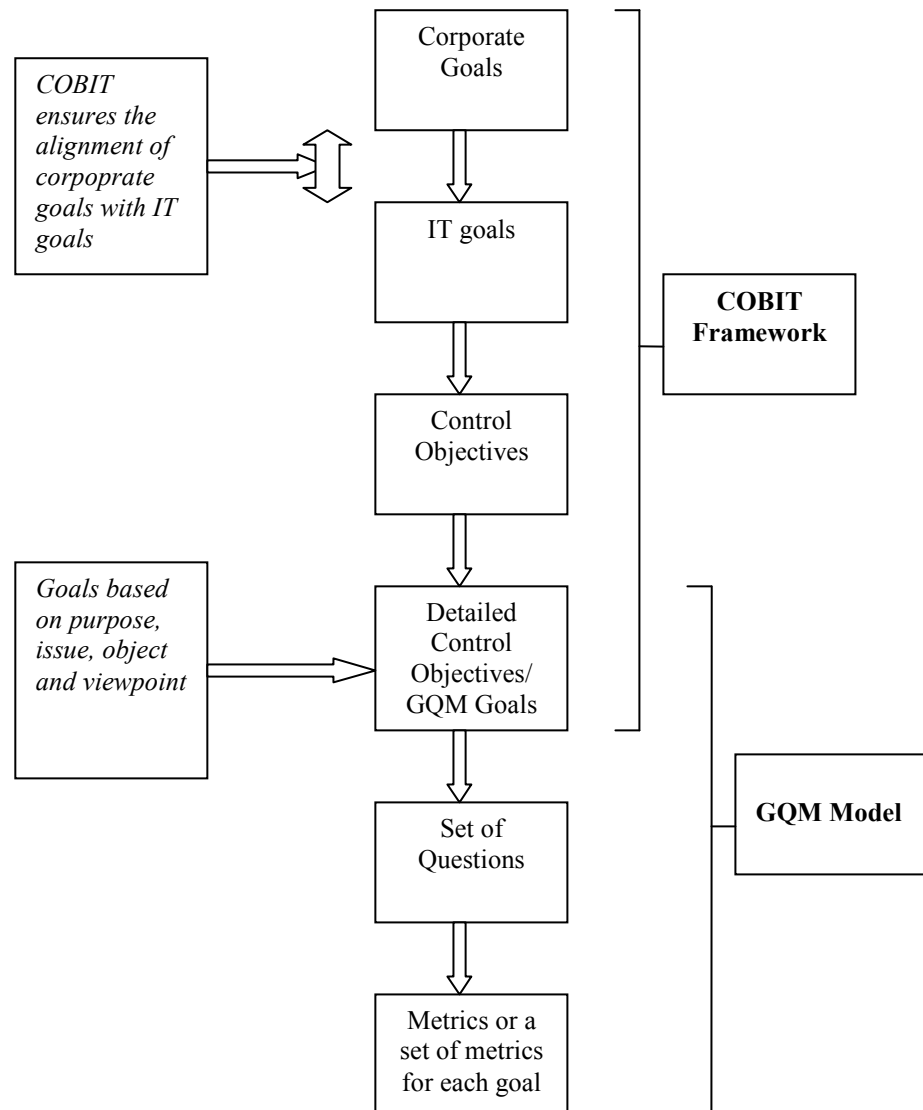
Figure 2.4 A COBIT-GQM information systems measurement framework for generating customised and goal oriented metrics

COBIT complies with the GQM's statement that "measurement goals are defined on the basis of high level corporate goals, and refined into metrics" (Solingen & Berghout, 1997, p. 2) through its alignment of IT goals with corporate goals (ITGI, 2005) and these IT goals drive the control objectives. COBIT IV provides a robust framework for applying the GQM approach to metrics generation since the goals for each entity, process or activities are clearly defined in the form of 316 detailed control process and the purpose, issue, object, and viewpoint is

evident in most of the detailed control objectives. In this COBIT-GQM model the DCOs are taken for generating metrics rather than the COs because, the GQM model is more suited for lower level control objectives and goals rather than high level goals or objectives (Bache and Neil 1995; Zeeuw 1994; cited in Solingen & Berghout, 1997). Moreover the HLCO comprises of a number of detailed control objectives and the more specific, the objective the more effective will be the measurement process. Basili, et al. (2005) stated that in order for measurement to be effective, the goals should be specific, applied to all life-cycle products, processes and resources.

Once the DCO is selected and turned into a goal based on the five perspectives, a set of questions can be generated. The elicitation of questions can be done through survey of the project team or brainstorming as both of these processes are used in GQM (Latum et al., 1998; Solingen & Berghout, 1997). The guidelines provided for developing questions for product and process related goals are followed to generate sufficient questions for the selected goal. Once the quantifiable questions are generated, metrics are then derived from these questions. Hence it is easy to trace the metrics to the relevant goal or objective.

2.4.1.1 Measuring COBIT using IT goals in lieu of the DCO

COBIT can also be measured from a different perspective using IT goals instead of the DCO. COBIT lists 20 business goals linked to 28 generic IT goals that are in turn linked to all the 34 HLCOs (Grembergen & Haes, 2006) thus providing a seamless integration. Thus alternatively instead of measuring the DCO using GQM, the IT goals can also be used, provided these IT goals are defined clearly as in the case of the DCO.

2.4.2   A Theoretical Demonstration With An Example

The model can be tested theoretically by taking a DCO from any domain and control objective of COBIT. As an example to illustrate this, a DCO is taken from the first control objective (PO1. Define a Strategic IT Plan) coming under the first domain (Plan and Organise). It reads as:

PO1.3 Assessment of Current Performance

"Assess the performance of the existing plans and information systems in terms of contribution to business objectives, functionality, stability, complexity, costs,

strengths and weaknesses" (ITGI, 2005, p. 30). The tables (2.14 – 2.16, templates) given below illustrate the application of GQM model using a DCO.

Table 2.14 Goal definition in the GQM model

DCO/Goal **Assess the performance of the existing plans and information systems in terms of contribution to business objectives, functionality, stability, complexity, costs, strengths and weaknesses (PO1.3)**				
Object to be measured	Purpose of measurement	Measured property (quality focus)	Subject of measurement (viewpoint)	Measurement context (environment)
Existing plans	Performance	Functionality, stability, complexity, costs, strength, weakness	Business Executive & CIO	Organisation/ department

Stage – 1 Transformation of the DCO of COBIT into a GQM goal based on five perspectives

This process involves breaking down the DCO into three co-ordinates namely the object to be measured, the purpose of measurement, and the measured property. The subject of measurement and the measurement context are taken from the project or environment. Some of the DCOs in COBIT are explained in detail and can be defined according to the three coordinates appropriately in line with the GQM requirements, while from some other DCOs the reader has to analyse and dissect the coordinates appropriately.

Stage – 2 Framing quantitative questions (table 2.15)

In this stage questions are framed following the guidelines given by Basili and Rombach (1988, p 761) and it may not be possible or necessary to generate questions for each guideline corresponding to the major sub goals. Regarding framing the questions the creators have further stated that "the process of setting goals and refining them into quantifiable questions is complex and requires experience." The problem with developing questions is that if the questions are not specific to the goal and not quantifiable then it may not only be impossible or difficult to generate metrics form these questions, but even if metrics can be developed it may not directly measure the goal. Here there are three sub-goals for each question namely the definition of the product, definition of quality

perspectives and feedback for improving the product followed by 11 guidelines for developing the questions. These aid the implementer to generate the questions.

Table 2.15 Developing questions from the goal using the GQM model

Three major sub-goals for each question	Guidelines to be followed for developing questions	Sample Questions
Definition of the product	Physical attribute Cost Changes & defects	- How far is/are the plan/plans clear, effective and user friendly in conveying information? - How far are the costs reasonable? Was it within budget? - How many times in an year was the plan modified? - How many defects are evident in the plan/plans?
Definition of the quality perspectives	Major models used Validity of the model Validity of data Model effectiveness Model substantiation	- Does the plan/plans confirm to the business/IT objective? - How far is/are the plans functional? - Do the plan/plans provide stability? If so how far is it stable? - Is/are the plan/plans simple or complex? How far is/are the plans simple/complex? - Are the results consistent from various perspectives? - List out the number of weakness/defects in the plan/plans - Is clarity of objectives, functionality, stability, complexity, costs, strength and weakness the best way to measure the quality of the plan/plans?
Feedback for improving the product	-Quantitative feature quality -Quality problems -Suggestions for improvement	- What is/are the quality level of the present plan/plans? - What are the problems regarding quality of the plan/plans? - How can we improve the quality?

Stage – 3   Deriving metrics from questions (table 2.16)

While the above table demonstrates the usefulness of the model in generating questions, the next step will aid in generating the metrics. Whereas there are a lot of guidelines to be followed for developing metrics, in most cases it may seem quite impossible or impractical to follow each and every guideline for generating questions from an information systems perspective as the guidelines developed by the creators was for the specific purpose of generating metrics for software engineering activities and secondly during the course of two decades a lot of

things have changed in the software engineering and information systems field. Commenting on this Basili and Rombach (1988, pp. 761) state in their own words "we do not claim that these templates and guidelines are complete; they will most likely change over time as our experiences grows" (templates for goals, questions and metrics) But since the questions are framed in a quantitative manner, it is not difficult to derive the metrics from them and in a real environment.

Each question can generate one or more metrics or one metrics can be generated from two or more questions through the use of surveys, brainstorming sessions, Delphi technique or by using focus groups. Beside this, the measurement framework is a dynamic process whereby when the organisations change, the metrics also change leading to re-specification of the goals, questions and metrics.

Table 2.16 Generation of metrics from questions

Question	Q1	How far is/are the plan/plans clear, effective and user friendly in conveying information?
Metrics		
M1		Rating scale for evaluating clarity
M2		Rating scale for evaluating effectiveness
M3		Rating scale for evaluating user friendliness
Question	Q2	How far are the costs reasonable? Was it within budget?
Metrics	M4	% of cost overruns from the budgeted amount
Question	Q3	How many times in an year was/were the plan/plans modified?
Metrics	M5	Number of times the plan was modified
	M6	Number of times requests were made to change the plan/plans
Question	Q4	How many defects are evident in the plan/plans?
Metrics	M7	Number of defects in the plan/plans
Question	Q5	Does the plan/plans confirm to the business/IT objective?
Metric	M8	A rating scale that measures the level of conformance to business objective
Metric	M9	A rating scale that measures the level of conformance to IT objective
Question	Q6	How far is/are the plans functional?
Metric	M10	A rating scale that measures the level of functionality
Metric	M11	% of functionality problems encountered in the plan/plans
Question	Q7	Do the plan/plans provide stability? If so how far is it stable?

Metric	M12	A rating scale that measures the stability of the plan/plans
Metric	M13	The time span/duration when the plan/plans are stable
Metric	M14	The number of times in a period where the plan's stability was questioned
Question	**Q8**	**Is/are the plan/plans simple or complex? How far is/are the plans simple or complex?**
Metric	M15	A rating scale to measure, with simplicity on one end and complexity on the other end.
Metric	M16	% of complex areas in the plan/plans
Question	**Q9**	**Are the results consistent from various perspectives?**
Metric	M17	A rating scale that measures the consistency of the plan/plans
Metric	M18	% of inconsistency in the plan/plans
Question	**Q10**	**List out the number of weakness in the plan/plans**
Metric	M19	Number/percentage of major weakness in the plan/plans
Metric	M20	Number/percentage of minor weakness in the plan/plans
Question	**Q11**	**Is clarity of objectives, functionality, stability, complexity, costs, strength and weakness the best way to measure the quality of the plan/plans?**
Metric	M21	A rating scale that measures the extend to which clarity of objectives, functionality, stability, complexity, costs, strength and weakness is capable of measuring the goal/DCO "assess the performance of the existing plans and information systems"
Question	**Q12**	**What is/are the quality level of the present plan/plans?**
Metric	M22	A rating scale that measures the level of quality of the plan/plans
Question	**Q13**	**What are the problems regarding the quality of the plan/plans?**
Metric	M23	Number/percentage of problems regarding quality
Question	**Q14**	**How can we improve the quality?**
Metric	M24	The extend to which quality can be improved

If the organisation already uses metrics either home grown or from COBIT, using this approach aids in cross checking to see how the existing metrics correlates with the one developed using this method. One of the main problems facing the IT auditor using this model is its exhaustiveness in generating hundreds or even thousands of questions and metrics from the 318 control objectives. This being the fact it is to be noted that the first exercise is the most extensive one and

subsequent ones can be done efficiently due to the 'experience curve' concept. Secondly basic automation can be done using spreadsheet and in this study database application is used to automate the process. Table 2.16 illustrates the methodology of developing metrics from quantifiable question.

2.4.3 Metrics

The three templates have aided in generating metrics with rating scale, percentages, frequency, and duration. While the above category of metrics suits the software development process where more objective metrics are used like 'lines of code', 'function points' than subjective metrics, in the field of information systems it would be difficult to come up with such objective measures and such a metrics system may not reveal performance of IS. Hence the issue is to find out a suitable metrics system suitable for measuring IS effectiveness via IS audit. For answering this question it is imperative to have a look at the literature on IS effectiveness. From the study on information systems effectiveness and performance [see section 2.2] it was shown that the rating scale (multi-point scoring system) was the preferred method for measuring IS effectiveness (Chang & King, 2005; Doll & Torkzadeh, 1988; Evans, et al., 1988; Ishman, 1996; Malik & Goyal, 2001; Miller & Doyle, 1987; Pitt, et al., 1995; Saarinen, 1996). This necessitates the need to find a metric system that can transform the metrics generated into a rating scale for performance evaluation. Hence there is a need to add one more step to the proposed COBIT-GQM model which is the process of conversion of the metrics into a five point rating scale. Hence the revised model is given in figure 2.5.

2.4.4 Model Automation

Automation of the measurement process has support from the information system, audit and software engineering discipline. Audit automation is the application of information technology to accelerate or enhance the quality of audit procedures and have been automated (Manson, Mccartney, Sherer, & Wallace, 1998). Even though the market for IT governance automated tools are in the infant stage of the product life cycle (Jamal & Jansen, 2006) the COBIT business process have been automated using the IBM Rational Portfolio Manager (Myerson, 2006) and spreadsheets have also been recommended for COBIT implementation (Butler,

2001).
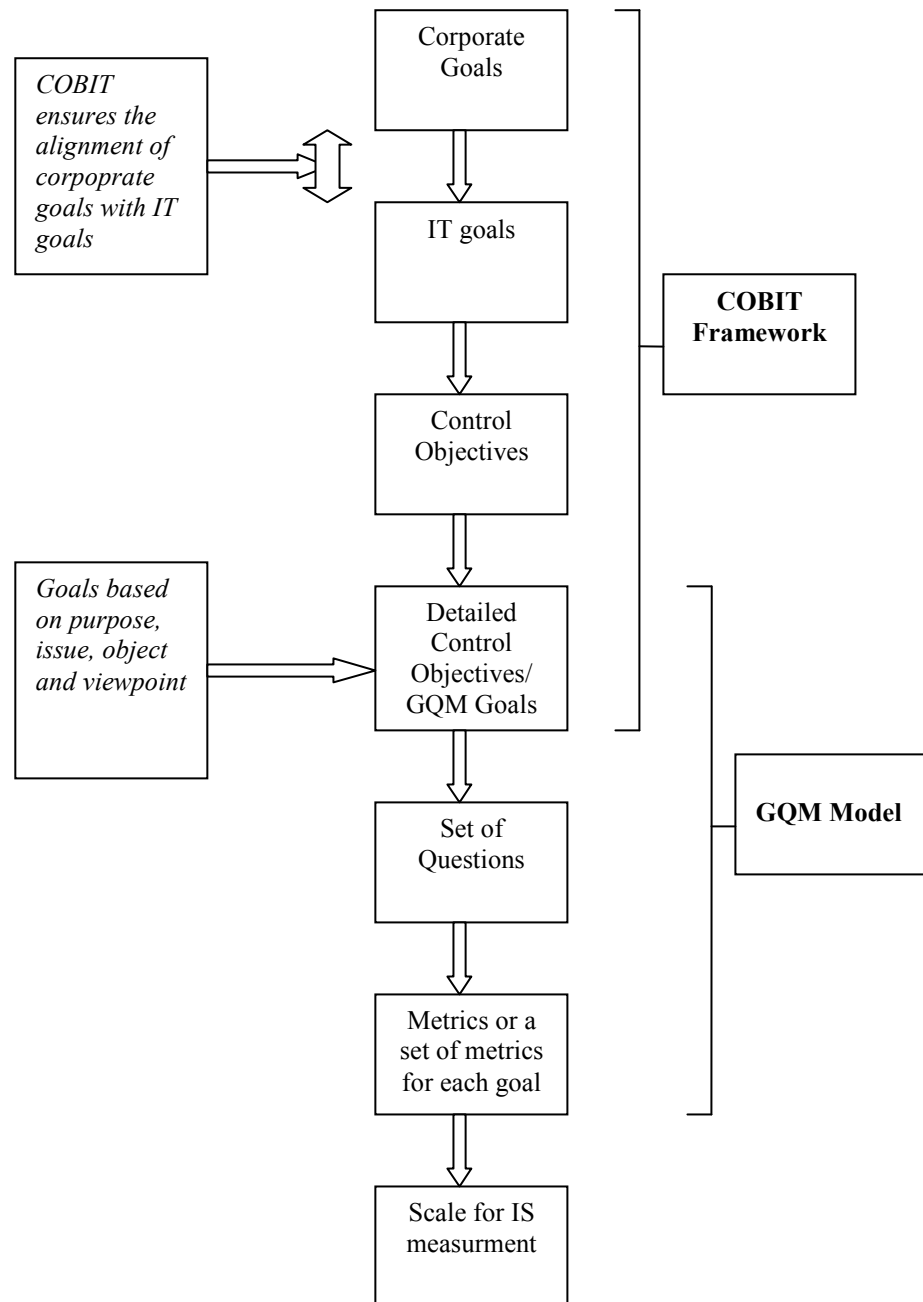
Figure 2.5 Revised COBIT-GQM model

Computer assisted audit tools can be categorised into electronic working papers, information retrieval and analysis, fraud detection, network security, e-commerce, continuous monitoring, audit reporting, database of audit history, computer based training and time tracking (Grand, 2001). Based on the above, the proposed model can also be used for information retrieval and analysis, network security,

continuous monitoring, audit reporting, and a database for audit history, apart from IS performance. Since organisations are heavily dependent on IT, "day to day compliance measurement and enforcement activity is essential" (Solms, 2005b, p. 445). This ensures continuous auditing and assurance of IT (Posthumusa, et al., 2005) that allows for fast rectification of problems (Flowerday, Blundell, & Solms, 2006). The benefits of automation include motivation, job satisfaction and increased performance by staff (Manson, et al., 1998). All of these reasons drive the need for automation of measurement and assurance services.

From a software engineering perspective, measurement process should be automated as far as possible (Iversen & Mathiassen, 2003) as automation enhances the visibility of the measurement process (Sirvio, Parvianen, & Ronkainen, 2001). The GQM process has been automated into a software application focussing purely on software development by VTT Electronics of Finland. Since the GQM process has been criticised as being non repeatable and non terminating, automated tools can overcome this problem with the use of database with a library of goal, question, and metrics that are consistent with a given context (Lavazza, 2000).

Table 2.17 Propositions derived from the section on the COBIT-GQM model

Propositions that have emerged from this section (2.4)
P 9: A COBIT-GQM information systems measurement framework assist in generating customised goal oriented metrics for the target IS entity*
P 10: A ratings scale is preferred for measuring IS
P 11. Automation enhances the visibility of the measurement process

2.5 PROPOSITIONS

Based on the review of literature on information systems measurement, IT governance and software engineering all the 11 propositions listed under the respective sections can be summarised into four main propositions (table 2.18).

Table 2.18 Final research propositions

P 1: There is a driver identified by the literature for an automated instrument/framework/model that can measure/evaluate IS effectiveness continually in a systems life-cycle

P 2: The metrics for measuring IS entities need to be context based and aligned to the respective goal or objective or entity that it measures

P 3: A scoring system is required for measuring IS entities using IS audit frameworks

P 4: A COBIT-GQM information systems measurement framework assists in generating customised goal oriented metrics for the target IS entity

In the above table, the propositions P1, P3 and P10 (derived from the previous sections) are integrated into P1 (table 2.18). In the same manner the propositions P2, P4, P5 and P7 have been integrated into P2; propositions P10 integrated into P3; and proposition P6, P8 and P9 integrated into P4.

2.6 CONCLUSION

In this chapter three domains of the information systems discipline were reviewed to identify a method, processes, a model, and concepts that can be used to measure IS entities from customised goal oriented metrics. The relevant literature (IS measurement) review has located the gaps and the weakness of the current IS measurement models and as well as the claims others make regarding model capabilities. Moreover the review of the literature has also delivered principles, concepts, and propositions in IS measurement. The information so gathered initiated a search on the IT governance and software engineering fields in order to locate similar constructs. Since the researcher could not find a model that would fully address the problem areas identified based only on IS measurement principles, further research revealed that if a significant part of the IT audit model COBIT is combined with the GQM model, then not only the research questions can be answered, but also the fusion would comply with relevant IS measurement principles and concepts. Hence the control objective aspect of the IT audit model COBIT was fused with the GQM model thus theoretically producing the COBIT-GQM model.

Even though a theoretical testing of the model (using GQM templates) with an example generated goal aligned metrics, this model needs to be tested empirically to prove the theoretical claims. For this purpose the templates have been automated into a software application with Visual Basic Express Edition 2005 as the front end and MS Access as the back end. Since the database need to be populated with COs, DCOs, questions and metrics, the first step (once the model have been automated) would be to get the feedback from IT audit experts in New Zealand on the most common COs/DCOs used in IT audit and thereby IT governance. Then the researcher would take these identified COs and DCOs and would generate the required questions and metrics to populate the database. Thereafter the populated model would be subject to usability testing by experts before it is made available for empirical research (to be given in the form of a CD and an operation manual). The next chapter outlines a methodology proposed for the testing of the model in practice and the justification for selecting the identified methodology.

Chapter - 3
The Research Methodology

3.0   INTRODUCTION

The previous chapter reviewed the selected literature in IS and SE to identify research learning about metrics. In depth reviews of metric related themes in the two domains of knowledge has located similarities and differences, and a foundation on which to propose the development of new knowledge in the area of IS measurement. It was hypothesized that a COBIT-GQM model could effectively measure from a theoretical perspective the IS entities in an IS domain using customised, goal oriented metrics, that were well aligned with the IT goals. The effectiveness of the theoretical model requires testing and the assertions operationalised so that empirical data may be collected. Thus the objective of this study is to evaluate the model developed out of the theory in its effectiveness to develop customize and goal-aligned metrics for measuring the various entities of information systems from an IT audit perspective. This chapter develops a research methodology that addresses the IS problem area of measurement and answers the questions that emerged in chapter 2. The research methodology follows a positivist tradition using qualitative approach to undertake multiple case studies in two countries to evaluate the proposed model.

The purpose of this chapter is to summarize the problem area and questions that have emerged in chapter 2 and then to outline and define the research philosophy underlying the study. An appropriate research paradigm is selected, the research process is outlined, similar studies in information systems are reviewed for instruction so that the research methods employed are identified, and appropriate research instruments developed. To evaluate the proposed theoretical model an empirical approach is adopted and the introduction of the model to a real life setting (organizations) is to be made through working software. The model can be physically modeled into a set of templates or automated into a basic prototype software application. The model provides a method to measure the IS effectiveness using

customised metrics in an efficient manner, hence it was deemed appropriate to automate the model.

The chapter is structured into seven major sections (3.1 – 3.7) starting with a review of the problem area and questions arising from chapter 2 (3.1). This is followed (3.2) with a detailed discussion of the research philosophy where the basic assumptions underlying the research are discussed. Here the research paradigm relating to qualitative research is discussed and compared with alternatives. The next section (3.3) specifies the research design where the steps in the research process are not only outlined and explained, but also the proposed research processes are mapped with a popular system development research process model. Section 3.4 investigates three similar case studies undertaken in the information systems field with the objective of identifying and evaluating the major similarities of the proposed study with the discussed cases in relation to the topic, and methodology. These studies by other researchers balance and provide guidance on how to best approach a similar study. In the 'research method' section (3.5) the justifications for choosing a case study method is discussed using the criteria developed by Yin (1994). Along with that, the research instruments namely the data collection techniques, tools, criteria for selection of the case, sources of data, processing and the steps taken to ensure validity and reliability are outlined. Section (3.6) explains the method of analysing the data and reporting the findings. Importantly LeCompte's (2000) data analysis method for case data analysis is specified in detail. Finally the limitations and the expected problems of field research (3.7) are declared so as to moderate any claims or speculation that may arise from the research.

3.1   THE RESEARCH QUESTION

In any organisation, an IT audit/governance framework is implemented in the information system department under the responsibility of the CIO (for a large organisation). Hence the theoretical model tested in chapter 2 needs to be evaluated and tested in an IS department, and with IS personnel who are involved with IT audit/governance implementation or management. In the previous chapter the theoretical answers to the question of what 'knowledge' may be found by applying

the model has been demonstrated. The next phase is to take the theoretical conjectures and test them in practice. Since a deductive strategy requires an inductive approach, the questions of how tactic knowledge is acquired and what the respondents know about the model and its implementation are explored (While deductive reasoning move from the more general to the more specific, inductive reasoning works the other way, moving from specific observations to broader generalizations and theories). The epistemological issue of research philosophy clarification is addressed in the next section. This section will now summarize and reference the development of researchable questions from chapter 2.

The research question that have been derived from the review of literature of the three IS domains and the propositions is "How can an IT audit or governance framework be used to measure the effectiveness of IS entities in a scientific manner using customised and goal aligned metrics?" [see figure 3.1]. Figure 3.1 lists the sub questions that have been theoretically answered in the sections of the literature review to come up with the research question. Even though section 2.4 theoretically answers the research question (through a model) empirical research is required to validate the claims of the model.

Research Question	How can an IT audit or governance framework be used to measure the effectiveness of IS entities in a scientific manner using customised and goal aligned metrics?			
Leading Question	What is the relevance of IS measurement, the models used, and the concepts?	How does an organisation measure IS scientifically in IS and software engg'(SE) field?	What are the ITG tools available and how are they linked to IS measurement?	What's the role of GQM in generating metrics for IS entities?
Sub Question	1. What is the need for measuring IS effectiveness and performance? 2. What are the different perspectives of IS measurement? 3. What are the measurement principles in this domain? 4. What are the different models proposed in this domain? Its strength and weakness 5. What are the challenges in measuring IS effectiveness? 6. How is IT audit addressed in these studies?	1. Describe the field of measurement in IS, its concepts and process. 2. How far has the field of IS measurement advanced? 3. What are the areas where measurement has been taking place and how? 4. Which are the models used in measurement in IS and SE? 5. What are the problems encountered with these? 6. Can this/these model/s of measurement be used in IS and how?	1. What are the concepts of IT governance? 2. How far does IT governance links with measurement and performance of IS? 3. What are the popular frameworks of IT governance? 4. Does the selected IT governance framework address measurement? If yes, to what extend and what are its strength and weakness? 5. Evaluate the measurement tools used in the selected framework 6. How is it implemented in organisations?	1. Can the selected ITG framework combined with any software engineering model? If so how? 2. Is it possible to generate metrics for measuring information systems through this combined model and if so how? 3. What are the prospects of automating this model? 4. How can the model be empirically tested
Lit. Rev. Sections	Section 2.2 Measurement of IS - A review	Section 2.3 Metrics and Measurement	Section 2.4 IT Governance, Audit and Measurement	Section 2.5 CoBIT – GQM Model - leading to **RM chapter**
Model	A METRICS GENERATION MODEL FOR MEASURING IS EFFECTIVENESS AND PERFORMANCE			

Figure 3.1: The derived research question, the sub-questions and the theoretical model

Table 3.1: Sub-question 1 (that partly address the research question) and the rationale for seeking the answers

<table>
<tr><td colspan="3">Main Research Question

How can an IT audit or governance framework be used to measure the effectiveness of IS entities in a scientific manner using customised and goal aligned metrics? [section 2.1]</td></tr>
<tr><td></td><td colspan="2">Sub-question - 1

What is the relevance of IS measurement, the models used, and the concepts?

</td></tr>
<tr><td></td><td>**Questions that address the sub-question**</td><td>**Rationale for answering the question**</td></tr>
<tr><td>1</td><td>What is the need for measuring IS effectiveness and performance? (Section 2.1.1)</td><td>To know the importance, need and relevance of measuring information systems for the organisations and the financial implications for this requirement</td></tr>
<tr><td>2</td><td>What are the challenges in measuring IS effectiveness? (Section 2.1.2)</td><td>The problems and issues faced by academics and practitioner in measuring information systems will greatly aid the researcher in finding ways to overcome these challenges. Gaps in the literature regarding this can be located</td></tr>
<tr><td>3</td><td>What are the different perspectives of IS measurement? (Section 2.1.3)</td><td>Information systems being a multidimensional field, someone intending to measure can approach it from various perspectives. This aspect will reveal which all perspectives have been pursued till date in this topic</td></tr>
<tr><td>4</td><td>What are the measurement principles in this domain? (Section 2.1.4)</td><td>Measurement principles and concepts proposed in the IS field will greatly aid in crafting a suitable model for IS measurement</td></tr>
<tr><td>5</td><td>Which are the different models most close to the research question? Its strength and weakness (2.1.5)</td><td>IS literature is abound with numerous models of IS measurement. An evaluation of these will help to know if any of these can find answers for the main research question and if not which are the closest one</td></tr>
<tr><td>6</td><td>How does the study address IT audit? (Section 2.1.6)</td><td>It is necessary to find out if there are any IT audit or governance concepts/models evident or implied in the field of IS measurement and how it is linked</td></tr>
</table>

The purpose of researching the IS measurement domain was to find out an appropriate model that can answer the research question and to come up with some principle on IS measurement. Section (2.1) highlighted relevant studies done in the field, explored the challenges in IS measurement, the areas of concerns where research is deficient and the problems with information systems measurement. Similarly a research into the field of IT governance/audit is done to find out an IT audit model that can be used to measure IS performance in a way that can answer the research question and that conforms to the principles of IS measurement derived from the previous section.

Table 3.2: Sub-question 2 (that partly address the research question) and the rationale for seeking the answers

Main Research Question		
How can an IT audit or governance framework be used to measure the effectiveness of IS entities in a scientific manner using customised and goal aligned metrics? [section 2.2]		
	Sub-question - 2 What are the ITG tools available and how are they linked to IS measurement?	
	Questions that address the sub-question	**Rationale for answering the question**
1	How does the concepts of IT governance address IS measurement issues? (Section 2.2.1)	Since measurement is viewed from an IT audit perspective , it is quite imperative to see how the concept of measurement is addressed in ITG
2	What are the popular IT audit frameworks and which one is comprehensive enough with a measurement focus? (Section 2.2.2)	A search for popular IT audit frameworks is necessary to select the one most commonly used by organisations, is comprehensive enough to measure IS entities, have a measurement focus and robust
3	Does the selected IT governance framework address IS measurement? If yes, to what extend and what are its strength and weakness? (Section 2.2.3)	IS measurement principles and models are taken from the IS/SE field and mapped to the selected IT Audit framework to evaluate the correlation and differences
4	Does the selected tool help in aligning the metrics with the goals? (Section 2.2.4)	To evaluate whether metrics can be traced to goals
5	What are the measurement tools used in the selected framework? (Section 2.2.5)	Evaluate (strength and weakness) the measurement tools used in the selected framework to analyse whether these tools can address the research question

In section 2.2 the different perspectives and dimensions of IT governance/audit; the extent of overlap of the concept of measurement in IT governance, and the tools/models/frameworks used in IT audit were explored. And this gave rise to sub-question 2 (see table 3.2). In the section 2.4 on software engineering the search for a model that can measure IS performance continued, and sub-question 3 emerged (see table 3.3).

Table 3.3: Sub-question 3 (that partly address the research question) and the rationale for seeking the answers

Main Research Question	
How can an IT audit or governance framework be used to measure the effectiveness of IS entities in a scientific manner using customised and goal aligned metrics?	

	Sub-question - 3	
	How does an organisation measure IS scientifically in IS and software engineering (SE) field? [section 2.3]	

	Questions that address the sub-question	**Rationale for answering the question**
1	Describe the field of measurement in SE its concepts and process. (Section 2.3.1)	Measurement principles in SE can guide the researcher in (1) knowing the concepts of measurement (2) taking the concepts to examine how it relates to the IS field and (3) to examine how far the selected metrics generation method/model conforms to this principles
2	How far the concept of metrics is applicable to the broader IS domain? (Section 2.3.2)	The concept of metrics originated in the SE field in the 1960s and whether it can be applied to the IS domain need to be verified here.
3	What is the relevance of measurement in SE? (Section 2.3.3)	The relative importance of measurement is SE can reveal the importance and need of this research
4	What are the problems with software measurement? (Section 2.3.4)	Naturally the challenges faced in SE measurement may reveal areas that need further research or show areas where the researcher has to tread with caution
5	Which is the appropriate metric generation method/model? (Section 2.3.5)	The objective here is to select an appropriate model that can seamlessly integrate with COBIT

Areas that were explored included the concept of 'metrics' and 'measurement', objects of measurement, methodology of generating metrics, and the problems encountered in measurement using metrics. An analysis of the research questions and the related questions converged on a set of criteria to look for while selecting the proposed model namely (1) comprehensive view of IS entities (2) performance oriented measurement, (3) customised measures, and (4) goal oriented metrics. The literature reviewed presented more criteria. Thus the research question (above) had helped in deriving a set of criteria to look for while formulating a model. Research into the IS measurement domain and software engineering has provided more criteria and these are given in table 3.4.

Table 3.4: Sub-question 4 (that partly address the research question) and the rationale for seeking the answers

Main Research Question		
How can an IT audit or governance framework be used to measure the effectiveness of IS entities in a scientific manner using customised and goal oriented metrics?		
	Sub-question - 4	
	What's the role of GQM in generating metrics for IS entities? [section 2.4]	
	Questions that address the sub-question	**Rationale for answering the question**
1	Can the selected ITG framework combined with any software engineering model? If so how? (Section 2.4.1)	This section will demonstrate how the IT audit model COBIT and the GQM model fits into each other especially shows where the integration takes place (which aspects of COBIT and GQM connects together)
2	Is it possible to generate metrics for measuring information systems through this combined model and if so how? (Section 2.4.2)	Using a detailed control objective from COBIT and suing GQM the process of generating metrics from goal is illustrated
3	Does the generated metrics give a proper measurement focus? (Section 2.4.3)	To see whether the metrics generated according to SE principles is congruent with IS measurement
4	What are the prospects of automating this model? (Section 2.4.4)	Gives the reasons favouring automation
6	How can the model be empirically tested	Leads to the chapter on research methodology

3.2 RESEARCH PHILOSOPHY

Research is defined as a human activity based on the intellectual investigation aimed at discovering, interpreting, and revising human knowledge on different aspects of the world (Wikipedia), and *philosophy* (which means the love of wisdom, based on the terms *philo* and *sophia*) etymologically connotes the love of exercising one's curiosity and intelligence rather than the love of wisdom (philosohpicalsociety.com). This *research philosophy* can be defined "as the underlying theory which places research activities in perspective with man's existence in the universe" (Bryan, 1966, p. 69). Researchers, like individuals hold some set of beliefs about the world and nature of reality. Such an understanding of philosophical issues of research is important as it not only helps in understanding the wider philosophical perspective underlying the research but also aids in choosing the appropriate research method. Hence when planning a research study, "clarification of these basic beliefs can assist in our understanding of the interrelationships between ontological (what is the nature of reality?), epistemological (what can be known?), and methodological (how can the researcher discover what she or he believes can be known?) levels of enquiry"

(Proctor, 1998, p. 74). Viewed from a different perspective (Easterby-Smith et al, 1997, cited in Crossan, 2003) an exploration of philosophy with particular reference to research helps the researcher to refine and specify the research strategy, (that help in answering the research question); assist the researcher to evaluate different methodologies; and help the researcher to be creative and innovative in the selection and adaptation of methods. A researcher mainly tries to seek knowledge and epistemology "addresses the question of how a person can arrive at cognition" (Becker & Niehaves, 2007). A research philosophy is concerned with knowledge, and how it is to be acquired – the domain of epistemological. Epistemology is the branch of philosophy that studies the nature, methods, limitations, and validity of knowledge and belief, and it answers the question about knowledge, the manner of acquiring it, and what people do know about it (Myers, 1997).

To answer these questions, the framework (based on the theory of culture by Edgar Schein) outlined by Niehaves (2005) is used that will explain the epistemology, paradigm and research method employed by the researcher for the purpose of extracting knowledge (table 3.5). The last column had been added and elaborated by the author to point out the choice of selection of the method that is highlighted in bold. While epistemology addresses the question of how we come to know of the reality, methodology identifies the practices used to attain knowledge about the reality (Kraus, 2005). The section that follows explains the rationale for selecting a particular paradigm and method.

Table 3.5: The philosophical framework of research from a culture perspective Adapted from Niehaves (2005).

(A) Level of - Artifacts & Symbols	Visible, but have to be interpreted	Research methods: Research results, language, rituals, and so on.	Action research, **case study research**, ethnography, grounded theory research (Myers, 1997)
(B) Level of – Norms & Values	Visible in parts; subconscious	Research paradigms: Ideologies, ethics, maxims, guidelines, and so on.	**Positivist,** Interpretive, critical (Orlikowski & Baroudi, 2002)
(C) Level of – Basic Assumptions	Mostly invisible; subconscious	Epistemological assumptions: Assumptions about nature of man, time, and so on.	**Critical ontology** (as noted in Myers 1997).

3.2.1 Research Approach

There can be three approaches to social research namely quantitative, qualitative research and mixed (both qualitative and quantitative) approach (Cresswell, 2003).

Table 3.6: Evaluating qualitative and quantitative research in relation to the study

Quantitative research	Qualitative research	Nature of the study
Quantitative methodology is routinely depicted as an approach to the conduct of social research which applies a natural science, and in particular a positivist, approach to social phenomena with emphasis upon fixed measurements, and hypothesis testing (Bryman, 1984).	Qualitative research is deemed to be much more fluid and flexible than quantitative research in that it emphasizes discovering novel or unanticipated findings (Bryman, 1984)	*The topic under research is quite new as not much literature have been published in this field and the researcher expects to find 'novel' and 'unanticipated' findings. Moreover there are no fixed measurements or variables to measure*
Quantitative research is more concerned with the measurement of frequency of phenomena in the social world" (Schwandt, 2001, cited in Rowlands, 2005, p. 81).	Qualitative research has been described as an 'array of techniques seeking to describe, decode, translate, and somehow come to terms with the meaning of the problem (Schwandt, 2001, cited in Rowlands, 2005, p. 81).	*There is no measurement of frequency rather, it is an attempt to understand the problem in a real setting through theory testing*
Quantitative research methods were developed to study natural phenomena using quantitative methods namely survey methods, laboratory experiments, formal methods (econometrics) and numerical methods (laboratory modeling) (Myers, 1997)	Qualitative methods enable researchers to study social and cultural phenomenon using methods like action research, case study, and ethnography. (Myers, 1997)	*Even though case study is being used, there is not much study of social and cultural phenomena. A few aspect of the social and cultural setting are being explored like elicitation of responses regarding the normal method used by the respondents to measure information systems, as the thrust of the research is to test theory.*
Empirical research where the data are in the form of numbers while qualitative research (Punch, 1998).	Empirical research where the data are not in the form of numbers (Punch, 1998).	*The data collected are not in the form of numbers, but rather in the form of recorded conversations, responses to open ended questions, and written or scribbled notes.*
Features of quantitative method - Hard, fixed, objective, value-free, survey, hypothesis testing, abstract (Silverman, 1998)	Features of qualitative method – soft, flexible, subjective, political, case study, speculative, grounded (Silverman, 1998)	*The data collection does not follow any rigid pattern, as the questionnaire are based on some themes and questions are encourages focusing on the themes, the answers can be subjective based on the respondents or organisation.*

Quantitative research is empirical research where the data are in the form of numbers while qualitative research is empirical research where the data are not in the form of numbers (Punch, 1998). Table 3.6 gives the different perspectives of the two types of research approach and in this the shaded portion reveals the approach taken by the author with the last column outlining the nature of the proposed study.

There is a growing recognition of the value of qualitative method on social, behavioral, organisational and evaluative research (Kaplan & Duchon, 1988). But in a study (Orlikowski & Baroudi, 2002) of 155 papers (published during the years from 1983 – 1988) in the four top IS journals only 21 were seen as case studies while 76 were surveys. Even though qualitative research in IS was hard to find until the 1970s (Howe & Eisenhart, 1990) it is viewed as a high growth area, as "there has been a growing interest in the use of qualitative techniques in the administrative sciences"(Benbasat, Goldstein, & Mead, 2002). Thus in the proposed research a qualitative approach is deemed more suitable than a quantitative one, as the objective is to understand the phenomenon from the point of view of the participants and the particular context (Kaplan & Maxwell, 1994).

3.2.2 Research Paradigm

A paradigm framework is made up of the underlying philosophy, ontology, epistemology and methodology (Ruskin, 2006). An explanation of these frameworks helps in guiding the research to a better and correct methodology and in justifying the reasons for choosing the methodology for the empirical research. Thus the research approach being qualitative in nature, a philosophical perspective reveals four underlying paradigms namely positivism, post-positivism, critical theory, and constructivism (Guba & Lincoln, 1994), while according to Chua (1986, cited in Orlikowski & Baroudi, 2002) there are three research paradigms namely positivist, interpretive and critical. The features of these three categories from two perspectives (Myers, 1997; Orlikowski & Baroudi, 2002) have been summarized into the table 3.7 below by the author to choose and fit a type that suits the proposed study. The shaded portion represents the paradigm concepts that fit into the proposed study.

In the previous chapter, a theoretical model for measuring IS entities using customized metrics was tested and it has been stated by Pare (2001, p. 5) that "Positivist IS research is concerned with the empirical testability of theories."

Table 3.7: Research paradigm

Ref.	Positivist	Interpretive	Critical
(Orlikowski & Baroudi, 2002)	(1)Premised on the existence of a priori fixed relationships within phenomenon which are typically investigated with structured instrumentation	Assume that people create and associate their own subjective and inter-subjective meanings as they interact with the world around them	Aim to critique the status quo, through the exposure of what is believed to be deep seated structural contradictions within social systems.
	(2)Serves to test theory in an attempt to increase predictive understanding of the phenomenon	Attempt to understand the phenomena through the meanings that participants assign to them	A critical stance taken towards taken-for-granted assumptions about organisations and information systems
	(3)Evidence of formal propositions, quantifiable measures of variables, hypothesis testing, and the drawing of inferences about a phenomenon	Reject the possibility of an 'objective' or 'factual' account of events and situation	N / a
	N / a	Generalization from the setting to a population is not sought as the idea is to understand the deeper structure of the phenomenon	N / a
(M. Myers, 1997)	(4)Positivists assume that reality is objectively given and can be described by measurable properties which are independent of the observer and the instruments	Assume that access to reality is only through social constructions such as language, consciousness and shared meanings	Assume that social reality is historically constituted and that it is produced and reproduced by people
	N / a	(5)Does not predefine dependent or independent variables, but focuses on the full complexity of human sense making as the situation emerges	Recognize that the ability of people to change their social and economic setting is constrained by various forms of social,, cultural and political domination

Moreover the researcher does not in any way facilitate or control the study in the real setting as according to (Orlikowski & Baroudi, 2002) "Because positivists believe that scientific inquiry is "value-free," what such a desired state of affairs is cannot be resolved scientifically. It is believed that as impartial observers, researchers can objectively evaluate or predict actions or processes, but that they cannot get involved in moral judgments or subjective opinion." To arrive at the answer, instead of the formal propositions the answer is extracted through a research question that results in

drawing a set of inferences about the measurement phenomenon. Since the phenomenon can be systematically and logically studied, investigated and analyzed in a real setting the premise that an objective reality is assumed hold true. On reflection, it has been observed that a positivist paradigm suits this proposed study and the only overlapping characteristic the study has with the interpretive study is regarding the non specification of any dependent or independent variables.

3.3 RESEARCH DESIGN

Yin (1994, p. 19) has defined research design as "an action plan for getting from here to there, where *here* may be defined as the initial set of questions to be answered, and *there* is some set of conclusions (answers) about these questions". According to Blaikie (2000) a research design should help in providing answers for some basic questions namely 'what', 'why' and 'how' of the study. This serves as a very useful starting point to explain and define the proposed research. While the '*what*' and '*why*' components have been answered in the section on literature review, it is imperative that this section answer the '*how*' questions of research. The 'research methodology' chapter address the latter type of question by explaining the method of acquiring knowledge and the underlying philosophy undertaken for the design. Blaikie (2000) has further subdivided this question into four components namely the type of research strategy that will be used, the source of data, how the data will be collected and analysed and finally when will each of these stage will be carried out. While these are explained in subsequent sections, figure 4.1 outlines the steps of the research process. While analysing similar studies it has been observed that the design of this study closely follows that of the one conducted by Sambamurthy & Zmud (1999) which is explained in detail in section 3.4

3.3.1 Steps In The Research Process

The first step involves building an automated version of the model for implementation by the participating organisation. This requires the taking of the theoretical model, and automating it using a front end application and a back end database. In parallel, a survey is taken from the IT audit community regarding the

most common control objective/s (COBIT) used in the industry [appendix 2]. The purpose of this step is to populate the model database with a set of control objectives. From this control objective a set of questions and metrics were developed (by the researcher) to populate the database. One advantage of a populated model is that it is easy for the researcher to demonstrate the model to the participating organisations and secondly organisations can evaluate the utility of the set of metrics that is present in the model database generated using the GQM model, or a customised set).

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┌─────────────────────────────────────────────────────────────┐
│     1. Automate the model/ Start the research process        │
└─────────────────────────────────────────────────────────────┘
                            │
┌─────────────────────────────────────────────────────────────┐
│ 2. Get feedback from IT auditors regarding the most commonly used │
└─────────────────────────────────────────────────────────────┘
                            │
┌─────────────────────────────────────────────────────────────┐
│ 3. Develop and generate a database of metrics for the identified CO/DCO │
└─────────────────────────────────────────────────────────────┘
                            │
┌─────────────────────────────────────────────────────────────┐
│   4. Usability test - Modify or alter model based on the feedback │
└─────────────────────────────────────────────────────────────┘
              │                              │
┌──────────────────────┐      ┌──────────────────────────────┐
│ 5a. Implement the    │      │ 5b. Study the organisation to │
│ model with the generic│      │ find out how they audit and   │
│ set of metrics       │      │ measure the IS performance    │
│                      │      │ implementation)               │
└──────────────────────┘      └──────────────────────────────┘
              │                              │
┌─────────────────────────────────────────────────────────────┐
│ 6. Allow sufficient time duration for implementation. Also provide support │
│                 and training if needed                       │
└─────────────────────────────────────────────────────────────┘
                            │
┌─────────────────────────────────────────────────────────────┐
│ 7. Triangulation done by interviewing the main participant; obtaining │
│                 written notes or reports                     │
└─────────────────────────────────────────────────────────────┘
                            │
            ┌──────────────────────────────┐
            │    8. Analyse the results    │
            └──────────────────────────────┘
                            │
            ┌──────────────────────────────┐
            │    9. Present the findings    │
            └──────────────────────────────┘
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Figure 3.2: Steps in the research process

The fourth step involves getting feedback regarding the model in terms of features and usability. Since the automated version is based on the theoretical model proposed in the previous chapter, care is taken not to get feedback on the theoretical model, but

rather on the usability of the version. This again is the distinction between theory and practice (software). The usability testing allows the researcher to get feedback on the following attributes of the model namely usability, structural adjustments, content, relevance of the use of DCO for generating metrics, and any other issues that may be raised by the experts. Figure 3.2 summarises the steps in the research process.

The fifth stage diverges into two whereby the populated model with the semi-generic metrics is implemented in the target organisation (5a). The organisation is given sufficient time (3 to 7 days) to use the model in their organisation and generate various reports. At the same time, they are briefed extensively about the IS audit process used, the methodology and feedback regarding their audit process. Getting feedback is the next process (7) where three types of data are collected through interviews, and written notes and reports if any, during the process of implementation. The data collected and the rationale is given in detail in section 3.5.6., while the method of analysis and reporting the finding are given in section 3.6

3.3.2   The Model Followed

In the study the major thrust is to evaluate and test the model, with less emphasis on identifying the features of the automated solution. But looking at this research from an applied research perspective the end result may be an application for generating metrics for IT audit goals/process and entities. Thus if this study is viewed from a systems development perspective, then it is imperative to look at the research method from that perspective. Hence from a system development perspective the research process follows the model given by Nunamaker, Chen & Purdin, (1991). Figure 3.3 illustrates how the model has been applied in the proposed research. The words in italics show the work to be done in this study.

Construct a conceptual framework *(Undertaken in the literature review section)*	♦ Research question ♦ Investigate systems functionalities and requirements ♦ Understand the system building process ♦ Study relevant disciplines
Develop a system architecture *(GQM and COBIT has been integrated into a single structure)*	♦ Develop a unique architecture design for extensibility, modularity, etc ♦ Define functionalities of system components

Analyse and design the system
*(Templates have been designed and
theoretically tested. For each goal a
set of metrics have been
generated)*
	♦ Design the database/knowledge base schema
	   and processes to carry out system functions
	♦ Develop alternative solutions and choose one
	   solution

Build the system (Prototype)
*(System built, populated and
pilot tested)*
	♦ Learn about the concepts, framework, and
	   design through the system building process
	♦ Gain insight about the problems and the
	   complexity of the system

Observe and evaluate the system
(case studies)
	♦ Observe the use of the system by case studies
	   and filed studies
	♦ Evaluate the system by laboratory experiments
	   or field experiments
	♦ Develop new theories/models based on the
	   observation and experimentation of the system'
	   usage
	♦ Consolidate experiences learned

Figure 3.3: Systems development research process (Nunamaker, et al., 1991)

3.4 METHODOLOGICAL REVIEW OF PREVIOUS RESEARCH

Three case studies from literature have been presented in this section with the sole purpose of evaluating the co-relation of the proposed study with the identified one. The studies are selected based on similarity of topic, approach, method and instrument with the sole purpose of evaluating how such similar studies have approached the empirical research. For each of these studies after a brief explanation

of the study, the similarities and differences with the proposed study are given. The differences are highlighted and the rationale for these differences (for choosing a particular methodology) is explained. Table 3.8 gives a comparative analysis of the three studies along with the similarities and differences with the proposed study.

3.4.1   Case Study 1

The first study (Sarker & Lee, 1998) which follows the positivist paradigm uses the case research methodology to test a theory about IT-enabled business process redesign. Here the authors have taken a theory called the 'technology oriented theory of business process re-design' from the business process re-engineering literature. The theory views IT as necessary for the creation of efficient business process configurations, is the centre object of redesign, and that computerised business process re-engineering (BPR) tools have a positive effect on the development of effective business process redesign.   Using a longitudinal study of a single organisation, the authors refute the claims of the theory.

Even though similarities are seen from the use of a qualitative positivist paradigm with a case research eliciting responses through interviews, the major difference from the proposed study lies in the theory itself and the propositions. The theory is taken from BPR literature, unlike in the proposed study where a theory was built from literature. Secondly instead of research questions, there are three propositions. Thirdly the authors have stated that the "evaluation of redesign effectiveness is a complex activity" and so can be understood only by understanding the shared values and expectations of the various stakeholders. This involves an in-depth study which is can be achieved only through a longitudinal perspective unlike in the proposed study where an detailed in-depth analysis is not required.

3.4.2   Case Study 2

The second study (Freimut, Hartkopf, Kaiser, Kontio, & Kobitzsch, 2001) involves a case of implementing a risk management model called *Riskit* in a German telecommunications company. The objective of this study was to find out the usefulness and adequacy of the method, and also to analyse the cost-benefit of using

this method. The model was presented to the implementers in the form of a template. The process started with a workshop where the participants were given a tutorial on the model and briefed on the activities of goal definition, risk identification, risk analysis and risk control planning. The implementations were facilitated and controlled. The data collected came in the form of questionnaire containing 33 questions and one hour interviews with all the five members of the team. To versify the conclusions and suggested process improvements a feedback session was conducted with the members.

In the above study the topic and the objectives are similar to the proposed study, including some aspect of the methodology like the use of multiple cases, but the manner of conducting the research is different. Also both qualitative and quantitative data were collected in the form of questionnaire and interviews. Possible reasons can be found in the lack of research question/s, the need for facilitating and controlling the implementation and the need to get involved in the implementation due to the following reasons - new and challenging technologies being applied; web technology to be used in a client-server application context; use of object-oriented technology for implementation; a new development process and a new project organisation. Hence here for testing the model a part of the organisation was restructured process and technology wise, and according to the authors this "added complexity to the project" and so a positivist approach may not help.

3.4.3   Case Study 3

This study by Sambamurthy & Zmud (1999) is one of the commonly discussed study from a positivist case study perspective where they explain how multiple contingency forces influence a firm's three types of IT governance arrangements. According to the authors this is the first such study where the effect of multiple contingency factors on the choice of a specific IT governance mode using the theory of multiple contingencies is tested through the use of three hypotheses. After a preliminary screening of 35 firms to fit certain criteria, they selected eight firms for the study. The study being positivist the data was gathered through telephone interviews using a structured interview protocol and the findings supported the three hypotheses.

Table 3.8: Analysis of the three relevant case studies

	(Sarker & Lee, 1998)	(Freimut, et al., 2001)	(Sambamurthy & Zmud, 1999)
Topic	Using a positivist case research methodology to test a theory about IT-enabled business process redesign	An Industrial Case Study of Implementing Software Risk Management	Arrangements for Information Technology Governance: A Theory of Multiple Contingencies
Objective/ Purpose	To test the 'technology oriented theory of business process re-design – which views IT as necessary for the creation of efficient business process configurations; where IT is the centre object of redesign and computerised BPR tools have a positive effect on the development of effective business process redesign.	To evaluate the usefulness and adequacy of the model and secondly to evaluate cost-benefit of the model	To explain how multiple contingency forces influence and firm's three types of IT governance arrangements.
Approach	Qualitative	Qualitative	Qualitative
Research Paradigm	Positivist	Researchers were observing,, facilitating the study with some level of control, hence assumed to be interpretive	Positivist
Research Method	Single cases study – longitudinal	Multiple – Three cases – replicated	Multiple – Eight cases; using criteria for selecting the eight cases
Research Question/ hypothesis	Three propositions	Two research goals	How contingency forces influence the mode of IT governance? Using three hypotheses
Research instrument	Interviews, documents	Structured interview	Telephone interviews
Findings	The technology-oriented theory of business process redesign is wrong. BPR can be more successful in situations where interactions between the social and technological dimensions are anticipated, than where the technology receives the bulk of attention.	The model is a practical and useful tool for managing risk; regarding cost, its impact on the project were too low	The three types of multiple contingencies (three hypotheses) does influence the firm's IT governance styles thus proving the hypotheses
Similarities	Theory testing; use of qualitative approach; interviews and documents as data collection tools;	Similar objective, multiple case study, qualitative approach, interviews, implementing anew model	Theory testing, qualitative approach, positivist paradigm, multiple case, criteria for case selection
Differences	Theory testing - but developed from the literature; longitudinal study; research propositions instead of research questions.	The research paradigm is not positivist; the study involves a full/real implementation of a new risk management approach; Facilitating and controlled implementation.	The theory is intangible in this study, but in the proposed study, the theoretical model was automated and given to the participants

The study is similar to the proposed study in terms of the nature of topic (theory-testing), development of the hypotheses from an implied research question (how contingency factors influence the mode of IT governance), use of multiple case studies, and the use of interviews. The study also used some criteria to select the cases which is similar to the proposed study where a set of criteria are used to select the cases (listed in section 3.5.3). The major difference is the use of a theory, instead of developing a theoretical model (as was the case in the proposed research).

An analysis of the three studies reveals that the proposed study compares well with case study of Sambamurthy & Zmud (1999), in terms of research paradigm, research approach, research method, selection of cases, research instrument, the use of a research question (implied) with 'how', and theory testing. Comparing the remaining two studies, the study by Sarker & Lee (1998) comes next with the main difference being the use of a longitudinal study. Among the three studies the proposed study least resembles the second case mentioned (section 3.4.2), in spite of the fact that the topic is more or less similar in nature and execution.

3.5 RESEARCH METHODS

While a research methodology is a "combination of the process, methods, and tools that are used in conducting research in a research domain" (Nunamaker, et al., 1991, p. 91), a research method is regarded as a technique for collecting data (Bryman, 2004). The method used to conduct the research is qualitative mainly due to qualitative nature of the data that is to be collected from various sources and this requires in depth interviews. Qualitative research methods comprise of many techniques that describe, decode, translate and try to understand their meaning in a natural setting (Maanen, 1979). While Cresswell, (1994) has divided qualitative research into five main types namely the biography, phenomenology, grounded theory, ethnography and case study, Myers and Avison, (2002), categorised them into four qualitative research methods namely action research, case study research, ethnographic research, and grounded theory. In attempting to study the phenomena of measuring information systems in an organisation from an audit perspective, it was found appropriate to use the case study method due to the need for a deep inquiry into

the problem and the novelty (evaluating a model generating customised goal aligned metrics for identified IS entities) involved since "case studies are an important research method in areas where innovations are studied, such as in the field of IS" (DeVries, 2005). In qualitative research, researchers look for 'evidence' and 'theory' (Gillham, 2000) which comes in the form of documents, interviews and questionnaire; and theory that can be used by other organisations.

3.5.1 Case Study Method

The case study research approach is widely used in the field of information systems research (Shanks, 2002) and "is a common way to do qualitative enquiry" (Stake, 2003, p. 443) . Yin (1994, p. 13) has defined a case study as "an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident." The proposed study involves studying a contemporary phenomena of measuring IS entities/goals/objectives through goal oriented metrics and involves finding answers for the research question. "A case study examines a phenomenon in its natural setting employing multiple methods of data collection to gather information from one or a few entities, people, groups, or organisation" (Benbasat, et.al., 2002, p. 370). Moreover in case study research the research questions are specified prior to the study by researcher who are observers/investigators rather than participants (Benbasat, et.al., 2002). In the proposed study there is no intervention from the side of the researcher to involve in the study, rather the model is evaluated and tested by the participants who then give response to the interview questions. To further identify the appropriateness of the case research method for this research, the researcher did a self analysis by asking the four questions recommended by Benbasat, et.al., (2002) given in table 3.9, that directed to the researcher to the case study method. Benbasat, et al., (2002) have identified eleven characteristics of case studies that is given in table 3.10 along with the characteristics of the proposed study to identify the similarities so as to further justify the case study approach.

Table 3.9: Rationale for choosing the case research strategy. Table adapted from (Benbasat, Goldstein, & Mead, 2002) to map the proposed study.

Questions	Answer	Relation to this study	Result
Can the phenomenon of interest be studied outside its natural setting?	If No, then Case Study	This is a study where a model is tested or implemented in an organisational context and thus cannot be studies outside its natural setting	**Case study method**
Must the study focus on contemporary events?	If yes, then Case Study	The topic is contemporary and not historic as it involves studying a contemporary phenomena in organisation	**Case study method**
Is control or manipulation of subjects or events necessary?	If no then Case Study	There is absolutely no need to control or manipulate the subjects or events, as the researcher is not present during the implementation	**Case study method**
Does the phenomenon of interest enjoy an established theoretical base?	If no then Case Study	There is very little academic literature in this topic and the model being innovative does not have any prior research.	**Case study method**

Table 3.10: Characteristics of the proposed study. Table adapted from (Benbasat, Goldstein, & Mead, 2002) to map the proposed study

	Characteristics of case studies	Characteristics of the proposed study
1	Phenomenon is examined in a natural setting	The model is evaluated and examined in more than one organisation
2	Data are collected by multiple means	Triangulation method is used to collect data through interviews, questionnaires, notes and documents
3	One or few entities (person, groups, organisations) are examined	The IT audit personnel within the IT department inside the organisations are examined
4	The complexity of the unit is studied intensively	Questions covers different aspects of the testing process. (The study can take one to several weeks within one organisation)
5	Suitable for exploration, classification and hypothesis development stages	The findings of this study may give rise to hypotheses
6	No experimental controls or manipulation are involved	Controls are not needed as the person evaluating the model in the selected organisation is independent of the researcher
7	Independent or dependant variables *may* not be specified in advance	There is no need to test the effect of any independent or dependent variables as specific variables are not identified in this study

8	The results derived depend heavily on the integrative power of the investigator	The investigator being independent of the researcher, requires some knowledge in implementing the model and thus will be thoroughly briefed by the researcher before and after the research
9	Changes in site selection and data collection methods *could* take place as the investigator develops new hypothesis	Not applicable in this study
10	Useful for the study of 'why' and 'how' questions	The research question concerns 'how'
11	The focus is on contemporary events	The topic is new and contemporary as few studies have been done in this area.

Yin (1994, p. 4) has given some justifications for conducting case studies. According to him the criteria for choosing a research strategy depends on "the type of research question posed, the extent of control an investigator has over actual behavioural events, and the degree of focus on contemporary as opposed to historical events." Taking the cue from Yin (1994) since in this study the research question starts with 'How' it drives the research towards a case study approach. Moreover as stated in table 3.9 the topic is contemporary and not historic as it involves studying a contemporary phenomenon in organisations and that the researcher does not in any way control or manipulates the subjects or events. A strong point in favour of a case study approach is derived from the research question itself. The type of research question for this research starts with 'how' and thus it had been stated by Yin (1994, p. 6) that "'how' and 'why' questions are more explanatory and likely to lead to the use of case studies, histories, and experiments as the preferred research strategies. This is because such questions deal with operational links needing to be traced over time, rather than mere frequencies or incidence.

3.5.1.1 Multiple case study

The proposed study involves research into multiple cases. The reason for selecting multiple cases is due to the fact that the proposed study is not a revelatory case, where a situation previously inaccessible to scientific investigation, neither it represents a critical case for testing a well-formulated theory, nor it is an extreme and unique case. Moreover multiple cases are used for hypothesis generation as the findings may give rise to hypothesis that can be further tested. According to Pare (Yin 1994; Eisenhart 1989, cited in Pare, 2001, p. 14) "as a general rule, the number

of replications is a matter of discretionary and judgemental choice, it depends upon the certainty a researcher wants to have about the multiple-case results." There are two reasons for choosing three case studies in two countries. Regarding the choice of three cases in one country it has been mentioned in the research design that three approaches are being followed in the three cases to provide answer to the research question. Singapore was selected apart from New Zealand because these two selected countries (New Zealand and Singapore) have different perspectives regarding (http://www.singstat.gov.sg/statsres/conferences/governance/singstat.pdf) IT audit and measurement. The reason for not having a third country is due to limitations of time, money and the possible saturation level of data (the study in Singapore was conducted through an award from the NZ Ministry of Education, and trying for a second award for doing a study in another country cannot be justified). It also seemed appropriate that these two cultures give an overall picture of the topic of study and a saturation level can be attained.

3.5.2 Data Collection Techniques

This section which outlines the data collection method explains criteria of choosing the organisation; the use of the pilot study; the data sources; the different types of data being collected; the nature of data being collected; how validity and reliability is ensured; the method of analysis and reporting data. Some of the limitations that can be expected from this study are also presented.

3.5.3 Criteria For The Selection Of The Organisation

Three organisations from two different countries will be selected for the study. Two different countries (New Zealand and Singapore) representing two diverse cultures can present a comprehensive view of the nature of IT audit and measurement process. While in one organisation a generic set of metrics is given to test the model, in the second organisation customised metrics are given while in the third organisation, the study involves ascertaining the method used by them to audit and measure information systems and sp here no model is presented. The same process is done in both the countries where the case study is being done. Even though the model is a

fusion of COBIT and GQM, there is no requirement that only those organisations using COBIT be selected as any organisation using any from of IT governance framework can be selected.

Hence for selecting the organisations the researcher would strive to select those that have already undertaken measurement programs and/or implemented auditing measures namely COBIT, COSO, ITIL or similar internal control frameworks since any goal or process from these frameworks can be used for generating metrics. The study targets medium sized and large scale organisations due to them having a well established IT department with defined quality control and/or audit functions. Moreover medium and large organisations are more eager to embark on an IT audit exercise (ITGI, 2006) and due to mandatory requirement for trading with some countries (complaint with SoX). The criteria for selection of the organisations are outlined in table 3.11.

Table 3.11: Criteria for selecting the organisations

	Criteria	Rationale
1	They should be familiar with or have used or using some form of IT governance framework/ software measurement tool / quality control program	While COBIT is an IT governance framework, GQM is a software measurement tool. Hence a familiarity with the IT governance or measurement program will make it easier for the respondents to compare this model with the one they are familiar with or the one used by the organisation. Secondly this aids in their ability to input values and generate reports and compare the reports, and even compare the cost and time/effort spent
2	The organisation should have at least one internal personnel who is involved in the IT governance or measurement process.	The reason for this is that some organisations use a consultant to implement the IT governance and measurement programs. Hence there can be an instance where criteria no. 1 is fulfilled but no one internal to the company is involved.
3	The organisation should be fairly large and preferable multinational	IT governance, measurement and control are followed seriously by large companies due to the need to be fully accountable and for compliance. Plus this gives some form of uniformity in comparing cases.

3.5.4   Usability Study

Once the model is ready to use, the first step is to conduct a pilot study on the model by getting reviews of this model from IT audit experts. The methodology used here is to contact the local ISACA (Information Systems Audit and Control Association) chapter which is an association of members of IT audit profession who are experienced in IT auditing especially COBIT.   These experts will be given a demonstration and the model along with a brief printed tutorial where after a day or two they give feedback on the model, the database and few features.

3.5.5   Source of Data

In general the IT personnel in the IT department in an organisation are the source of data. Among the IT personnel those who are involved with IT governance, IT audit, IT or software measurement/quality control are in a better position to evaluate the model than others. In the organisation, the IT department is the functional area where an implementation of this nature is being done due to the expertise of the company's IT personnel in doing this type of implementation and the department normally responsible for conducting or overseeing IT audit. IT audit exercise which involves measurement and metrics can be done by an independent consultant or by the company's own personnel depending on the size of the firm who can afford to have their own IT auditors. Even if it is conducted by independent auditors there will be some IT personnel who are concerned with the exercise and the researcher targets these personnel because they are knowledgeable with the nature of IT audit and it will be easy for them to implement the researcher's model and give an honest evaluation.

3.5.6   Data Collection

Case study research normally combines multiple data collection techniques (Pare, 2001; Yin, 1994)   Three types of data are being collected from all the three organisations namely interviews, questionnaires, written notes, and reports/documents if any. There will be an interview schedule with a tentative list of questions/themes that need to be addressed. Interviews will be done in all the three organisations   with   key   IT   personnel   who   are   responsible   for   the   IT

governance/audit/measurement exercise in the organisation. The stages of the interview process are given in table 3.15 as similar procedures are being followed in different organisations for initiating and conducting interviews.

3.5.6.1   Data Types

The types of data that can be collected from case studies include interviews, documentation, archival records, direct observation, participant observation and physical artefacts (Yin, 1994) each with their own strength and weakness. Out of the six types mentioned, the main mode being used here is interview followed by written notes, and generated reports (provided the organisation/participant agrees). The interview is done through an interview protocol (given in appendix III a). Apart from interview the participants will be asked to write down anything that comes to their mind while evaluating/testing the application.   No other types of data will be collected and table 3.12 lists out the data types other than the ones mentioned here to present the reasons for not collecting them.

Table 3.12: Reasons for not collecting some data types

Data types	Reasons for not collecting
Archival records	Archival record like survey data, personal records, charts and service records does not have much use in this study
Direct observation	The researcher is independent of the model testing and does not in any way observe the participant
Participant observation	The researcher is independent of the model testing and does not in any way observe the participant
Physical artifacts	Does not apply in this case.

3.5.6.2   Data Collection Process - steps

The collection of data follows a series of steps that are different for each of the three organisations (in each country) identified for the proposed study. The steps are outlined in table 3.15

3.5.6.3   Nature of Data

The research question gave rise to the three propositions that drive the nature of data to be collected. The four derived propositions are given in table 3.13.

Table 3.13   Propositions of the study (taken from chapter 2)

P 1: There is a driver identified by the literature for an automated instrument/ framework/ model that can measure/evaluate IS effectiveness continually in a systems life-cycle

P 2: The metrics for measuring IS entities need to be context based and aligned to the respective goal or objective or entity that it measures

P 3: A scoring system is required for measuring IS entities using IS audit frameworks

P 4: A COBIT-GQM information systems measurement framework assists in generating customised goal oriented metrics for the target IS entity

To identify the nature of data that is required for the propositions, the researcher used the nature of information sought by Freimut, et.al. (2001) in their implementation of the *riskit* model that is described in section 3.4.2. They implemented their model with (1) the sole objective of finding out its usefulness and adequacy with respect to risk management from the viewpoint of the users; and (2) to evaluate the cost-benefit of the model. It was evident that most of the data required to validate or refute the four propositions can be obtained by following the two objectives in the quoted study.

The nature of data collected from the first two organisations is similar while for the third organisation it is a study of their IT governance/audit/measurement process and so differs from the first two ones (unless they evince an interest in testing the model).   Table 3.14 details the topics/themes that are elicited from the participants, except that more information is sought regarding the model they use if any. The questions in the interview protocol reflect these themes in table 3.14.

 To follow the themes and to test the model (software) in practice interviews will be conducted with the main implementer who is responsible for implementing the model, to find out the usefulness and adequacy of the model; the cost benefit; and the evaluation of organisations model (if any). Moreover the nature of the propositions also necessitates the understanding of the current IT governance audit and control mechanisms that are being used by the organisation.

Table 3.14 Nature of data that are elicited from the participants (Four themes and the related sub themes)

Usefulness and adequacy of the proposed model	Cost-benefit aspect	Features of the application	The nature of IT governance/audit/ measurement in the organisation
- Strength and weakness of the model - Functionality - Usability -Ability to generate metrics - Effectiveness - Areas for improvement - Modifications needed - Alignment of metrics with goals	- Effort - Time - Cost (Compared to a similar model)	- Adequacy of the current features - Features to add/delete - Modifications needed	- The model being used - Adequacy of the model for measurement - Measurement framework used - Method of generating metrics - Strength and weakness - Compliance

The second type of information will be in the form of documents, procedures and tools normally used for the IT audit exercise and reports that are generated by the researcher's model and those that are generated by the model used by the organisation if any.

The triangulation approach followed to collect qualitative data from the organisation that has implemented this model in the form of reports and other documents generated, and in depth interviews (Myers & Avison, 2002) ensures validity. The triangulation approach has been emphasised by Yin (1994, p.13) when he stated that the case study enquiry "relies on multiple sources of evidence, with data needing to converge in a triangulation fashion".

3.5.7   Location of The Study

The studies will be conducted in New Zealand and Singapore. In New Zealand the organisations will be approached through the network of the research supervisor who is a member and an active participant of Information Systems Audit and Control Association (ISACA). ISACA is an international association of IT audit professionals started in the year 1967, now with a membership of 65,000 with chapters in 140 countries. Since the researcher is based in AUT University, Auckland no additional expense will be incurred for the conduct of case studies.   In a normal course, the

entire process of the study of three organisations in one country should not take more than three months.

Regarding the study in Singapore, the researcher applied to the New Zealand Ministry of Education for the annual New Zealand Post Graduate Study Abroad Awards (NZPSAA) in 2006 November. This award was instituted by the New Zealand government for students to do studies of this nature. Meanwhile the researcher corresponded with the Singapore Management University (SMU) in this regard and SMU was kind enough to provide facilities for the researcher to do the study while in Singapore and allotted an Assistant Professor who has similar interest to guide the researcher. In Singapore the researcher will be doing the field work of the doctorate as well as will do a joint IT project with the SMU in a similar topic.

Table 3.15   Steps in the data collection process in the three organisations

- Find out whether all the three criteria are fulfilled

- Give the participant information sheet and the consent form for approval from their side

- Brief the personnel regarding the model, give the model manual and show a demo of the model, state the purpose

- Let the participant take the model (with a generic set of metrics in the database that they can select and use)   and try to use the company data to generate different types of reports – where she/he may evaluate with their method. Contact after a week or two. She/he may involve other company personnel. The participant is asked to write down any comments that come to her/his mind while using/testing the model

- Conduct a detailed interview regarding the model that will be recorded with their permission. Also given them a questionnaire with a self addressed envelope that they can fill and send it at their leisure. Collect the written notes if any.

- Undertake a detailed interview regarding the nature of IT governance framework and the measurement process done in the organisation

- Get back to them with the transcripted report to validate the response

3.5.8   Processing Of Data

Even though there are three types of data to be processed, interview is the main type of data and is narrative in nature. These will be recorded using electronic recording device with the permission of the respondents and transcribed into a suitable format. The transcribed data will be shown to the respondents for validation purpose. The

second type of data includes written notes, and reports if any. Provided privacy laws and the organisations agree, the researcher will try to collect reports that have been generated using the model. These will be analysed using appropriate methods (LeCompte, 2000) to evaluate and compare with the statements made during the interviews mainly to find out the usability, effectiveness, efficiency and completeness of the model. The processing of data involves tidying up of the primary data, finding key items or units of analysis, creating stable sets of items, finding and creating patterns, and assembling structures (LeCompte, 2000). All the collected data will be processed using computer assisted qualitative data analysis software for indexing, searching and theorising qualitative data. The methodology of analysis of data is given in detail in section 3.6.1

3.5.9 Reliability and Validity

Validity and reliability are two factors that have to be taken into consideration by the researcher undertaking qualitative research (Patton 1991, cited in Golafshani, 2003). "Without rigor, research is worthless, becomes fiction, and loses its utility. Hence a great deal of attention is applied to reliability and validity in all research methods" (Morse, Barrett, Mayan, Olson, & Spiers, 2002, p. 2). A case study being subject to subjective interpretations need some sort of quality checks to ensure that it is done in the proper manner. Yin (1994) has outlined some criteria for judging and ensuring the quality of any empirical social research namely construct validity, internal validity, external validity and reliability. Construct validity involves establishing correct operational measures for the concepts being studied; internal validity establishes a causal relationship whereby certain conditions are shown to lead to other conditions; external validity establish the domain to which a study's findings can be generalised; and reliability demonstrates that the operations of a study can be repeated with the same results (Yin, 1994). Table 3.16 taken from Yin (1994) that provides a guideline of how a researcher can ensure validity and reliability in case studies has been adapted to include another column that explains the extent to which the proposed study follow the guidelines.

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Table 3.16: Case study tactics for four design tests (Adapted from Cosmos Corporation, cited in Yin, 1994, p. 33)

Tests	Case study tactic	Methodology of application	Plan for this study
Construct Validity	-use multiple sources of evidence	Triangulation by using multiple sources of evidence	Triangulation is resorted to for gathering evidence in the form of interviews; written notes; and documents if any
	-establish chain of evidence	Following the evidence from the research question to the case study report and tracing it back to the question.	This is done by allowing an external observer (the research supervisor) to follow the evidence from the research question to the case study report and trace it back to the research question. (The various components of the questionnaire, interviews and documents will be linked back to the propositions)
	-have key informants review draft case study report	Draft report reviewed by participants and informants in the case	The report of the case study will be given back to the respondents for review and comments and these will in turn be published in the chapter on analysis.
Internal validity	-do pattern matching -do explanation building -do time series analysis		Themes are grouped, identified, and checked for patterns between them and between cases.
External validity	-use replication logic in multiple case studies	A theory must be tested through replications of its findings in two or more cases	Six case studies are being planned
Reliability	-use case study protocol	The case study protocol contains the instrument, procedures and general rules that should be followed is using the instrument.	The researcher will be using a case study protocol consisting of the model, instruction manual, participant information sheet, consent form, questionnaire and interview questions. The format of the protocol will follow the one given by Yin (1994, pp. 63-66)
	-develop case study database	Use of two types of documentation namely the data or evidentiary base and the report of the investigator.	A case study database will be created as this is necessary for the research. The database will consist of (1) primary data in the form of audio tapes, hand written or types notes, reports generated, and documents, (2) reports and analysis and (3) formal documents required as per the AUT Ethics Committee guidelines.

3.6 ANALYSIS OF DATA

Unlike the analysis of quantitative data the analysis of qualitative data, especially from "the case study methodology is the least developed and hence the most difficult

(Whittaker, 2006). Since most of the data are in the form of interviews, responses to open ended questions, scribbles notes and reports, these will be treated in a similar manner. Since all the three types of data are qualitative in nature, these would be analysed in a similar manner. Analysis can be done where the data (especially the interview data) is coded, where the transcripted text is be systematically examined where key concepts are identified, grouping into similar categories; search for relationships between a category and all its concepts and between different categories (ibid). Analysis can also be done through pattern matching where an empirical pattern is compared with a predicted one (Tellis, 1997). For analysing qualitative data, it is worthwhile to look at the comprehensive guideline given by LeCompte (2000). Even though it may not be necessary to follow all of these as all cases are not conducted in the same manner, the guidelines are given in table 3.17 with the corresponding activities undertaken in this study regarding analysis.

Table 3.17 Guidelines for analysing qualitative data and the corresponding analysis in the proposed study (Table adapted from LeCompte (2000) by the author)

The five steps of qualitative data analysis	Analysis in the proposed case
Tidying up- involving making copies of data; putting the notes and interviews in chronological order; creating other files based on other data types; cataloguing and storing all documents; labelling; creating and index or table of contents; review research questions and comparing them against the data collected; identifying any missing data; returning to the field to collect additional data to fill gaps	*The interviews are transcribed, filed; the notes and questionnaires are sorted and filed accordingly. A copy of all the data collected will be taken where one set will be stored at the supervisor's room while the other will be with the researcher. If there is any missing data effort will be taken to return to the field to collect the additional data wherever possible subject to respondent's approval*
Finding items – analogous to sifting and sorting via – frequency; omission; declaration	*Sorting will be done to find out the frequency of any ideas/themes*
Creating stable sets of items – organising the themes into groups; comparing and contrasting; mixing or matching; assembling a taxonomy	*Data will be organised into the themes identified in chapter 2. Themes may be sub divided wherever necessary*
Creating patterns – Looking for similarities and analogy; co-occurrence; sequence; hypothesised patterns; corroboration or triangulation	*Comparing/contrasting and co-relating with the theory/expected outcome is done with the data*
Assembling structures – patterns are assembled to create a structure for clarity of presentation	*The last phase involves creating a meaningful structure out of the patterns for presentation*

3.6.1 Detailed Plan Of The Analysis And Discussion

The five steps outlined in table 3.17 have been broken down and explained in detail in this section. Since the first three steps forms the analysis followed by the last two steps relating to the discussion of the findings, two chapters will emerge from this namely the chapter on 'analysis' and 'discussion'.

3.6.1.1 Tidying up

This is the initial stage for preparing the data for analysis and steps in this stage are explained in table 3.18.

Table 3.18 Tidying up of the data (Table adapted from LeCompte (2000) by the author)

Steps	Strategies
1. Make copies of data	The interview will be recorded using a digital recorder and an analogue one (to make sure that if one gets stuck the other will record). The digital copies will be transferred to the researcher's folder in AUT computer (H drive) and then deleted from the digital one while the microcassette will be stored in the safe of the supervisor once it is transcribed.
2. Put all field notes and interviews into a file in order of their dates and creation	The transcribed interviews will be stored in the researcher's folder marked 'transcribed interviews' in AUT (H) drive
3. Create other files based on types of data, participants, organisations	Since only six interview sessions are going to be conducted there is a need for only a single folder
4. Catalogue and store all documents and artefacts	Hard copies like the consent form will be stored separately in the supervisor's safe and any relevant materials will be stored in the researcher's safe in WT 406. For each transcribed version there will be a document that details the context, the background of the researcher and the organisation. This will be put in the same folder along with any other relevant materials like field notes, documents and reports printed by the respondent if any
5. Label all files and boxes according to their contents	Names will be representative of the contents
6. Create an index or table of contents for all data	Will be created
7. Review research questions, comparing them against the data collected	The researcher will have a copy of the topics to be covered during the interview (Table 3. 19) with check boxes and the appropriate boxes will be checked as the interview progress
8. Identify any holes or missing data chunks by determining if data actually were collected to answer each research question	Identification of missing data chunks will be done after the transcription
9. Return to the field to collect additional data to fill gaps in the record. If not develop a rationale for why missing data cannot or will not be acquired.	Returning to the field to collect data will be done after the transcription if required, and provided it is feasible and possible

Regarding transcription of the data, it is planned to record the data using verbatim quotations, as "including verbatim quotations from the research participants has become effective standard practice in much reporting of qualitative social research, and some research funders specify final reports with direct quotations " (Corden and Sainsbury, 2004, p.2). Considering the confidentiality of the participants, the researcher aims to maintain the confidentiality and anonymity of the participants and organisations, as these "are central concerns for researchers working in all traditions' (Britten, Jones, Murphy, and Rosie, 1995, p.110).

3.6.1.2 Finding items

"Data are sifted by repeated readings through field notes, interviews, and text to identify items relevant to the research questions" (LeCompte, 2000, p 148). The task to be done at this stage is transformed in the table below. Here the frequency, the omissions and declarations are only stated but not interpreted or discussed.

Table 3.19 Detailed steps to be undertaken for 'finding items'. (Table adapted from LeCompte (2000) by the author)

Tasks	Strategies
1. Frequency: Items sometimes can be identified because they are numerous	Themes that are frequently stated explicitly or implied will be identified using NVIVO
2. Omission: Items can also be identified because they never appear, even though researchers might think it reasonable that they would	The researcher have a check box of topics to quiz the respondent and if there is a probability that some responses are not pointing to the topics, these will be pointed out in the analysis
3. Declaration: Items sometimes are identified as present or significant by study participants who tell researchers they exist	Those items that are identified as significant will be searched and identified if any

3.6.1.3 Creating stable sets of items

This stage involves organising into groups or categories by comparing and contrasting them; mixing or matching. This will be done using the NVIVO software where nodes (representing themes) are created from the transcript. Coding is derived from the transcript since "coding in qualitative research involves very different process from coding in quantitative research, as while quantitative coding requires preconceived, logically deducted codes into which the data are placed, qualitative coding, in contrast, means creating categories from interpretations of the data

(Charmaz 1983, cited in Essy, 2002). Hence in this research, coding is done by assigning a code to any material that fits into a preconceived theme or concept. These (preconceived themes and concepts) can come "from the conceptual framework, list of research questions, hypothesis, problem areas, and/or key variables that the researcher brings to the study" (Miles and Huberman, 1994, p. 58).

Considering the number of levels many researchers use a simple two-level scheme namely a general "etic" level and a more specific "emic" level, close to participants' categories but nested in the etic codes (Miles and Huberman, 1994, p. 61). The researcher in this case will follow a two or thee level coding scheme depending on the nature of data. The main "purpose of these activities is to clump together items that are similar or go together" LeCompte, 2000, p. 149). This mainly involves identifying taxonomy of items. Since according to LeCompte (2000), Spradley's (1979) list fits any culture or situation, the researcher plans to use the list. Here 'Y' is the theme identified and 'X' the responses or items. Even though all the items in the list may not be evident in the responses or may not be relevant, only those taxonomies that are relevant to the research will be taken and identified within a given data set. At this stage it is not easy to identify which all from the eleven semantic relationships can be used unless the interview is conducted, transcribed and read through several times. Table 3.20 details the steps in this stage and the analysis strategies that is planned to be adopted along with the taxonomy of Spradley (table 3.21).

Table 3.20 Detailed steps to be undertaken for 'creating stable sets of items'
(Table adapted from LeCompte (2000) by the author)

Tasks	Strategies
1. Comparing and contrasting	1. Comparing and contrasting within the case and between the case will be undertaken
2. Mixing and matching	2. Mixing and matching the coded themes will be undertaken only if it is deemed necessary
3. Using Spradley's list of taxonomy	3. Spradley's list for assembling taxonomy will be used wherever it is deemed necessary (Table 3.21)

Table 3.21 The semantic relationship that aids in identifying a taxonomy of items (Spradley, 1979, cited in LeCompte, 2000)

	Tasks
1	X is a kind of Y
2	X is a place in Y
3	X is a part of Y
4	X is a result of Y
5	X is a cause of Y
6	X is a reason for Y
7	X is a place for doing Y
8	X is a used for Y
9	X is a way to do Y
10	X is a stage or step in Y
11	X is a characteristic of Y

3.6.1.4 Creating patterns

According to LeCompte (2000), identifying patterns involves seeing how taxonomies can be clumped together in meaningful ways that involves reassembling items in ways to provide a coherent explanation, description of the program, event, or phenomenon under study. Apart from looking at frequency, of occurrence, omission and declaration, other patterns are similarity and analogy, co-occurrence, sequence, and hypothesised reasonableness and corroboration (ibid)

Table 3.22 Detailed steps to be undertaken for 'creating patterns' stage. (Table adapted from LeCompte (2000) by the author)

Tasks	Strategies
1. **Similarity and analogy**: Looking for sets of items that are identical or serve the same purpose	1. Sets of items that are identical or serve the same purpose will be identified wherever necessary
2. **Co-occurrence**: Looking for things that occur at the same time or place	2. Themes that occur at the same time will be identified wherever necessary
3. **Hypothesised reasonableness:** Looking for hypothesised patterns that the researcher think should exist based on the literature review	3. The propositions will be compared against the emerged themes
4. **Corroboration or triangulation**: Looking for corroboration or triangulation confirmed by other types or prices of data	4. Looking for corroboration or triangulation may not be possible since only interviews are conducted. But wherever possible the researcher may look for any similar responses repeated in the transcript

3.6.1.5 Assembling structures

"Once patterns are identified, groups of them are then assembled into structures, or groups of related or linked patterns that, taken together, build an overall description of the program or problem being studied. Doodling is one way to begin creating

displays, by creating diagrams, conceptual maps, taxonomic trees, flow charts, and casual maps to display relationships among patterns" (Miles and Huberman, 1994, p. 152). Even though matrix construction is a creative process some of the common descriptive displays given by them that can relate to this research are conceptually clustered matrix, thematic conceptual matrix, and meta-matrix (ibid). Since at this stage it is not easy to predict what type of matrix to use without looking at the data, the nine advices for developing matrix given by them will be followed for matrix design.

3.6.2   Reporting Case Studies

Yin (1981) states that "the typical case report is a lengthy narrative that follows no predictable structure and is hard to write and hard to read", hence recommends the need for the study to built on a clear conceptual framework or the report to be replaced by a series of answers to a set of open-ended questions. For situation of cross case analysis as the case is with this research where cases are compared he has recommended the use of brief summaries of individual cases, followed by the cross-case analysis. Hence in this study the researcher follows the procedure of presenting brief summaries of the individual cases, followed by brief summaries country wise, and then followed by cross-case analysis (intra and inter country wise). Apart from the guidelines given by Yin, to make the report easy to read, as far possible it will also follow the guidelines listed by Pare   (2001). The guidelines in the form of optimal qualities are listed in the table 3.23 along with the precautions taken by the researcher to follow the guidelines wherever possible.

Table 3.23 Guidelines for ensuring optimality of a case report

Optimal qualities of a case report (Pare, 2001)	Actions taken and considered by the researcher to comply with the presented guidelines.
Accessibility and clarity (e.g., no technical jargon; assumptions explicitly stated)	*Due diligence and care will be taken in this regard*
Conceptual structure (i.e., themes or issues)	*The responses centre around the four themes identified (table 3.14).*
Coherence (e.g., effective interpretation of the context)	*Due diligence and care will be taken in this regard*
Sense of story to the presentation	*This may be applied if applicable*
Sufficient raw data are presented	*Due diligence and care will be taken to make sure that the raw data is comprehensive, subject to the limitations of the study*

Quotations are used effectively	*This will be used wherever appropriate to support or contradict the assumptions*
The data, analytical framework and interpretations and results must be separated	*Due diligence and care will be taken in this regard*
Headings, figures, tables, appendixes are used effectively	*For ease of clarity and readability the researcher will separate the findings into sections, with subheading for further separation of themes. Moreover figures and tables will be used if deemed that these will enhance the clarity and readability.*
Observations and interpretations have been clearly triangulated	*To be decided.*
The role and point of view of the researcher are apparent	*To be decided.*

3.7 PROBLEMS EXPECTED TO BE ENCOUNTERED

Four types of problems are expected to be encountered in the research. One is the relative experience of the participant in IT governance/measurement process. Even though the researcher cannot find any co-relation with the experience and the feedback, it is generally assumed that the more experienced the participant in the topic of research, the better will be the feedback. The issue here is, since there is no yardstick to measure the level of experience and skill of the participants, there is no way to ensure that all the participants have the same level of experience. Thus there is a possibility that the feedback given in the form of interviews, notes and questionnaires can differ with the relative experience and skills of the participants. Second is the difference between the organisations in terms of the expertise in IT governance/audit/control and measurement implementation; the size; and nature of operation. Even though care is taken to ensure that all organisations are of similar size, it has been observed that the IT governance/audit/ measurement framework are implemented in earnest by finance companies than by other organisations (ITGI, 2006) with the results that they will have better expertise in the topic. Hence the relative importance of the model (in the particular organisation) to a particular organisation may vary and this may provide new ideas and can diversify the findings especially when comparisons are made using the same factors. Thirdly it may be difficult to get the IT audit/measurement/control reports from organisations as these are highly sensitive information and just a template (if they are only willing to provide just a template) may not reveal everything and this may put the concept of triangulation in jeopardy (if interview data are insufficient). Lastly GQM is a tool

used in the software engineering field and it is not something that can be easily comprehended by the participants (who are in the field of IT governance/audit/measurement field). Even the IT personnel in the software measurement and quality control field may find it difficult to understand the basic principles of the GQM model.

3.8 CONCLUSION

The model that emerged through the process of researching the related field from various sources is theoretical and the concept requires to be tested through empirical research to prove the validity. The nature of the research question directed the researcher to undertake a qualitative study, while the research philosophy pointed towards a positivist paradigm. These directives acted as a basis to go to the next step of selecting a research design and choosing the case study technique.

Three studies that were similar to the researcher's topic and the proposed methodology were selected and analysed again to identify the most appropriate way to approach the study. One was not only similar to the research topic, but also conformed to the philosophy, research paradigm and research design. This study was further analysed and selected as a guide. LeCompte's (2000) method of case analysis was adopted. While creating the plan for the analysis, different emerging empirical scenarios were visualised. But since the future is always uncertain along with the expected answers and the manner of answering (by the respondents), there may be variations in the way the analysis will be done and these will be explained in the relevant report sections.

A great deal of work needs to be done before starting the main empirical research. First of all the researcher has to automate the model with a front end and back end interface. Secondly while the automated version is being developed, IT audit experts need to be contacted for the purpose of identifying the commonly used CO and DCO so that the user can develop a set of questions, and metrics for the expert identified goals. Thirdly the model requires to be tested for usability with a different set of users. Once all of these tasks are completed, the main empirical research can start.

Chapter – 4

Analysis of the Findings

4.0   INTRODUCTION

The requirements for the field research specified in chapter 3 (3.5.4) were implemented with minor variations (see appendix II and III for a full report). The automated model (appendix IV) was given to five respondents from five organisations in New Zealand and Singapore. Four of these were able to evaluate the model using data from their organisations along with the dummy data and gave feedback regarding the model. The average time period of providing the application in the form of a CD, and demonstrating it to the point of giving the feedback was 36 days. The feedback was in the form of interviews. All of the three interviews in New Zealand took place at the respective organisations (One was at the room of the ITG manager of the company; the other was at the meeting room of the IT Security department of the company; the third at the office of the IT consultant). In Singapore the interview was conducted at the School of Information Systems of Singapore Management University. The first interview was conducted on 17th of July 2007 and the last interview on the 15th of May 2008. The empirical research faced a few difficulties in getting cases and gathering multiple evidences (See appendix V).

The collected qualitative data follows the process outlined in section 3.6 where the research follows the five steps outlined by LeCompte (1998) namely tidying up, finding items, creating stable sets of items, creating patterns, and assembling structures. Out of these five steps, the first two that involve active analysis of the data will be discussed in this chapter, while the last three will be discussed in the next chapter (Chapter – 5). Hence in this chapter the first two steps will be followed while in the next chapter will focus on creating stable sets of items, searching for patterns, comparing and contrasting, internally and externally so that a holistic picture should emerge out. Here the data that has been collected is tidied up, categorizing into different themes, to present a picture of frequency, omission and declaration based on the plan created in section 3.6.

In this chapter the first two steps in LeCompte's data analysis are completed. In section 4.1 the four cases are profiled and sufficient detail is provided so that the characteristics of each are identified. In section 4.2 the tasks of 'tidying up' and 'finding items' are performed according to LeCompte's methods (as per chapter 3) on each case. This is a long and comprehensive section with many sub sections that detail the analysis of data to the level of text. The importance of this section is the detailed critique of the model (software) in practice.

4.1   CASE PROFILE

For the purpose of anonymity the names of the respondents have been disguised as NZ 1, NZ 2, NZ 3 and SG 1 representing the first, second, third and fourth respondents interviewed in New Zealand and Singapore respectively. The profile of the four respondents and the organisations (hereinafter referred to as 'case') are given in the table 4.1 below. To maintain proper anonymity, the company profile given is very brief as New Zealand and Singapore being small countries with a few large organisations it is very easy to identify a company using a few attributes. In both New Zealand and Singapore, services sector being more dominant than the industry sector it was not easy to identify any organisations in sectors other than services, through the local ISACA chapters of New Zealand and Singapore.

For all the cases in New Zealand the senior mangers in the ITG field have been contacted whereby the respondent evaluated the model and gave feedback. No information was provided whether the respondent has consulted with any of her/his colleagues regarding the model during the period that they took the model to evaluate it. In the case of Singapore the response came from a team of four audit personnel led by the Audit Director.   During the demonstration of the model and the initial session that lasted 3 ½ hours (2.00 pm to 5.30 pm on the 14th of November, 2007), the full team (of four members) were present at the seminar room of the School of Information Systems of SMU. The team then went back and all of the members have tried the model and gave feedback to the Audit Director. During the feedback interview sessions with the researcher, only the Audit Director was present and the response given by the respondent to the researcher during the interview (29th

December 2007 at 2.00 pm) was representative of the whole team.   All these four
members were involved in the COBIT implementation in their organisation.

Table 4.1 Profile of the four cases studied

	NZ 1	**NZ 2**	**NZ 3**	**SG 1**
Company profile	One of the three largest media companies in new Zealand (Service sector)	One of the top 10 businesses in NZ in terms of turnover (Service sector)	An independent audit consultant working for a top IT audit firm in NZ (Service sector)	The foremost government organization that does audit of all government and autonomous organisations in Singapore
Respondent position	IT Security and Audit Manager	Senior IT Governance Manager	IT Audit Consultant	Audit Director
Knowledge of IT Audit/governance	More than 10 years of IT security/ assurance/audit experience and participated in ITG seminars and conferences	More than 10 years of IT audit/ governance experience and participated in ITG seminars and conferences; long time member of ISACA Auckland	More than 10 years of IT audit/ assurance experience and participated in ITG seminars and conferences; long time member of ISACA Auckland	More than 15 years of IT audit experience; participated in ITG seminars and conferences; senior member of the International board on IT Governance; one of the founding member of ISACA Singapore active and member of ISACA Worldwide
Knowledge of COBIT	One of the three personnel in that organisation that have knowledge of COBIT; have not implemented COBIT, but may use COBIT in the future.	Managing the implementation of COBIT and other standards	Hands on experience in implementing COBIT and other standards	Hands on experience in managing COBIT implementation and other standards
COBIT used in the organisation	No	Yes	Yes	Yes

4.1.1   Case NZ 1

The first case being investigated is a leading organisation in the media and
broadcasting business in New Zealand. They have not done any implementation of
COBIT or any IT audit frameworks, but do have an ongoing compliance program that
is limited only to the IT security domain. The performance measurement process is
limited to the tracking the performance of hardware only and not to the entire IS
domain and they don't use any tool for tracking the performance. The purpose of
getting feedback from an organisation of this profile is to understand how far a model

like this does helps an organisation that has a narrow IT audit orientation, and the modifications to be done in the model to suit their purpose. One person was interviewed for the purpose. He has been with the firm for more than 5 years and is the person in charge of the IT control and audit role. He is knowledgeable on the major IT audit models and participates in international IT audit and governance conferences. The respondent in this case is referred to as NZ 1.

4.1.2   Case NZ 2

The second case in NZ is one of the top 15 companies in New Zealand with a market capitalization of over $ 1 billion dollars (NZ). They have a well established IT governance structure and process in place and they hire consultants for the purpose of implementing IT governance. They have also done CMMI to view the level of their maturity. The respondent is a member of ISACA and participates in major IT governance seminars and conferences. The senior manager in charge of IT governance of this organisation was contacted, and the model was demonstrated in her office on the 12th of July 2007 and the researcher could not get a date to interview her due to her job commitments. Ultimately another attempt was made on February 2008 (after the researcher came back from Singapore) and the model was again demonstrated to her at her office on the 17th of March 2008. Finally on the 26th of March 2008 the interview was conducted.

4.1.3   Case NZ 3

This respondent was initially contacted twice at his office in July 2007 and the model was demonstrated from the researcher laptop and the CD was given to him. Unfortunately both times due to some technical problem in the respondent's computer the application was not able to load properly. Ultimately he was again contacted in March 2008 and the model was demonstrated and another CD given. But despite his very tight schedule the interview was able to be conducted on the 19th of May 2008. He is an IT audit consultant and a very active member of the Auckland chapter of ISACA. He had worked in IS Quality control and assurance and IT audit. He is very familiar with COBIT and had also done certification in COBIT. Currently

he is working as a consultant to a large consulting firm undertaking IT audit exercise for their clients throughout New Zealand.

4.1.4   Case SG 1

Even though five and half months were spent in Singapore, it was very hard to get contact and get organisations to agree for this study. They are highly secretive regarding even the implementation of COBIT. The organisations in Singapore are highly closed and very secretive and people are so much busy with the fast paced life that they can't even spare a few minutes. The contacts were made through the industry liaison Professor of the School of IS in Singapore Management University and through the Singapore ISACA chapter. Even though four organisations agreed to the study, only one organisation materialized.   This organisation is from the government sector and had installed COBIT. Even though four members of the audit team took part in this study only the most senior manager in charge of IT audit and governance took part in the interview session. He is one of the founding members of the Singapore ISACA chapter and a member of the international board of the ITGI. Even though initial contact was made in September 2007, an initial session with the team was conducted on the 14th of November 2007 and a final interview was able to be conducted only on the 29th of December 2007. The interview had to be postponed several times due to the tight work schedule of the respondents.

4.2   ANALYSIS OF CASES

The two stages in this section are tidying up, and finding items. The coding of emerging themes (4.2.1.1 – 4.2.1.5) have been done immediately after step one and before step two as it was observed that this was necessary to do the analytical steps outlined in the second stage namely presenting the frequency, omission and declaration.

4.2.1   Tidying Up (Stage – 1)

This is the first of the two steps in the analysis and the following table (4.2) illustrates this. The purpose of presenting this table is to do an internal audit whereby the plans of analysis outlined in chapter 3 (section 3.6) are checked for conformance and

variations. Hence the first column of the table that is taken from the above mentioned section outlines the steps that were proposed to be undertaken, while the second column outlines the actual steps taken.

Table 4.2 Stage 1 of the analysis and the actions taken (Audit of analysis plan-1)

Strategies proposed	Action taken
The interview will be recorded using a digital recorder and an analogue one (to make sure that if one gets stuck the other will record). The digital copies will be transferred to the researcher's folder in AUT computer (H drive) and then deleted from the digital one while the microcassette will be stored in the safe of the supervisor once it is transcribed.	For the interview the respondent took a Digitor WD 200 microcassette recorder and a Sony NWD –B103F digital recorder. The digital file was transferred to the researcher computer at AUT and the file in the Sony recorder was deleted. The cassette was also played and stored securely
The transcribed interviews will be stored in the researcher's folder marked 'transcribed interviews' in AUT (H) drive	This step was done
Since only six interview sessions are going to be conducted there is a need for only a single folder	No action to be taken
Hard copies like the consent form will be stored separately in the supervisor's safe and any relevant materials will be stored in the researcher's safe in WT 406. For each transcribed version there will be a document that details the context, the background of the researcher and the organisation. This will be put in the same folder along with any other relevant materials like field notes, documents and reports printed by the respondent if any	All these actions were done accordingly
Names will be representative of the contents	Proper name format was followed
A table of content will be created for the data	Done using a folder for the data collection
The researcher will have a copy of the topics to be covered during the interview (Table 3. 14) with check boxes and the appropriate boxes will be checked as the interview progress	Provided in table 3.14
Identification of missing data chunks will be done after the transcription	There are no missing data chunks
Returning to the field to collect data will be done after the transcription If required, and provided it is feasible and possible	There was no need to return to the field as the data was complete in all the cases

4.2.1.1 Definition of the Nodes

After going through the transcribed versions several times, the following nodes emerged (table 4.3). Even though the respondent has conducted the interview with a tentative schedule of the topics to be covered, care had been taken to ensure that the nodes are derived from the transcript rather than the preconceived topics. The actual

wordings of the questions were framed at the time of the interview according to the situation, but based on the 'guidelines for interview' (given in table 3.14). Care had been taken to elicit as broad an answer as possible, but at the same time bounding the respondent to the topic. This is to ensure that the respondent does not limit his response to the researcher's question, but gives a broad view as possible and to the point. Direct questions on the propositions were not asked since there can be a bias. Hence the propositions were substantiated through the responses given to questions given in the guidelines and contextual questions framed at the time of interview to clarify a stated point.

Once the nodes have been listed it was categorized into the four themes (table 3.14). Due to the qualitative nature of the response, there are numerous overlap between the nodes and care has been taken to separate them as distinct as possible. Out of the four themes, the evaluation of the model and the features are linked in such a way that whenever any modifications to the model have been suggested these have been listed under the theme 'model', but to implement these changes, the features and ultimately the source code have to be changed. Hence any minor cosmetics changed to the model that have very less implication to the structure of the model as a whole have been listed under 'functionality'. Thus much of the responses have been coded around the 'model' rather than the application, as application is only an automated tool of the model and moreover the model is the main component of this research. The table (4.3) also presents the difference between the areas that have been probed by the researcher during the interview with the actual responses. None of the propositions have been asked as direct questions, but a number of comments have pointed to the propositions. In the table (4.3) the unshaded portion represents the topics that have been asked during the interview and the shaded portion represents the topics that have emerged from the interview other than those queried.

While discussing the nodes, all other nodes have been classed under 'tree node' while 'proposition' was coded as a free node as various themes of the tree node that have any direct or indirect mention of any of the propositions have been grouped under 'proposition'. Since the discussion of the propositions involves it matching with the derived responses to find out the similarities and contrasts, this comes under

the stage four of the analysis (refer section 3.6.1.4 of chapter 3). Hence the discussion of the free node 'proposition' is not discussed under this chapter, but is discussed in detail the chapter on the 'discussion of findings' (chapter 6).

Table 4.3 List of nodes that have emerged during the interview

	Nodes	Nodes level 1	Nodes level 2	Description of the nodes
1	Propositions (4)			Any direct or indirect reference to the four propositions, either supporting or rejecting has been classified into this node.
2	Commercializing the model			Responses which stated that this model can be developed and marketed on a commercial scale
3	Current IT audit, governance, control models			Responses relating to this idea include the IS governance, audit, control models, frameworks and procedures implemented in the organisation
4		Functionality		Responses relating to minor cosmetics changes to the layout and functions of the application. Any functions that require major modifications have been categorized in 'model'. It has also been noted that any modifications suggested in the model does affect the functions as the functions needs to be changed or modified or improved. Hence there can be a slight overlap between 'functionality' and suggested changes to the 'model'
5		Scoring system		Responses that commented on the 1 to 5 scoring system used for evaluating the metrics
6	Features of the application	Alignment	Alignment of the model	Overall alignment of the model including the alignment of metrics with the questions and the questions with the goals and the goals with the IT goals. Also included are responses that stated that the model doesn't help in alignment since the questions and metrics are generic. There is an overlap of this with the questions and metrics
7			Alignment and understanding with COBIT	Responses that relate to whether alignment is proportional to the understanding of COBIT
8		Application of the model		Responses that commented on the various practical uses of this model
9		Automation		Comments on the automation of auditing and/or the model
10		Bench marking		Responses relating to benchmarking the goal, questions and metrics with similar organisations

11		CO or DCO?		Responses that commented on the appropriateness of using a high level control objective or a low level control objective for measurement
12		COBIT in the model		Comments on the role and utility of COBIT in the model
13		Contextual layer		Responses that suggested a need to add a contextual layer to the model. This is a major modification to the model
14		Goals, questions and metrics	Clarification of goals and questions	Comments that focused on the clarity or lack of clarity of goals, questions and metrics used in the model database
15			Context of the goals, questions and metrics	Responses regarding the need to contextualize the goals, questions and metrics to the organisation or the relevant industry
16		GQM		Comments on using the GQM model in IT audit, appropriateness of the current GQM structure for IT audit and comments on the various aspects of the GQM model
17		Measurement/ auditing perspective	Auditing perspective	Responses that commented on the level and nature of auditing perspectives in the model and the absence of auditing perspectives
18			Compliance and measurement perspective	Responses that relate to the compliance method used in auditing as distinct from the measurement orientation
19		Model evaluation		Evaluation of the model, whether effective, efficient or not
20		Other standards		Comments regarding the inclusion of other relevant control standards into this model
21		Ranking		Responses that commented on the ranking, priority, weightage or the absence of these for the questions and metrics
22		Tracking progress of a goal		Comments regarding the utility of tracking the progress of a goal using this model
23	Similar tool or method			Responses regarding the presence or absence of a similar tool or model that the respondent have come across
24	Input to the model			Different perspectives on who should provide input to the model, who should decide on the questions and metrics to input and who should see the reports

Table 4.3 reveals that not only a lot of themes have emerged during the course of interview, but most of these are also directly or indirectly linked to the model. The

questions formulated during the interview being semi-structured and open-ended gave flexibility to the respondent to provide a rich experience in that area. In the following analysis of the four respondents, the entire nodes generated by all the four respondents have been listed with the shaded portion revealing those that have not been cited by the respondent.

4.2.1.2   Coding summary - NZ 1

The coding summary of the first respondent is given in table 4.4 where the discussion was centered on the topic of functionality of the application and 'benchmarking'. Since the respondent is not a professional IT auditor, but an IT security personnel who also does IT audit in the organisation around the IT security areas, this weightage was quite evident. Since they have not implemented COBIT in their organisation, the discussion on the 'current IT audit, governance, control models' was limited to the ones used for IT security rather than on the implementation, or methodology of use of COBIT. Out of the 24 areas, 17 areas have been covered during the interview session. (In the following tables 'references' refer to the frequency or the number of times the theme has been referred to while 'coverage' refer to the extent of coverage for that theme)

Table 4.4: Coding summary report for NZ 1

	Nodes	Nodes level 1	Nodes level 2	References	Coverage
1	Propositions (4)	P1		10	16.36%
		P2		7	7.87%
		P3		3	4.00%
		P4		31	20.18%
2	Commercializing the model			1	0.25%
3	Current IT audit, governance, control models			4	4.28%
4	Features of the application	Functionality		8	19.49%
5		Scoring system		0	0
6	Model	Alignment	Alignment of the model	8	3.45%
7			Alignment and understanding with COBIT	1	0.26%
8		Application of the model		4	3.03%
9		Automation		0	0
10		Bench marking		8	4.51%

11		CO or DCO?		1	2.05%
12		COBIT in the model		0	0
13		Contextual layer		1	0.35%
14		Goals, questions and metrics	Clarification of goals, questions and metrics	5	3.22%
15			Context of the goals, questions and metrics	0	0
16		GQM		0	0
17		Measurement/ auditing perspective	Auditing perspective	0	0
18			Compliance and measurement perspective	3	2.97%
19		Model evaluation		1	0.14%
20		Other standards		0	0
21		Ranking		0	0
22		Tracking progress of a goal		1	1.26%
23	Similar tool or method			2	2.43%
24	Input to the model			1	5.64%

4.2.1.3   Coding summary - NZ 2

The coverage of areas for this respondent is quite high. Out of a total 24 areas, 19 areas have been covered during the interview session. Two reasons have been attributed to this, one is that the organisation has implemented COBIT, and secondly the respondent is the senior staff heading the department that does IT Governance. The respondent has a very broad knowledge of IT governance and thus the discussion on the 'current IT audit, governance, control models' covered almost 10% of the time. The topic that was discussed most was the 'clarification of goals, questions and metrics' and according to the respondent these are not contextual and hence very subjective and interpretive. Since the discussion was more focused on the model rather than the application, very less have been discussed on 'functionality'. But it has to be noted that if much of the suggestions made to the model should be implemented, changes have to be made to the functionality and features of the model. A major theme that had emerged is the need for 'benchmarking' the metrics against industry standards.

Table 4.5 Coding summary report for NZ 2

	Nodes	Nodes level 1	Nodes level 2	References	Coverage
1	Propositions (4)	P1		5	4.88%
		P2		9	12.17%
		P3		7	9.81%
		P4		34	44.56%
2	Commercializing the model			0	0
3	Current IT audit, governance, control models			9	9.23%
4	Features of the application	Functionality		2	1.31%
5		Scoring system		0	0
6	Model	Alignment	Alignment of the model	1	0.74%
7			Alignment and understanding with COBIT	1	0.20%
8		Application of the model		1	0.93%
9		Automation		1	1.48%
10		Bench marking		5	8.43%
11		CO or DCO?		2	1.27%
12		COBIT in the model		0	0
13		Contextual layer		0	0
14		Goals, questions and metrics	Clarification of goals, questions and metrics	7	14.13%
15			Context of the goals, questions and metrics	3	3.45%
16		GQM		1	0.78%
17		Measurement/ auditing perspective	Auditing perspective	0	0
18			Compliance and measurement perspective	1	1.29%
19		Model evaluation		4	5.94%
20		Other standards		3	2.33%
21		Ranking		7	6.95%
22		Tracking progress of a goal		3	5.80%
23	Similar tool or method			1	0.14%
24	Input to the model			9	9.44%

4.2.1.4   Coding summary - NZ 3

The profile of the third respondent from New Zealand is slightly different from those of the other two since he is an IT audit consultant working for a leading IT audit

consulting firm in New Zealand. He is responsible for doing regular IT governance audits in the client organisations and is more practical oriented with hands on implementation experience of IT governance and auditing.

Table 4.6 Coding summary report for NZ 3

	Nodes	Nodes level 1	Nodes level 2	References	Coverage
1	Propositions (4)	P1		1	0.67%
		P2		6	13.22%
		P3		6	8.43%
		P4		21	34.35%
2	Commercializing the model			1	1.52%
3	Current IT audit, governance, control models			6	18.25%
4	Features of the application	Functionality		3	5.83%
5		Scoring system		1	2.15%
6	Model	Alignment	Alignment of the model	2	4.46%
7			Alignment and understanding with COBIT	0	0
8		Application of the model		0	0
9		Automation		0	0
10		Bench marking		3	6.53%
11		CO or DCO?		0	0
12		COBIT in the model		1	2.43%
13		Contextual layer		4	7.62%
14		Goals, questions and metrics	Clarification of goals, questions and metrics	4	4.62%
15			Context of the goals, questions and metrics	0	0
16		GQM		0	0
17		Measurement/ auditing perspective	Auditing perspective	4	3.90%
18			Compliance and measurement perspective	1	2.15%
19		Model evaluation		2	2.48%
20		Other standards		3	5.43%
21		Ranking		3	5.01%
22		Tracking progress of a goal		0	0
23	Similar tool or method			3	5.09%
24	Input to the model			1	0.09%

The areas of coverage is comparatively less than the other three and out of the 24 themes, only 16 have been covered. Discussion was mostly centered on the implementation and audit of 'current IT audit, governance, and control models' in organisations. The two major themes that have emerged is the need for adding a 'contextual layer' (a set of qualifying questions for the purpose of auditing) and 'benchmarking' the metrics against industry standards. The respondent has worked with applications that can automate COBIT and has done considerable work on software quality assurance.

4.2.1.5   Coding summary - SG 1

The respondent from Singapore has not only hands on experience in implementing COBIT and other relevant standards, but also is a very senior and experienced person in the IT governance and audit field. His responses reflected more of auditing the performance. The two major themes that have emerged regarding the model is the need for adding a 'contextual layer' (a set of qualifying questions for the purpose of auditing) and 'auditing perspective'. The coverage of topics was the highest among all the respondents with 20 out of the 24 areas covered. Moreover the concept of 'GQM' in the model was also discussed at great length.

Table 4.7: Coding summary report for SG 1

	Nodes	Nodes level 1	Nodes level 2	References	Coverage
1	Propositions (4)	P1		1	5.37%
		P2		15	16.73%
		P3		5	6.04%
		P4		38	46.02%
2	Commercializing the model			0	0
3	Current IT audit, governance, control models			6	12.72%
4	Features of the application	Functionality		2	2.85%
5		Scoring system		4	4.88%
6	Model	Alignment	Alignment of the model	1	0.81%
7			Alignment and understanding with COBIT	0	0
8		Application of the model		0	0
9		Automation		0	0
10		Bench marking		4	3.93%

11		CO or DCO?		3	3.46%
12		COBIT in the model		7	8.59%
13		Contextual layer		13	16.37%
14		Goals, questions and metrics	Clarification of goals, questions and metrics	3	2.83%
15			Context of the goals, questions and metrics	0	0
16		GQM		2	5.01%
17		Measurement/ auditing perspective	Auditing perspective	9	8.45%
18			Compliance and measurement perspective	2	2.49%
19		Model evaluation		3	1.18%
20		Other standards			
21		Ranking		3	2.05%
22		Tracking progress of a goal		0	0
23	Similar tool or method			1	1.07%
24	Input to the model			2	3.47%

4.2.2 Finding Items (Stage – 2)

This stage involves finding themes/nodes (these words will be used interchangeably and does mean the same.) that are cited frequently, those that are omitted, and those themes that have not been asked, but have unexpectedly emerged during the course of the interview. Table 4.8 illustrates the initial plan and the action taken at this stage regarding stage two (finding items) while the next chapter outlines the initial plan and the current action taken for stage three (creating stable sets of items).

The verbatim transcription of the interview was done using a freeware software called 'express scribe' that aided in the process of transcription. Once the interview was transcribed it was played several times to make sure that the transcript was appropriate to the response and to fill minor gaps in the transcript. The final transcript was loaded into the NVIVO 7 software and after reading through the final transcript again several times, familiar and non familiar themes emerged. The themes that emerged from the data were coded properly into nodes. This process was repeated a few times to make sure that the coded text really represented the nodes. The nodes that have emerged from these cases have been listed in tables 4.4 to 4.7.

Table 4.8: The second step in the analysis and the steps taken (Audit of analysis plan - 2)

Strategies	Actual steps taken
Themes that are frequently stated explicitly or implied will be identified using NVIVO	This has been done using NVIVO where the software aids in this aspect by giving the frequency of occurrence
The researcher have a check box of topics to quiz the respondent and if there is a probability that some responses are not pointing to the topics, these will be pointed out in the analysis	There is a change in the action taken here. All the nodes that have been generated by all the four respondents is listed along with those that have been generated by the particular respondent. This will give an indication of missing nodes.
These items that are identified as significant will be searched and identified if any	NVIVO has the feature of identifying those that have been emphasised providing the percentage of that item among the interview. This can give an indication of its emphasis along with the frequency.
NIL	A minor modification at this stage is the addition of tables at the end of each theme separating the summary of the theme using the criteria namely issues, evaluation of the model and suggestions. While most of these are direct references, some of them may be indirect or implied. This is due to the fact that (1) the researcher noticed that most of the themes focus around issues and suggestions; (2) the main purpose of the research being evaluation of the model, it was deemed appropriate to differentiate these wherever it is possible

Two types of coding have been done to ensure that the steps outlined for undertaking the analysis (chapter 3) are followed. First of all the transcription have been read through repeatedly to derive the nodes without taking into account any propositions. Once all the possible nodes have been derived, the noding exercise was repeated from a different perspective. Here the four propositions are named as four nodes and all those topics that are referred to the propositions are grouped under the four propositions.

All the nodes that have been derived from all the four cases have been listed below (under each case) with the frequency of references, the percentage of coverage in the total transcripted interview with the nodes that have not been mentioned in this particular case given in shaded cells. This gives an overall idea of which all nodes the respondent have discussed, the number of times these were discussed and time given for discussing that particular node that can be an indication of the intensity of the

theme that is represented by the node. The respective table also gives an indication of those themes that have not been discussed by the respondent.

Three aspects are being displayed namely frequency, omission and declaration. While the study being qualitative, two aspects are being considered for frequency. One is the number of times the emerged themes have been mentioned directly or indirectly, and the proportion of time/weightage given in terms of the percentage of reference in the transcription. It was observed that both these perspectives gives similar results in all the cases. The following sections outlines the themes that have been given maximum, average, minimum and zero coverage (omissions) and in terms of the number of times these have been referred to by the respondent. Declarations that involve the emergence of new unexpected themes are also discussed. The following section (4.2.2.1 to 4.2.2.4) discusses the frequency, omissions and declarations. In the ensuing section the tables have been graphically represented to give a visual picture of the citation of themes. Likewise since the themes overlap, and some feedback are nor relevant, the totaling of the coverage may not add to hundred percent and thus there is no need to add another column with cumulative coverage.

4.2.2.1   NZ 1 (Stage – 2)

This is the first interview being conducted and so the first one to be transcribed and analysed using the software NVIVO. Even though the most frequently covered and cited themes focus around 'functionality', 'benchmarking', 'current IT audit, governance, control models', and 'input to the model', (even though this topic was covered to a great extend this was cited only once), a major unexpected theme that had emerged during the course of interview is 'benchmarking' the scores with similar industries and the question of who should really decide which the questions and metrics to select and who should really input values to the model. While the concept of benchmarking is related to IT audit, the methodology outlined is unique. Out of the 23 areas, 15 areas have been covered by this respondent, representing approximately 65% of all the themes that emerged during the interview with all the four respondents. Considering the extent of coverage the most important theme that has been discussed is around the various functions of the model especially the automated application. Of the four respondents this is the highest coverage given for any theme.

Table 4.9: Frequency table showing the nodes with the maximum to zero coverage

	Nodes level 2	References	Coverage
1	Functionality	8	19.49%
2	Input to the model	1	5.64%
3	Bench marking	8	4.51%
4	Current IT audit, governance, control models	4	4.28%
5	Alignment of the model	8	3.45%
6	Clarification of goals, questions and metrics	5	3.22%
7	Application of the model	4	3.03%
8	Compliance and measurement perspective	3	2.97%
9	Similar tool or method	2	2.43%
10	CO or DCO?	1	2.05%
11	Tracking progress of a goal	1	1.26%
12	Contextual layer	1	0.35%
13	Alignment and understanding with COBIT	1	0.26%
14	Commercializing the model	1	0.25%
15	Model evaluation	1	0.14%
1	Context of the goals, questions and metrics	0	0
2	Scoring system	0	0
3	Automation	0	0
4	COBIT in the model	0	0
5	GQM	0	0
6	Auditing perspective	0	0
7	Other standards	0	0
8	Ranking	0	0

Figure 4.1: Chart showing the relative coverage of the nodes for NZ 1

While the table (4.9) and figure (4.1) above shows the extend of coverage of the topics, the table (4.10) and the figure (4.2) below shows a similar perspective in terms of the number of times the themes have been cited during the interview for the respondent NZ 1.

Table 4.10: Most frequently mentioned nodes to those that were not mentioned

	Nodes level 2	References	Coverage
1	Functionality	8	19.49%
2	Bench marking	8	4.51%
3	Alignment of the model	8	3.45%
4	Clarification of goals, questions and metrics	5	3.22%
5	Current IT audit, governance, control models	4	4.28%
6	Application of the model	4	3.03%
7	Compliance and measurement perspective	3	2.97%
8	Similar tool or method	2	2.43%
9	Input to the model	1	5.64%
10	CO or DCO?	1	2.05%
11	Tracking progress of a goal	1	1.26%
12	Contextual layer	1	0.35%
13	Alignment and understanding with COBIT	1	0.26%
14	Commercializing the model	1	0.25%
15	Model evaluation	1	0.14%
1	Context of the goals, questions and metrics	0	0
2	Scoring system	0	0
3	Automation	0	0
4	COBIT in the model	0	0
5	GQM	0	0
6	Auditing perspective	0	0
7	Other standards	0	0
8	Ranking	0	0

Figure 4.2: Chart showing the relative frequency of citation of the nodes for NZ 1

In terms of the frequency of citing the themes, three themes have been cited eight times, seven themes cited once and one theme cited five, four, three and twice during the interview.

Regarding omissions, out of the seven areas not discussed it has been observed from the table that two major areas not discussed are automation and the GQM model. Out of the minor ones, scoring, ranking of the questions/metrics, COBIT in the model, audit perspective, and other relevant standards all comes under the main theme 'model'. Concerning declarations, the two major unexpected themes that have emerged are 'benchmarking' and the questions of who should input the values to the model. Benchmarking here mainly refers to the need for benchmarking the results with similar organizations in the same industry and choosing the metrics that are relevant to them. Input to the model focus on the need to separate the process of managing and selecting the questions and metrics to answer, from the personnel who really provide the input values to the metrics.

The biggest issue with the model from this respondents' perspective is functionality. The various features that have been discussed are given in the sections below.

4.2.2.1.1 Functionality

A great deal has been discussed regarding functionality as is evident from the coverage given for this topic. The first issue he raised regarding the application is the inability to save while halfway through the process. If a user decides to complete the input after a specific part of the process have been done, there is no way for her/him to get back what he has done with the model,other than to close it and start gain later. To this he says:

> *"I'd make the program remember what you selected because as soon as you go out of the window………… Yes, yeah, Because - otherwise when I went out of that window and back in again, I'd had to select all those questions again OK, and I have no idea which ones I selected."*

When asked if a file save method is suitable, he replied in the affirmative. Similar to this aspect is the issue of profile as the application need to have a provision to create

a profile for each user so that the results can be stored periodically, separately and/or on an incremental basis.

> *"So that is like a profile - profiles if you like and, and the whole idea, is if you want to customise to an organisation and you want the organisation to choose the questions, then it is appropriate to you want to be able to save that as a profile or some sort of that can be recalled.* **OK, yeah that is one, any other?** *Yeah.. You've got to store the results, OK, and, and then once you store the results, you need a way of, of doing the comparisons between different reports."*

Moreover the application should have the facility where the results or reports saved over a period of time can be compared and analysed:

> *"I mean as a user at least I use this thing it for 6 months and I save stuff one of the 14 questions over 6 months, I don't want to go back and look at six different html reports and compare the results..... because I don't want to flick through lots of html reports and go over like this one and tell –this one went up and that one went down -* **that's fine** *- and I would like to have a grab a pie chart or something like that ..... Ultimately, when you know that when it get quite detailed in the development and then you could say well, for areas what do you look for - 14 - you could choose that and say well, OK. Choose one of those and grab me the results of the last 2 months, 6 months, 1 year or whatever.*

Moreover there should be summary of reports for different levels of managers:

> *"I mean the, the very high level one might be simply –* **something like this?** *Might be simply, we're better now that we were 6 months ago,* **OK, yeah**, *and in each of these areas these ones have improved and those ones haven't, and ahm, down one here in the detailed would be what would help people actually go and make changes to how they work."*

A different issue discussed is the problem of ticking the wrong question by the users. It can be by mistake or intentional. For the latter problem the respondent gives a suggestion:

*"I kind of wasn't happy, that, I wasn't convinced - you know you had these tick boxes to check the questions you want to be asked – **yeah**, ahm, I'm concerned that - that could be misleading - you could easily pick the wrong questions through ignorance – **Yeah** – OK - or you could in fact willfully pick the wrong questions ahm.. to put yourself in a better light and, and not actually reveal the true picture and what your infrastructure is like, now I 'm I don't know if that's"*

The respondent suggests that the audit people should decide on the questions and the user input the values due to two reasons. One is that the users may do it intentionally to present a good picture and secondly, they may not fully understand the real implications of the questions or metrics:

*"your audit people should be specifying which questions should have been asked, but your IT people actually answer the questions. **OK…** You see what I mean? Because if, if you just gave it to the IT people to select those questions, they, they may not care as much as the audit people as the.. don't know the meaning of fit."*

A web based application is proposed to solve the technical part of the issue.

*"and yes, you could make it like a web based application/ **web based application.** So I mean if you have it so flashy you could have the auditors specifies the questions, and assigns them to the IT guy or something or rather and, and he gets an email that says go to this page in the Intranet and review the questions to answer on the Intranet and then that goes into the database and then it gets collated in everything else. You could spend a lot a time into it."*

Table 4.11: Table showing the summary of the node 'functionality' for NZ 1

Issues	• There is no provision to store the results • There is no facility for multiple users to log in and have a profile • There is an issue of ticking the wrong questions. • The users does not have the facility to choose their own goals, questions or metrics
Evaluation	• The features of the model are basic
Suggestions	• There is a need for a file save method so that even if a person was only halfway through the process and wants to interrupt it then he/she should have the facility to save the unfinished work

	• There should a facility for creating a profile for each user
	• The results should be stored and there should be a feature to do comparisons of a set of goals, or metrics over a period of time
	• There should be summary reports for high level and detailed reports for medium and low level managers
	• There should be a facility where the audit people should have control over the selection of the questions/metrics and then send the selected questions/metrics to the selected users to fill it where after filling it up it comes back tot the auditor. The respondent suggested a web based application

4.2.2.1.2 Input to the model

This theme is similar to one of the issue discussed above as to who should manage the application, decide the questions to answer and who should provide inputs to the model. Hence there is an overlap with 'functionality'. The respondents states that the control of the application should be with the auditor as he understands the goals, and its implications and know who are the best people to input to the selected questions and metrics.

Table 4.12: Table showing the summary of the node 'input to the model' for NZ 1

Issues	• There is no provision for some group of personnel to manage the application
	• All users are given access to all areas of the application
Evaluation	• The model currently suitable for single use
Suggestions	• There is a slight overlap with 'functionality'. The auditor should be given the authority to view and select the goal, questions and metrics for each department of set of users.
	• They should have main control over the software, it use and who should use this tool.
	• All users should not be given equal rights as to the control of the application

4.2.2.1.3 Benchmarking

This aspect have been given emphasis regarding the model and is one of the two major comments regarding the model apart from functionality (other being clarification of goals, questions and, metrics, and alignment of these). The respondent is least interested in measuring his own organisational IT resources, but rather would like to benchmark these controls against similar controls of organisation in the same industry and this point was duly emphasized:

> *"that's another comment I was going to make was how do you align all of these to some sort of industry standard baseline? If you start developing everything specific to a particular industry, then it becomes self referential*

and you are measuring against yourself, but you can't measure against
anything else. ……………I think it needed to be tied back to some sort of
standard"

He also suggested linking the specific terminologies used in the questions to relevant standards so that users can objectively know the meaning of these terms that are used on the questions and metrics:

" ……..either that need to tied back to something that defines what big, small,
clear, is or you need to avoid that kind of stuff altogether……the use for a tool
for this kind of stuff is this a regular baselining…… how, how would your
tool accommodate some recommended baseline or some standards to
compare against?………. because they need to know what they are marking
*against. **OK** - So they need to know what the metric refers to - what they are*
marking against.

Table 4.13: Table showing the summary of the node 'benchmarking' for NZ 1

Issues	• The tool does not have any facility to benchmark
	• There are no relevant standards are incorporated into the model
	• There is no provision for baselining in the model
	• The metrics are generic
Evaluation	• The concept of benchmarking should be incorporated into the model
Suggestions	• There is a need to align the goals, and metrics to some industry standard baseline
	• There is no use measuring against yourself
	• There is a need to link the measures to some sort of relevant IT standards
	• Each score (1 to 5) in the metrics should be tied back to something that defines these scores relevant to the industry
	• The use for this tool is mainly for baselining and hence the tool should incorporate some recommended baseline
	• There is a need to incorporate ISO standards into the model
	• The metrics should be relevant to the industry and they need to compare with similar organisations

4.2.2.1.4 Current IT audit and governance framework

The current audit process is a blend of both, performance measurement, compliance and return on investment type of measurement. There is no IT governance and hence no governance tools are being used but rather the IT audit is manual and focus on IT security. They do this based on a list of questions similar to the IT audit process.

"The nearest thing we have and this is in the security space it is not in, not in
general IT, just the security stuff, we have a compliance program. So we've

*got a schedule of things that we check every week, every month, every two months, every 6 months OK so on –…….I don't believe we are particularly strong on IT governance and not particularly strong on IT auditing either. **Right.** Usually when we are doing audit work, that's for a large project, and the project as a whole will be audited, so, but, but in general we don't really do regular audit of IT systems or IT governance"*

They have used automation in their audit work but in a very narrow perspective:

*"I have seen similar things with vulnerability scanners for example, have a button for SOX compliance - you know – **Yes, the SOX compliance is linked to ITG.** Yeah – So, so we for example use have a McCaffe Soundstone Scanner, that scans all our networks and all sorts of computers and stuff like that and it can probably produce a report that can tell that whether SOX is complaint or not"*

Table 4.14: Table showing the summary of the node 'current IT governance and audit controls' for NZ 1

Summary	- They have a compliance program for IT Security - Similar to audit they got a schedule of things that they check every week, every month, every two months, every 6 months - IT auditing and governance (other than IT security) is done only when they are undertaking a large project where the project as whole will be audited - They don't do regular audit of IT systems or IT governance - They use a tool called McCaffe Soundstone Scanner that scans the network and produce a report to tell whether they are SOX compliant or not - They use SOX because they don't have any choice, but to use it; but with COBIT they have a choice and hence they are not using it - Unless some employees know about COBIT and are interested there is no way of introducing it in their organisation

4.2.2.1.5 Alignment of the model

The perspective of alignment for the respondent is from the point of mismatch between the questions and metrics as he doesn't see any link. He states: "I wasn't convinced that the metrics and the questions are aligned satisfactorily" as these doesn't make any sense without a context or benchmark. Moreover, the terminologies used are "fuzzy" with a lot of anomalities between the questions and metrics.

Table 4.15: Table showing the summary of the node 'alignment of the model' for NZ 1

Issues	• "I wasn't convinced that the metrics and the questions are aligned satisfactorily" • Some of the questions and metrics doesn't make any sense • The terminology used in the questions and metrics are rather fuzzy • There are a lot of anomalities between the questions and metrics
Evaluation	• The questions and metrics are not aligned properly in the model
Suggestions	• No suggestions are given but can be implied.

4.2.2.1.6 Clarification of goals, questions and metrics

The questions and metrics lack clarity, objectiveness and is too subjective:

*"There are a lot of questions where you use things like big, small, clear, unclear, simple, complex, how much effort, comprehensive, **yeah,** and they are all rather fussy kind of ……….. You need to avoid things like big, small, clear, unclear, hmmm, because they are too, too interpretive. So………………either that need to tied back to something that defines what big, small, clear, is or you need to avoid that kind of stuff altogether."*

According to the respondent one advantage of having clarity is that anyone in the organisation related to this domain can view from the same perspective if the questions and metrics are clear:

*"The key thing for this kind of stuff is that it is repeatable, **It is repeatable, yes**, repeatable and works the same way for different people ……………Is xyz in place? or, do you have xyz?, or - is xyz properly done? I might answer it, Yes, because I have inside knowledge, because I'd been here 5 years or something like that. Someone else come here in six months time and ask the same question, and they don't have my prior knowledge where do they go to find out whether it's been done properly or not? Ahm, where is it defined what 'proper' is?"*

Tying these questions and metrics to some standards are also recommended to reduce the subjectivity.

Table 4.16: Table showing the summary of the node 'clarification of goals, questions and metrics' for NZ 1

Issues	• There is no context for the questions • The questions can be interpreted differently and is thus subjective
Evaluation	• The questions and metrics lacks clarity
Suggestions	• The questions and metrics need to be clarified and linked to something that defines the terminology used in the questions and metrics so that the users know what these mean • The thing is that the process should be repeatable – that means that if two people does the audit for the same goal, questions and metrics the results should be similar, OR if one person does it at two different points of time the person should perceive the same meaning for these terms

4.2.2.1.7 Application of the model

According to the respondent, even though the tool can be used for IT audit, it is more suitable for high level governance than specific audit and is useful for those who knows COBIT, as COBIT controls are being used here in this model.

> *"and with this COBIT stuff you ..for to be of any use, you have to have some folks in there who, who are interested in COBIT and wants to use COBIT as a, as a governance model for IT and otherwise it's no use at all, but that's usually audit………..and maybe it would be better to say this tool is better used by the audit arm as a basis for their audit and their governance, depends if it is used as a governance model as COBIT…COBIT it is a pretty high level governance model"*

Hence the model suits organizations that had implemented COBIT and according to the respondent, COBIT is getting more widely used thus have good prospect.

> *"the strengths I think is if you develop it and give it to an organisation who was already familiar with this kind of stuff and wanted to use it I think that a key point ………..would tell people who are already familiar with COBIT as COBIT is probably going to will continue growing as well and if people are already down that path, then it becomes an useful addition…."*

Table 4.17 The summary of the node 'application of the model' for NZ 1

Issues	• This tool can be applied only if people in that organisation knows COBIT • This tool is more used for high level governance than specific IT audit as COBIT is a high level governance tool • This tool is more useful if the organisation is using COBIT and does high level governance
Evaluation	• The model is narrow in terms of scope
Suggestions	• There is a good scope for this tool as COBIT is growing in popularity

4.2.2.1.8 Compliance and measurement perspective

The audit program that they have had already been discussed in section 4.2.2.1.4. The respondent use both quantifiable measures and compliance method for their audit and this is more technical based than measuring general IS:

> *" it's a combination of - we don't - that's a combination – yes, where some of it is just a check to make sure that something is being done, **OK, all right,** just to make sure it is being done, some of the answers are yes, some of the answers are no, other things are for example – ahm, a measurement like how many inactive accounts are there in active the directory- **OK** – all right, that kind of thing they track all the time……………………….. we, we did, we have a monitoring and reporting on performance in terms of like CPU, disk and memory and network bandwidth and network availability and all that kind of thing stuff you means*

Table 4.18: Table showing the summary of the node of the topic 'compliance and measurement perspective' for NZ 1

Summary	• They do not measure the performance of IS systems, but have a compliance program. A compliance program is normally a checklist of YES/NO • Apart from YES/NO checklist the measurement is in the form of 'number of' 'how many' • Performance measurement is limited to only the performance of hardware and not IS systems

4.2.2.1.9 Similar tool or method

They don't have a similar tool or method, but have used a software application that tells whether they are SOX compliant or not. Apart from that they are concerned with the measurement of hardware.

Table 4.19: Table showing the summary of the node 'similar tool or method' for NZ 1

Issues	• NIL
Evaluation	• NA
Suggestions	• The model can be used for specific performance measurement

4.2.2.1.10 Use of CO or DCO

They have a need to use both the CO and DCO since the respondent have expressed the need for different reports for different levels of managers, and the need to go into details.

*"It depends on your audience. So do you want to get really smart with your tool, you would have some high level reports that are targeted at your senior managers **yeah**, and then a more detailed report which will go to the analysts, **so you need both**, yeah, because management people want one or two pages that can show them graphically, very quickly if things are getting better or getting worse, but then that's no use to your technical teams or your analysts who, who actually need to say 'all these controls aren't working, ahm, because this is going up, and it should be going down so we need new controls."*

Table 4.20: Table showing the summary of the node 'use of CO or DCO' for NZ 1

Issues	• NA
Evaluation	• The model needs both the CO and DCO
Suggestions	• NA

4.2.2.1.11 Tracking progress of the goal

This aspect has been discussed in section 4.2.2.1.1 and 4.2.2.1.4 and thus he has emphasized the need for tracking the progress of a goal.

*"the process improved from one month to the next month? **Yeah..** or something like that or – 'do the processes' or 'what gaps are left by the processes' or 'do the processes leave gaps that needs addressing?' **right**, and then you can say well - at the beginning like - leave a significant amount of gaps and then a year later it might ah.. only a negligible amount of gaps..."*

Table 4.21: Table showing the summary of the node 'tracking progress of a goal' for NZ 1

Issues	• Currently no provision exists to track the progress of a goal
Evaluation	• The model does not have facility for profiling and storing the results
Suggestions	• NA

4.2.2.1.12 Contextual layer

This aspect is assumed from sections 4.2.2.1.6 and vaguely mentioned here:

> *You might ask the question – Do you have xyz?, but how do you know whether that its actually good or bad?* ***yea***

This is a set of qualifying questions that IT auditors ask to converge on the context and relevance of the entity being measured.

Table 4.22: Table showing the summary of the node 'contextual layer' for NZ 1

Issues	• A contextual layer may be missing
Evaluation	• There is no context for the questions and metrics
Suggestions	• NA

4.2.2.1.13 Alignment and understanding of COBIT

According to the respondent the model is more suitable for those who know about COBIT and the questions and metrics can only be developed if they know COBIT.

Table 4.23: Table showing the summary of the node 'alignment and understanding with COBIT' for NZ 1

Issues	• It is not easily understood by non COBIT personnel
Evaluation	• The model is narrow in that it include only COBIT
Suggestions	• May include other standards

4.2.2.1.14 Commercialising the model

The respondent is positive about the prospect of the model being turned into a fully functional piece of software:

"I'm sure you could easily blow this out into a pretty complicated thing."

Table 4.24: Table showing the summary of the node 'commercialising the model' for NZ 1

Issues	• NA
Evaluation	• There is good scope for the application
Suggestions	• Need to add a lot of features and sort out the issues.

4.2.2.1.15 Model evaluation

The idea of using GQM and COBIT is good according to him, but there are lots of issues to be solved before this can be used.

Table 4.25: Table showing the summary of the node 'model evaluation' for NZ1

Issues	• NIL
Evaluation	• The model is a safe
Suggestions	• Issues should be resolved

4.2.2.2   NZ 2 (Stage – 2)

Contrary to the response of NZ 1, the themes that are most important both from a coverage and frequency of reference perspective are more focused on the nature of the goals, questions and metrics that have been given in the database of the model. Since the organisations is using COBIT along with other IT governance framework, discussion has also focused much on the nature of IT governance in the organisation. Regarding the coverage of topics it has been observed that 18 out of the 23 topics have been covered representing 78.2% of the total themes discussed by all the participants.

Table 4.26: Frequency table showing the nodes with the maximum to zero coverage for NZ2

	Nodes level 2	References	Coverage
1	Clarification of goals, questions and metrics	7	14.13%
2	Input to the model	4	9.44%
3	Current IT audit, governance, control models	9	9.23%
4	Bench marking	5	8.43%
5	Ranking	7	6.95%
6	Model evaluation	4	5.94%
7	Tracking progress of a goal	3	5.80%
8	Context of the goals, questions and metrics	3	3.45%
9	Other standards	3	2.33%
10	Automation	1	1.48%
11	Functionality	2	1.31%
12	Compliance and measurement perspective	1	1.29%
13	CO or DCO?	2	1.27%
14	Application of the model	1	0.93%
15	GQM	1	0.78%
16	Alignment of the model	1	0.74%
17	Alignment and understanding with COBIT	1	0.20%
18	Similar tool or method	1	0.14%
1	Commercializing the model	0	0
2	Scoring system	0	0
3	COBIT in the model	0	0
4	Contextual layer	0	0
5	Auditing perspective	0	0

While NZ 1 focused on the functionality of the application, this respondent discussed the various aspects of the model thus giving more coverage. Table 4.26 and 4.27 and the corresponding figures 4.3 and 4.4 give an overview of the topics and the density with which it was covered.

The theme that had been discussed the most during the course of interview concerns the clarification of goals, questions and metrics implying that these are generic, while the least discussed topic was the mention of a similar tool or method thus implying that some of the methods of IS audit may have been evident in the model.
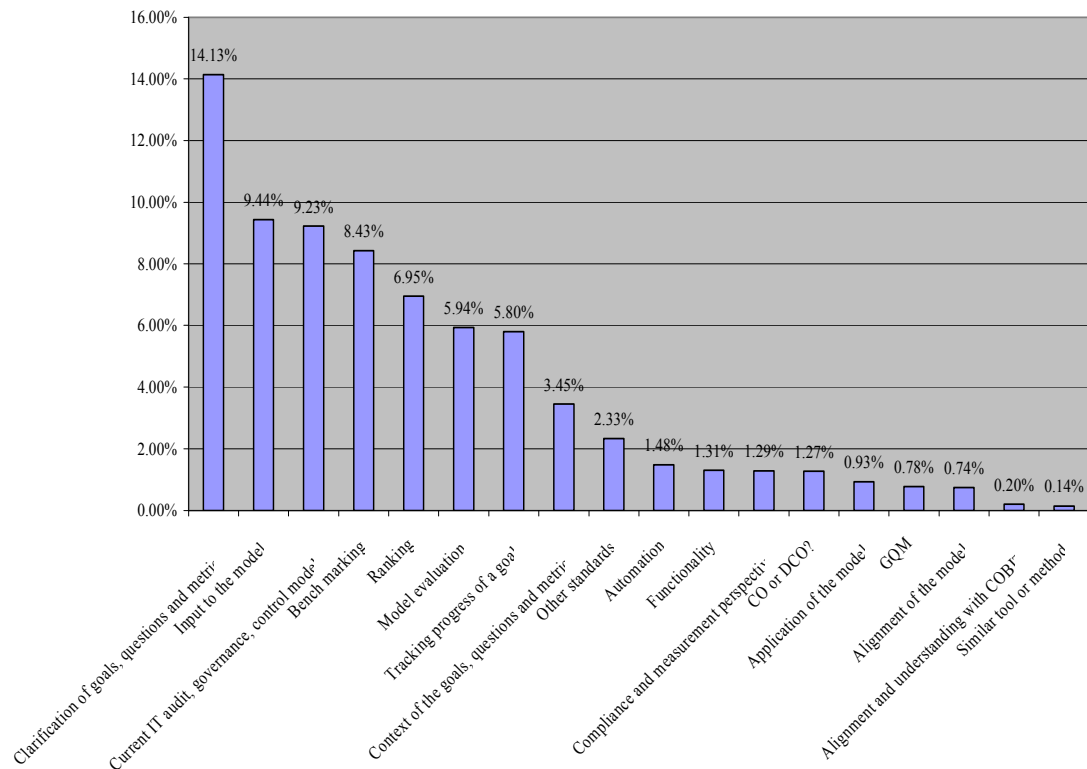
Figure 4.3 Chart showing the relative coverage of the nodes for NZ 2

While the table (4.26) and chart (4.3) above shows the extend of coverage of the topics, the table (4.27) and the chart (4.4) below shows a similar perspective in terms of the number of times the theme have been cited during the interview.

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Table 4.27: Frequency table showing the nodes with the most frequently mentioned to those that were not mentioned for NZ 2

	Nodes level 2	References	Coverage
1	Current IT audit, governance, control models	9	9.23%
2	Clarification of goals, questions and metrics	7	14.13%
3	Ranking	7	6.95%
4	Bench marking	5	8.43%
5	Input to the model	4	9.44%
6	Model evaluation	4	5.94%
7	Tracking progress of a goal	3	5.80%
8	Context of the goals, questions and metrics	3	3.45%
9	Other standards	3	2.33%
10	Functionality	2	1.31%
11	CO or DCO?	2	1.27%
12	Automation	1	1.48%
13	Compliance and measurement perspective	1	1.29%
14	Application of the model	1	0.93%
15	GQM	1	0.78%
16	Alignment of the model	1	0.74%
17	Alignment and understanding with COBIT	1	0.20%
18	Similar tool or method	1	0.14%
1	Commercializing the model	0	0
2	Scoring system	0	0
3	COBIT in the model	0	0
4	Contextual layer	0	0
5	Auditing perspective	0	0

Figure 4.4 Chart showing the relative frequency of citation of the nodes for NZ 2

Contrary to the above perspective, considering the most discussed theme from a frequently cited perspective, it was observed that the organisation's current IT audit, governance and control models have been the most frequently cited.

The following section will describe the various themes that have been discussed by the respondent.

4.2.2.2.1 Clarification of goals, questions and metrics

Much of the discussion were focused on the issues being faced with the current database questions and metrics. The first point raised during the discussion is the way the questions and metrics have been written. A few questions were picked up by the respondent from the database to demonstrate the lack of clarity

> *"the first thing I probably pick up for me was eh, the explanation of this. So depending on who your target audience is, **OK**, eh, how's access control managed in the company. So eh, obviously when you, you know, you know, you have to be saying, who's your audience. Now if he's saying an IT governance professional, you wouldn't need to necessarily tell them what is access control mean. But there were things that I did think like – how many times the system have been modified, may have to be bit more like – what system do you mean? Should they be specific or we're talking about systems, obviously we have hundreds of applications here.*

According to the respondent, the questions should be suit the target audience as the terminologies used in the questions may mean different to different users and thus may not reveal the true picture. To the question whether the wording of the questions should be more specific to the context, the respondent replied:

> *"Yes, in terms of what you want them to, how you want them to answer. So I was just wondering, again it depends on who's your target audience is. **Right**. Ahm and so if it's a high level IT professional, you wouldn't have to do anything,"*

The questions being very generic need to be explained further clearly with the target audience in mind. The suggestion given was:

> *"So I think it, its just enquiring a little bit more detailed, so I mean you obviously talked about and given a description of what IT security is at the*

high level, but I'm thinking – I'm thinking you'd probably need to explain further the questions in terms of making sure of the way in which they are answered is how you're wanting to."

There is a very high level of subjectivity in the questions as well as the metrics where different people can interpret in different ways. The scores given for the metrics (1 to 5) are subjective and may not represent the true picture.

"So when you do this (working with the application and inserting rating) and you come out with the levels, you're saying ahm– "Is critical IT security decisions taken at the highest level?" You've got not really any, if 5 is a yes. So it's a kind of very subjective as to what 2, 3 and 4 is. So what's 2? Kind of? 3...? Did you not mean? So you need to be kind of careful on that scale."

The subjectivity increases when different persons input values to the metrics:

"you know you're talking about rating between, you know, 1, 2 and 3, and you know, its quite contentious and the thing is, you know, what someone may say its 1, and somebody else may say its 2 and if you've got one person doing it consistently across you know that you got consistent approach to the metrics."

A suggestion given by the respondent is the explanation for each of the scale to denote what each mean:

"Yeah, and look each of these questions are going to be different and I noticed that the way in which you ranked them, but what I suppose you need to probably say is you know, here's a rating scale – 1 is not taken at the highest level and 5 is taken at the highest level. Where do you think it will fit in? So you could make it like that or you could say that 1 is this, 2 is this, 3 is this, 4 is this and 5 is this."

Regarding questions, another suggestion given is to make sure that the end user understands the question and metrics fully and it can also be done through formal training of the end user according to the respondent:

"you'll need to really make sure that the person who's receiving that question understands the intent of that question, purpose of that question, and how they

should answer that question. Ahm, so I don't know where there is necessarily

an education process involved"

Table 4.28: Table showing the summary of the node 'clarification of goals, questions, and metrics for NZ 2

Issues	- The questions and metrics are clear and targeted at the specific audience - The questions and metrics are generic - There is a high level of subjectivity in the questions
Evaluation	The questions and metrics component of the model does not serve its purpose of measurement
Suggestions Implied	- Each of the scales (1 to 5) should be explained to denote what they really mean - The questions and metrics should be designed with the target audience in mind - A formal training sessions can be provided to the end users regarding the correct perspective of the questions and metrics

4.2.2.2.2 Current audit, governance control models

The organisation currently uses a blend of COBIT, ITIL, ISO 177990 and 270002 and all of these comes under IT general controls. Regarding this NZ 2 says:

"when we had previous assessments done, it's tended to be a bit of blended

approach in terms of what's out there. So when the, we wouldn't say that

we're going to adhere to all of COBIT. I mean we've looked at security, you

know, 177990 and the 270002. So I suppose the thing is looking at that and

picking up the ones that are meaningful to our organisation in terms of the

ones that we want to measure ourselves against…………our service

management is based on ITIL. So we've got, we use ITIL, we've got COBIT,

we've got ISO 177990………………

Often, often we, you know, say user account management. Its part of our

ITGC, IT general controls for the financial audit. We have ITGC at which

they look at user account management."

They have external consultants doing the IT governance and audit process and currently it is done manually.

"Well, basically, you know in terms of what's happened in past is that we had

- you know auditors coming and do an assessment for us. So ahm, you know,

had maturity model done for several occasions to understand where we sit within that model, but it is not something that's done internally............................ Ah, well, we actually had the framework set up by the external auditors.............. and all of its manual reporting"

They don't follow any IT governance or control framework but rather they customise the generic framework to suit their organisation and among the family of products of COBIT they choose some of the control objectives of COBIT (and not the detailed control objectives) as they tend to look at the high level picture rather than a detailed done .

*"No, just the control objectives .... so as I say when we had auditors in eh. I believe that they just look at the high level To some extend, **to some extend, some of the control objectives**. That's right, but its not something that we say we are going to follow COBIT. Same with ITIL – we say ITIL is a framework for better practice, but we still need to work within our current structure, culture, beliefs, operating environment."*

They have external as well as internal audit process and regarding the use of high level control objectives she admits that the high level control objectives doesn't go into details:

*So we basically have two audit functions. We have internal and external. The external is ITGC, which is our general controls audit and that's, so they can sign off the financial results. **Right**. The weakness for that to me is that, it doesn't go into details. So we don't have - to me, and although they take some ample work, I don't believe it goes into low enough details. Obviously the strength is that it can highlight areas that we need to focus on. From the internal point of view that's around process controls, ahm, so a little bit different with the process is our business processes as opposed to IT type processes. So we wouldn't have an internal audit on the change management process. And so, ahm, they are seen that as being a weakness as well. So, so for me, if I wanted to actually, really understand where our current, you know, where there's strength or weakness in around IT audit controls, I'll have to commission something separately because I don't believe it go to the*

*levels we need to fully understand all of the areas – **the detailed ones.** The*

*detailed ones. **OK right.***

Hence there is a need to use the detailed control objectives to get a more detailed view and the proposed model (incorporating the suggestions) can be used for internal audit.

Table 4.29: Table showing the summary of the node 'current audit, governance and control models' for NZ 2

Summary	• The organisation currently uses a blend of COBIT, ITIL, ISO 177990 and 270002 and all of these comes under IT general controls. • They have external consultants doing the IS audit process • They customize the audit framework to suit their organization when it comes to IS audit • The organization does high level audit process • The high level audit process highlight the areas that they are weak but doesn't go into details • There is a need to do a detailed IS audit that go into details

4.2.2.2.3 Input to the model

According to the respondent the automated application of the model should be managed by the auditor as they have a more holistic view of what is being asked in the audit process and the purpose:

> *"I believe that the auditor should use the software. I wouldn't say this…… I*
> *think that someone should interfere with this from the shop floor. And the*
> *reason I say that is that sometimes you know depending on who's calling shop*
> *floor (personnel) may not fully understand the full implications of what are*
> *being asked and it may be that the auditors who may have a bit more high*
> *level, more holistic view on what they are trying to achieve here can explain*
> *in such a way to get an answer that may be slightly different.."*

Regarding the query on whether the input to the model (both in the selection of questions and assigning the scores to the metrics) should be done individually or through a panel of users, the respondent favours a collective input to the model.

> *"Ahm, I would say person that is actually using the software as one person*
> *and it may be that they interview more than one person to arrive at that*
> *question; So because again you know, if we got quite a few different views,*

you need to explore and understand that, and make, you know, an objective approach to when you complete this. So its you know, ahm... so someone like myself or the audit and risk manager, which would complete the software, but depending on the control objective that may be that they have more than one person that they interview, either individually or collectively..."

Also there need to be a interaction between the auditor (who manage the application) and the users who provide input to the questions. Hence according to the respondent a simple web based application that reach all the users may not suffice, but it needs to be interactive:

"It (web based application) can do, but you are taking away that interactive. So you're basically, that's where you'll need to really make sure that the person who's receiving that question understands the intent of that question, purpose of that question, and how they should answer that question."

This is because the shop floor person may not fully understand the intent of the questions or metrics.

"They being the shop person, shop floor person, well in some cases they wouldn't know that you'd be questions to generate.."

Table 4.30: Table showing the summary of the node 'input to the model' for NZ 2

Issues	- Who should manage the application? The questions to select and the metrics to input? - The users may not fully understand the full implications of the questions and metrics
Evaluation	Currently the model is open as anyone can input values without anyone tracing it
Suggestions Implied	- The automated model should be managed by the auditor - The auditor decided the questions and metrics that the users have to input - This necessitates for a web based application

4.2.2.2.4 Ranking

The respondent is not quite happy with the way the list of questions and metrics are presented as the model currently gives equal weightage to all. Commenting on this she states that "my, eh, next comment is around prioritising some of these based on risks". For achieving this a two dimensional rating system based on values from 1 to 10 on the x and y axis representing priority and risk was suggested by her:

"But the question then becomes if I answer 1 to this, what priority should I give it, and this is where I've done a little diagram as to how I was thinking that I would – (referring to the graph in the notes………………. Well if I didn't have any control objectives in this area, the potential risks to the organisation is up here and what you can then start doing is as you come through and measure, you've got (shows the graph) 2-3-4, you've have some up here."

The respondent would also like to explain the values in the scale for the two dimensional rating system as well as an explanation of the co-ordinates. This would also help in comparing the relative value of the questions:

"So to cover off, I would look at explaining the questions and may be expanding the ratings, looking at being more than 1 dimensional, so at least, you know trying to get - if you do risk or priority, so you actually see where the areas of focus are. Ahm, and then - the report to basically show those priorities, and also show an overall rating for each of these areas……… Well, I mean, in terms of, I mean the whole kind of look and feel is fine and I think it was more just the additional information that I was looking for and basically prioritising…………… So it could actually eh, you know, either put a weighting on how important that particular question versus the other questions."

Table 4.31: Table showing the summary of 'ranking' of questions and metrics for NZ 2

Issues	• Currently the questions and metrics in the model are given equal weightage
	• All the questions and metrics are not equal
Evaluation	• The model does not have a provision to assign priority to the questions and metrics
Suggestions Implied	• A two dimensional system cam be incorporated where on one axis the system assigns the priority and on the other axis the system assigns the risk factor

4.2.2.2.5 Benchmarking

This is a theme that has almost equal importance across all the respondents. Since the questions and metrics reflect a few IS standards it would be advisable to line these:

"*some of these (questions and metrics) are around standards and controls, you know, what sort of controls are we taking about.*

A benchmark is required to compare the results over a period of time. Other wise it would be subjective:

> *"the report is good, but at the end of the day, **it's subjective**, yeah. What do I do with that? The only thing I can do that is when I go to do this again in 6 months time and say "Oh, I well got 1 this time and its 2 nest time, what I am looking at is overall – how do I rate - in the management of IT security. So can I have an overall rating and benchmark that against similar industries, potentially and also then the areas of focus".*

The advantage of benchmarking against similar industries is that they can know their performance:

> *"Yes, so under management of IT security 'how do I rate overall' and what do other businesses look like. So if I come out with an average of 3 – **So it is a combination of 4 or 5 composite of 4 or 5 control objectives** – Yeah, yeah, and then being able to say – well, Industry says that you know – you should be aiming for this………………….. but I think it is important to understand, you know, where do we, how do we measure against other similar organisations."*

The benchmarking information (the industry standard for that particular set of controls) should be visible, only to the people who manage the IT audit and not the users:

> *"You're definitely right, they would be influenced by the information, because you've got to remember that some of this is quite contentious and people, people could be quite nervous at the way in which they answering. If they think that there will be a repercussion on their job, you know, that it is potentially, may be that they are not doing their job appropriately whereas what you want people to answer openly and honestly. So we can see the areas that need to be addressed".*

Table 4.32: Table showing the summary of the theme 'benchmarking' for NZ 2

Issues	• The reports generated are subjective • There is no method to compare the results with similar industries using same or similar control objectives • The benchmark value should be positioned near to the value of the organisation's report generated by the model
Evaluation	• NIL
Suggestions	• The controls should be benchmarked against similar industry • The relevant industry benchmark should be hidden from the people who input the value so that they are not influenced by the value

4.2.2.2.6 Model Evaluation

The respondent can certainly see some benefits from the model and according to her the model saves time and effort and is good for doing a pre-audit. What she means is that before any external consultant comes and does a thorough IT audit, this model serve the purpose of a pre assessment. She says:

*"I'm definitely, it's very good to use, so it would be, it wouldn't be something that will take a long time. Therefore, because its not ahm, its not a lot of effort required, that you were more likely to get a response and guide response to it and some action against that……………I can see the benefits of it (model) in terms of, I mean obviously there is ease of use,……………What it's basically doing is self assessment because often what happens is you know, we don't really understand - if we just say, you know if you use (searching for a control objective form the application). Often, often we, you know, say user account management. Its part of our ITGC, IT general controls for the financial audit. We have ITGC at which they look at user account management. What would be good you know, and how I'd see it's uses is it would be an internal tool whereby we can actually use this to actually do some - you know, pre-auditing ones. **Yes pre-auditing**. So to really say OK, raise awareness of what's required, and also regular process to - to check some of these areas and you can quickly do this, you know in terms ahm - you've got an audit come up. OK, let's, because all of these should be happening anyway. You got the process in place, there shouldn't be an issue, but it acts as a reminder and*

also a bit of an induction tool may be for many new IT employees as to the areas in which we'd be looking at around, say user account management."

The major problem with the model is its static nature due to the rigidity of the questions and metrics as currently there is no provision in the model to customize the questions or metrics:

"I think something like this is static in terms of the questions that have been assigned. Its, you know, particularly its user friendly, it serves the purpose of ahm, yeah, again going back to that pre-audit, but also making staff aware of what our requirements are ..."

Table 4.33: Table showing the summary of the node 'evaluation of the model' for NZ 2

Issues	• The model is static and thus not flexible enough to customize the questions and metrics
Evaluation	• The model is good to use and the application of the model saves time)as currently they are doing manual audit) • The model can help in undertaking a pre-audit or an internal audit • The model is user friendly
Suggestions	• The controls should be benchmarked against similar industry • The relevant industry benchmark should be hidden from the people who input the value so that they are not influenced by the value

4.2.2.2.7 Tracking progress of a goal

If the report generated by the model is to be of use it should have a facility to track the progress of a   particular control objective over a period of time. To do this there needs to be a facility in the model where the report generated at any point of time can be saved, a profile created and a link made with the previous report on the same control objective:

*"the report is, the report is good, but at the end of the day, **it's subjective**, yeah. What do I, do with that? The only thing I can do that is when I go to do this again in 6 months time and say "Oh, I well got 1 this time and its 2 next time, what I am looking at is overall – how do I rate - in the management of IT security. So can I have an overall rating and benchmark that against similar industries, potentially and also then the areas of focus. So, of the control objectives, there are the ones I really need to focus on, because potentially if there is a gap there there's a highest risk to the organisation.*

Hmm, so that would be what I'd said being more meaningful. The other thing would be is to basically make this state specific, so when you run it again, you could then start setting up graphs based on dates you actually can see where you are actually making progress……….Yeah, yeah, and then being able to say – well, Industry says that you know – you should be aiming for this. Ahm, and then I that that you need to save this based on date or version so that you can actually see what progress you're making as you redo the program."

Table 4.34: Table showing the summary of the theme 'tracking progress of the goal' for NZ 2

Issues	• The report generated is subjective • The current model does not have any provision to track the progress of a goal over time
Evaluation	• There is not much use for a report if it is generated for one time
Suggestions	• Incorporate the provision of tracking the scores of a control objective over time with visuals like graphs, dates, and even showing the industry benchmark alongside

4.2.2.2.8 Context of the goals, questions and metrics

Currently the context of the questions and metrics are generic since the database was prepared by the researcher. Even though the context was given, it is too generic and not specific. Hence there is a need to add the context of the questions:

*"the first thing I probably pick up for me was eh, the explanation of this. So depending on who your target audience is, **OK**, eh, how's access control managed in the company. So eh, obviously when you, you know, you know, you have to be saying, who's your audience. Now if he's saying an IT governance professional, you wouldn't need to necessarily tell them what is access control mean."*

Different people in the organisations have different levels of grasp of the context. Hence the context should be explained with the target audience in mind:

*"Yes, in terms of what you want them to, how you want them to answer. So I was just wondering, again it depends on who's your target audience is. **Right**. Ahm and so if it's a high level IT professional, you wouldn't have to do anything…"*

The explanation needs to be more clear and detailed:

"So I think it, its just enquiring a little bit more detailed, so I mean you obviously talked about and given a description of what IT security is at the high level, but I'm thinking – I'm thinking you'd probably need to explain further the questions in terms of making sure of the way in which they are answered is how you're wanting to. That was my first comment."

Table 4.35: Table showing the summary of the theme 'context of the goals, questions, and metrics' for NZ 2

Issues	• The questions and metrics are not detailed enough to be understood by all those concerned • The target audience are not taken into consideration
Evaluation	• NA
Suggestions	• Explain the questions in a more detailed manner taking into account the context so that all those personnel concerned with the audit can comprehend in a uniform manner

4.2.2.2.9 Other standards

Currently the model uses only COBIT and when queried if incorporating other standards and control framework (ISO, ITIL) into the model would help the respondent replied in the affirmative:

"I think so, yeah, you know, as I say when we did the assessment we didn't look at one particular ISO standard, or you know, one particular area, you know, we look at what's meaningful to for this particular organization……………….. Absolutely, it would definitely work."

The options in this regard can be such that the user should have the option to choose any one of the standards or a combination of standards; and also the option to select relevant ones (goals, questions, metrics) from different standards:

"I think it definitely would work because we are doing several things, all in that area. So ahm, I think, you know as an organisation what we are looking at is as I'm saying getting to better practice - where we try two controls. So I think you know, we're not looking at you, you know, tiny – looking down. So we can have more of a blended approach, or you're saying choose your framework, but ah …."

Table 4.36: Table showing the summary of the theme 'other standards' for NZ 2

Issues	• Currently the organization use a blend of different control frameworks while the model has only COBIT as the control framework
Evaluation	• NA
Suggestions	• There is a need to incorporate more control frameworks into the model so that the users have the choice of not only choosing the relevant ones for their organization but also the option to choose relevant portions of each, blend and customise it to suit their needs

4.2.2.2.10 Automation

The respondent favours automation of the IT audit process as this would make the audit process easier and can be done internally on a continuous basis rather than calling external consultants to do it. Regarding this she says:

"I'd definitely would look at using it, because, I mean at the end of the day you're paying somebody to come in and ask the right questions. Whereas if we had something that we know - that there is a right question, you know, in theory we would not have to answer those. So we wouldn't need to have an auditor come in and do that exercise for us, and something then that we do more regularly as supposed to say annually."

Table 4.37: Table showing the summary of the theme 'automation' for NZ 2

Issues	• NA
Evaluation	• Automation is highly favored since it would enable them to do the audit themselves on a continuous basis rather than hiring external consultants
Suggestions	• NA

4.2.2.2.11 Functionality

Many of the issues discussed regarding the model and the subsequent respondent suggestions requires the incorporation of features/functions to the application. Regarding usability and moving around the application and the effort in using it, she says:

"It's very easy to use. No issues. Didn't need any explanation as to… It was also self explanatory …………… I'm definitely, it's very good to use, so it would be, it wouldn't be something that will take a long time. Therefore, because its not ahm, its not a lot of effort required, that you were more likely to get a response and guide response to it and some action against that."

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Table 4.38: Table showing the summary of the theme 'functionality' of the model for NZ 2

Issues	• NA
Evaluation	• The model is usable, self explanatory and there is no difficulty in understanding and moving around the application
Suggestions	• NA

4.2.2.2.12 Compliance / measurement perspective

The model provides a performance oriented measurement (1 to 5) rather than an auditing perspective (Yes/No). Regarding the questions of compliance and measurement in auditing she states that both are identical:

> *"Ahm, again yeah, you know, you're looking at from a say, someone like myself who wants to understand the performance of the department, but in order to understand the compliance to COBIT. So taking probably from two different points of view, ahm, I think from the way in which the measurements are, and the results that you've received from, I think they are identical."*

Table 4.39: Table showing the summary of the theme 'compliance/ measurement perspective' for NZ 2

Issues	• NA
Evaluation	• A performance perspective presented by the model is also identical to the normal IT audit method of compliance (Yes/No)
Suggestions	• Compliance feature can also be incorporated into the model

4.2.2.2.13 Use of CO or DCO?

Regarding the choice of using a high level control objective or a low level detailed control objective, the respondent is of the opinion that both are required depending on the needs of the audience:

> *"Again it's really, really what's you are aiming for and I would definitely go for a high level."*

The organisation is currently doing the IS audit (through external auditors) using high level control objectives and the respondent being a senior manager and would like a short report.

Table 4.40: Table showing the summary of the theme 'control objective or detailed control objective' for NZ 2

Issues	• NA
Evaluation	• NA
Suggestions	• Both a high level control objective and a low level detailed control objective can be used in COBIT as senior managers would like to see short reports generated by the high level while managers would like to go into details which is provided by the low level DCO (Implied)

4.2.2.2.14 Application of the model

The model can be used to generate reports for the various levels of managers whereby managers can know where the organisation stand with respect to the various control objectives:

> *"And that's what I think you're aiming at to do with - to me, this sort of tool .... ahm, is to get that visibility for me to assess where we are, to make a report that I can then distribute to senior executives, or present it to the CIO or the IT steering group, so."*

Table 4.41: Table showing the summary of the theme 'application of the model' for NZ-2

Issues	• NA
Evaluation	• NA
Suggestions	• The model can be used to generate reports for the various levels of managers where for the senior managers can get an overview of the IT systems

4.2.2.2.15 GQM

Regarding the use of the GQM model, the respondent is quite happy with the current format:

> *"Ah, no, I think anybody who's exposed to COBIT, you know then goes to here, you know the areas they want to focus on (works on the application). I definitely think it's workable in its current format. Its definitely usable."*

Table 4.42: Table showing the summary of the theme 'evaluation of GQM method' for NZ 2

Issues	• NA
Evaluation	• The current format of the GQM model where the goal is broken into five perspectives and then into questions, is suitable
Suggestions	• NA

4.2.2.2.16 Alignment of the model

Commenting on the question of alignment of the metrics to the questions and the questions to the goal (DCO) the respondent states:

"I felt that the metrics are relevant to the questions and the questions are relevant to the goal. That's what you're asking? I didn't see any issues in that; that there's nothing that's sprung out too many".

Table 4.43: Table showing the summary of the theme 'alignment of the model' for NZ 2

Issues	• NA
Evaluation	• The metrics, and the questions are aligned with the linked goals.
Suggestions	• NA

4.2.2.2.17 Alignment and understanding with COBIT

According to the respondent the alignment is directly proportional to the understanding of COBIT. This is so because the goals, questions and metrics are derived from the COBIT DCO. Hence it depends on the persons knowledge of COBIT. She states that *"I suppose it depends on how much you know COBIT or not."*

Table 4.44: Table showing the summary of the theme 'alignment of the model and expertise with COBIT' for NZ 2

Issues	• NA
Evaluation	• Since the model is based on COBIT a person who know COBIT can see the alignment of the metrics, and the questions with the goal implying that a knowledge of COBIT is necessary to understand this model
Suggestions	• NA

4.2.2.2.18 Similar tool or method

The respondent had not come across any similar tool or method: She says: *"I have not come across any similar model"*

Table 4.45: Table showing the summary of the theme 'similar tool or method' for NZ 2

Issues	• NA
Evaluation	• The model is unique
Suggestions	• NA

4.2.2.3   NZ 3 (Stage – 2)

This respondent's profile is distinct from the other two due to the fact that he is an IT audit and governance consultant who does IT audit in client organisations. Hence there is a tendency to give more priority to current IT governance frameworks and its

implementation methodology. As expected the same theme 'Current IT audit, governance, control models' has a coverage of 18.25% with 6 references. Hence both from a coverage and frequency perspective this theme was the most discussed. But among all the respondents the total coverage of topics is the least with just 14 out of 23 topics discussed representing just 16% of the total topics. A new significant topic that has emerged here is the 'contextual layer' (this will be discussed in detail in section 4.2.2.3.2). Table 4.46, 4.47 and the corresponding figures 4.5 and 4.6 gives an overview of the topics and the density (coverage) with which it was covered.

Table 4.46: Table showing the frequency of themes based on the coverage of the themes during the discussion, for NZ 3

	Nodes level 2	References	Coverage
1	Current IT audit, governance, control models	6	18.25%
2	Contextual layer	4	7.62%
3	Bench marking	3	6.53%
4	Clarification of goals, questions and metrics	5	6.16%
5	Auditing perspective	5	6.04%
6	Functionality	3	5.83%
7	Other standards	3	5.43%
8	Similar tool or method	3	5.09%
9	Ranking	3	5.01%
10	Alignment of the model	1	2.92%
11	Model evaluation	2	2.48%
12	COBIT in the model	1	2.43%
13	Commercializing the model	1	1.52%
14	Input to the model	1	0.09%
1	Scoring system	0	0
2	Alignment and understanding with COBIT	0	0
3	Application of the model	0	0
4	Automation	0	0
5	CO or DCO?	0	0
6	Context of the goal, questions and metrics	0	0
7	GQM	0	0
8	Compliance and measurement perspective	0	0
9	Tracking progress of a goal	0	0

The chart (Fig. 4.5) gives a visual perspective of the topics that have been covered in great depth. 'Current IT audit and control models' have been covered in great length covering 18.25% of the total discussion and the least being 'input to the model'.
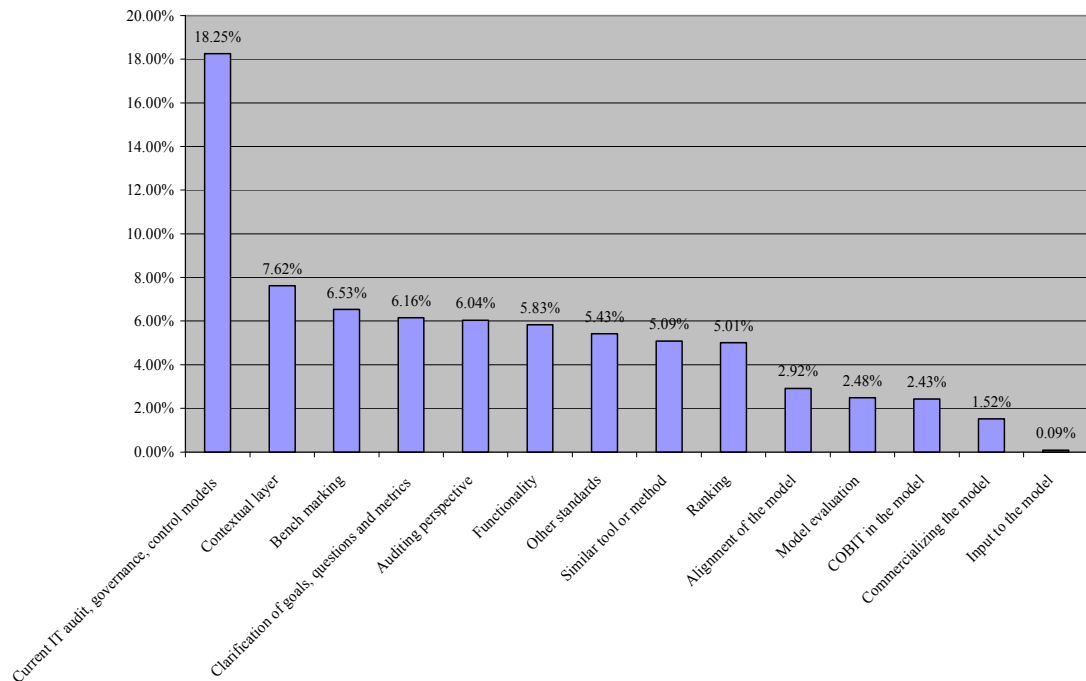
Figure 4.5: Chart showing the relative coverage of nodes for NZ 3

As expected, the same topic that have been discussed the maximum has also been cited most. This was expected since the respondent being an audit consultant, is more familiar with the tools, framework of IT governance and IT audit.

Table 4.47: Table showing the frequency of themes based on the number of times the themes have been referred during the discussion, for NZ 3

	Nodes level 2	References	Coverage
1	Current IT audit, governance, control models	6	18.25%
3	Auditing perspective	5	6.04%
2	Clarification of goals, questions and metrics	5	6.16%
4	Contextual layer	4	7.62%
5	Bench marking	3	6.53%
6	Functionality	3	5.83%
7	Other standards	3	5.43%
8	Similar tool or method	3	5.09%
9	Ranking	3	5.01%
10	Model evaluation	2	2.48%
11	Alignment of the model	1	2.92%
12	COBIT in the model	1	2.43%
13	Commercializing the model	1	1.52%
14	Input to the model	1	0.09%
1	Scoring system	0	0
2	Alignment and understanding with	0	0

	COBIT		
3	Application of the model	0	0
4	Automation	0	0
5	CO or DCO?	0	0
6	Context of the goals, questions and metrics	0	0
7	GQM	0	0
8	Compliance and measurement perspective	0	0
9	Tracking progress of a goal		

The chart (Fig. 4.6) gives a visual perspective of the topics that have been frequently cited during the discussion.
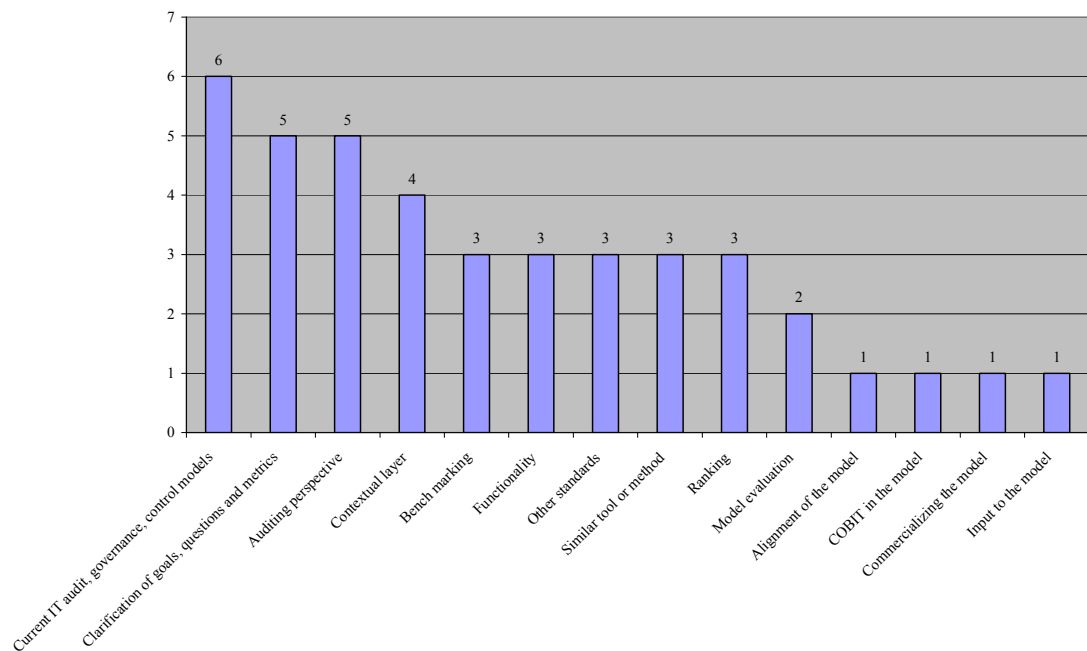
Figure 4.6 Topic Citation Summary for NZ 3

4.2.2.3.1 Current IT audit, governance, control models

The respondent being an IT audit consultant have discussed this topic in great length from different perspective. He does both quality assurance and IT audit. Similar to the model, the respondent develops and uses a set of goals/objective and questions for IT audit, but instead of the metrics with a scale, he use the compliance method of auditing by using 'Yes/No' for ensuring compliance. Moreover the questions developed by him are customised to the context:

"But surely people have developed – like at the moment I am using a same set of questions ah, I mean, set of objectives that I would go and verify the findings with their, with different clients, and I reuse some, some similar questions some other questions I would devise from - depends on their environment."

Comparing IT audit with quality assurance (QA), the respondent states that IT audit takes an overall high level and detailed view, while in the case of QA he just goes deep down into details testing everything that is relevant:

"Well the QA depends on the, again sometimes I do overall check and sometimes I go and most of the time I go into details. So with the QA, I test everything as much as I and I go drill down to the very deep level, technical level, ah, most of the time…………….. So I test all of these, while again here that's different it's a audit high level audit."

The respondent describes the process of IT governance. Even though ITG normally takes an overall, high level view, it does go into details dividing the IS system into different sections. The questions that the auditor uses are different from the ones in the model database as the questions derived using GQM are quantitatively oriented while here in the case of IT audit, it is compliance oriented:

"Even looking at the whether the organisation has, has established an IT governance process, security plan, do they include stakeholders, how do they communicate the findings to different people. When they set the plan, what kind of mechanisms they have to assure that they are sticking to the plan of the business? All the IS systems are all aligned? And do they have a risk assessment methodology? Now that's the overall, the high level then we go to the application level into different areas – the .. say project management, change management, ahm…. security, capacity management, even eh, even end user application. So this I break that into 6, 7 areas and within each area there are number of controls, mostly derived from COBIT because you know COBIT is an audit framework initially and it evolved to become and IT governance …"

Commenting on the purpose of this IT audit exercise, and how COBIT is applied in the audit program the respondent states:

"I will check whether these are aligned with COBIT 4.1 and how can we improve that, may be as some or check the security ones whether they are aligned with 27001 or maybe I go with change management or project management or helpdesk to eh, fit the item methodology for example, because for me the long term for me I think you know this audit, IS audit is about how do you enable the organisation or assuring the organisation that they are, they have the right IS system, IS systems that has mechanisms to align business perspectives into the IT; the technology the technology that they are using right? This is the purpose of IT governance."

Regarding the methodology of IS audit, the respondent scans the IT systems to check whether they have mechanisms in place to ensure that the IS technologies are utilized to achieve the IT goals and ultimately the business goals:

*"yes and and so the what's we need to do in here is I'm an IS auditor, I am going to check the IS systems to assure do they have these mechanisms? To these mechanisms to learn the business perspectives and how does they project that on the technologies that they are using so that they utilised the technologies to achieve their objectives, which is basically meeting the business perspectives. Now in that some of the mechanisms you need to have some processes, **yeah**. And other ones you need to have an operational level where you need to educate the staff, business, how they communicate to each other, how often they meet, how do they regulate their... how do they organise.. what do you call the meetings, their reporting, what level of information they need to convey - upwards or downwards **right**. So this all within the IS systems, and I think depends on what you call I think this is a IS governance **IS governance,** because you know the governance you need to map, you need to have the top view and look down to the down bottom nitty-gritty whether they are doing that they are supposed to do. So I am not the - of course in the middle of the .... to go into the... what you call the level of ah, sometimes how are you going to upgrade the server x and y? But that's if I*

educate the unit network manager to define a procedure on how to upgrade a particular server and I advise the manager how to train his staff, how to follow how and what to do if there is an exception and so on, and the kind of reporting; then I'd advise the manager or of that manager the upper level manager, how do they oversee how do they check through reporting, through meetings, through different available mechanisms; with that you have an ongoing process of conveying… the receiving the business perspectives or goals, conveying that into technical terms to technical people and getting a feedback from them, getting feedback from them, on what they are doing, whether they are doing according to the plan and you always check the two directions - Are they going according to the business goals, are they going according to the IS strategic plan where I want to be etc. It has to be an ongoing process, definitely considering business dynamics, change in technologies and other aspects for any organisation that would have………………….. over etc, etc. So that's how I do the audit…."

Since the above is not an evaluation of the model, there are no issues, evaluation or suggestions, but rather a description of the IS audit methodology. Hence the summary of this is given in the table below.

Table 4.48: Table showing the summary of the theme 'current IT audit governance and control model' for NZ 3

Description of IS audit	• Like the GQM method, the respondent uses objectives and a set of questions related to the objectives for the IS audit process • These are further divided into different areas where COBIT is applied • This is an ongoing process with a feedback loop where corrective procedures are applied if found lacking • Both QA and IS audit are similar except the fact that while IT Audit goes into details, QA go into the finer details • The audit process is more of compliance in nature than measurement

4.2.2.3.2 Contextual layer

According to the IT consultant, developing a set of questions for IS audit is one of the initial steps in the process. This is to ensure that the target IS area or domain covered by the questions are relevant to IS audit and it helps o priorotise the questions. This can also be termed as 'contextual layer; because these questions serves as a qualifier for further next level questions:

*"How relevant to the question to the organisation, because you have a set of questions right? for each objective, not all of then are going to be applicable to everywhere right? But those are the most likely, all the questions one needs to ask. **Yeah.** Now depends on the context the auditor would decide whether this question is relevant or not. That's why you are ticking which is a good thing. So may be within that, now as an auditor OK I check I look at if its relevant I'll tick it I'll choose 5 -6 questions out of the set. Now may be within these 5 – 6 questions I think the first three are the highest priority, the rest are you know come afterwards that's OK to ask them its ok to know about what the organisation is doing in this regard but they are not important as much as those three. I would need to ask more questions about the first three questions, this three etc, etc."*

The respondent have already discussed about two layers of questions namely the first layer which is contextual and qualifying and a detailed set of questions following this layer as this provides some sort of guidance to the auditor. Also another option is assigning a weight on the questions as different questions have different levels of importance. This is a case of concept of contextual layer and prioritising:

*"If you want to detail it or, or well we agreed it gives some kind of guidance for these questions or metrics but and you're giving an option to choose which applicable questions from the set of questions. And then I think, it would be good to weigh the whole question as the question is more important. **So which questions is more important** So may be I think maybe I'm trying just to think of a way how you should whether you want put that weight on the questions or on the metrics. I guess it's a good area to think about it."*

Table 4.49: Table showing the summary of the theme 'contextual layer' for NZ 3

Issues	• The current model does not have a contextual layer of qualifying questions to find out which all areas are relevant for the purpose of IS audit (Implied) • The questions are having equal weightage
Evaluation	• Similar to the model, the respondent uses a set of objective and questions to do the IS audit exercise
Suggestions	• There is a need to add another layer called a contextual layer of questions (Implied) • The questions need to be prioritised

4.2.2.3.3 Benchmarking

This is an unexpected common topic that was given by all the four respondents with relatively equal weightage. The respondent would certainly prefer to have a benchmark to judge the level of each control objective or goal and quantifying these using metrics gives an objective criterion to judge:

> *"Can we say that, just having metrics certainly its a good thing, and eh because it gives a guidance of I'm an auditor to have some sort of benchmark I could, judge the level of the, what you call, to judge how far the objectives have been met and instead of having , and I think that would reduce the subjectivity and instead of thinking I'm not…………..this client is half way and the other client you know is less or more, but they might not be. So I think the more metrics I derive, derived, and the more accurate are they to reality. It helps to judge you know how far or close to the objective rather than, you know aligned to the objective rather then thinking on applying. That's what I think."*

The respondent prefer to attach CMMI to the model as a criteria for benchmarking and advises the researcher to change the scale from 1 - 5 to 0 - 5 to comply with the COBIT standard:

> *"Definitely (attach CMMI to the model), because certainly, firstly COBIT is based on CMM and CMM is an international, it has become, you know widely used and it is, well I think even for you, you kind of chosen this scale based on CMM because you use 1-5, but COBIT, ISACA use 0-5. **0-5 you can change it.** Yeah, you can change it, but I would say myself if you trying to think of promoting this, for to be used by auditors and you hope that you would be marketed by ISACA people at least if ISACA blesses this, then I would say to use whatever they have CMM scales you know 0-5 preferably use some of their you know, terms and so on so that I think from my point of view it would be easier, easily accepted by them. It would be like something to add value to their … you know, what they are doing and I think.."*

The respondent would also like to incorporate the relevant industry benchmark value into the model for comparison:

"OK, so similar to the CMMI? That I think would be a good thing to have certainly. Yeah I think it would be more…"

Table 4.50: Table showing the summary of the theme 'benchmarking' for NZ 3

Issues	- The current model does not have the facility to benchmark - The model uses a five point scale rating as opposed to the six scale used by COBIT for their CMMI
Evaluation	The concept of using metrics gives objectivity to the auditor relative to the industry
Suggestions	- There is a need to add relevant standards and values for benchmarking to the model - The five point scale rating system should be changed to six to correlate with the COBIT CMMI model

4.2.2.3.4 Auditing perspective

The questions generated using the GQM model is similar to the questions IT auditors generate to undertake the audit process. When asked whether the model is a proper method to generate these types of audit questions the respondent replied that:

"But surely people have developed – like at the moment I am using a same set of questions ah, I mean, set of objectives that I would go and verify the findings with their, with different clients, and I reuse some, some similar questions some other questions I would devise from - depends on their environment."

Here the respondent have commented on the similarity of this tool with the auditing method used by him. Subsequently to the question whether he uses a similar method (COBIT-GQM) to generate the questions for his professional audit of clients, he replied in the affirmative with the exception that he uses an Yes/No perspective and a low, medium, high scale, but not a 1 to 5 scale. :

"Yes but I do not really… ahm, say for me I would say OK this is.. the, there is no risk, the risk is low, medium high. There is no risk. The objective… their controls are effective just like that…..effective, ineffective all right, black or white…."

Regarding the use of a 5 point scale in lieu of the compliance method of auditing, the respondent is not sure which one is better:

"I am not sure to give the right answer. It's good to have a scale because at the moment what I use is effective or ineffective right? the risk is low medium high. That's the, I ... mean, effective ineffective... well that is black and white but there is a grey area in between. **In between yeah, yeah***. But again I can't answer………. I personally would feel I would better say, have a scale, but maybe at the end of the day they want to say well you want to reach a conclusion – is it effective or ineffective. So that's why I am not sure."*

Subsequent to this the respondent pointed out the two categories of audit namely external and internal audit:

"and again you get to differentiate between external audit and internal audit. Internal audit - they go into a fine detail, because they have more time for the organisation and ..."

When asked whether the model is suitable for external or internal audit, the responded replied in the affirmative but gave reservations regarding the adequacy of the model's ability to go into details for specific audits:

"I think preferably you use for both, **both OK, yeah.** *Plus eh, but its not for specific audit.* **OK,** *you know because sometimes you have a security audit. Security audit you need to go into a lot more detail, the way it is, all right?"*

Table 4.51: Table showing the summary of the theme 'auditing perspective for NZ 3

Issues	• A minor issue in the model is that currently the users does not have the facility to answer it using extremes Eg: Yes/No, effective/ineffective, high/medium/ low (the compliance method)
Evaluation	• The respondent uses a similar set of questions (used in the application that had been developed by the researcher using the GQM method). • A somewhat similar method is used to develop the questions used for IT audit • The model can be used for both internal and external auditing subject to some modifications
Suggestions	• There is a need to go into finer details for using this model for internal auditing for specific systems • Apart from the five point scale system of scoring, it would be advisable to incorporate a compliance method of scoring to the model that would suffice the auditing audience

4.2.2.3.5 Functionality

As an application, the model is still in a very basic stage and lot of rework is to be done to be used by auditors:

> *"I mean as an application you know, if you are talking about the application how to improve the application in terms of QA there are so many things I could remember just the ahm, but I don't think you are after that at this stage. You want the core functionality"*

One feature requested is the need to customise the goals, questions and metrics where there need to be a provision to add these by the user:

> *"I think as an… as a module if it is developed as an application, you give the auditor a chance to add more in terms of .. to customise it, so that I add more questions. For example the module we use here is that you know, COBIT is not perfect so they add some questions in certain areas from their experience….. not from COBIT.   OK, **not from COBIT yeah**. So be their questions and objective, the objective control one needs to add into that particular area or other metrics might be I need to add from my experience. While at the moment there are a set of questions, set of controls, set of questions and metrics for each set objective. But that's I mean as an initial - it is a good step, but if you develop in that way so that people can add – **Add, modify delete that option should be there, all right**. To be able to customise that……..again that would be a very advanced you know… some stage for people knowledge so that they could utilise it."*

The main point is the lack of flexibility in adding, deleting, modifying controls, questions, metrics and the best way to make it more usable is to add more features.

Table 4.52: Table showing the summary of the theme 'functionality of the model' for NZ 3

Issues	• There is a lack of flexibility as the users currently cannot add or modify goals, questions and metrics
Evaluation	• The application is still in the very basic form with few functionalities and lot of rework is to be done to be used by auditors
Suggestions	• A provision to add and modify the goals, questions and metrics is needed to be added on to the application

Thus there is a need to add more functions:

> *"if you when you say, you refine it and you add more touches add more features and so on you make it like a more usable module."*

4.2.2.3.6 Other standards

Apart from the provision of adding goals, questions and metrics, the users should also be given the choice to choose the controls from relevant standards, and not concentrating solely on COBIT if it is to be of any use to an auditor:

> *"Maybe you can (the provision of adding goals, questions and metrics) that this is from COSO, the other one ITIL may be and.."*

Since COBIT is a generic model, there is a need to incorporate relevant standards into the model. So a blended approach is preferable:

> *"Because COBIT itself ahm, you know is a generic one. **Generic one yeah yeah yeah**. So if you want to really. So if you want to have this to be sufficient for the security audit, you would surely need to incorporate at least ISO 27001 or 27002 attached to it, yeah… because, that will allow you to go into more detail. And then there are different, in now a days other standards or compliance you know, for example PCI is gaining popularity. PCI is payment card industry, organisation that's have online payment using credit card they are trying to be……………complied to with this type of standard.*

When the respondent proposed to add other standards, he stated that it should be incorporated in such a way that not only users can have the choice to choose any one or a mix of standards, but also they should be able to work with one standard within another standard with option to add and modify:

> *"Oh yes, it would be a lot better but certainly as I said, that's going to be an application package not only on COBIT based on COBIT. You have other, however you could maybe develop it in a way to incorporate all of this. Say if only COBIT overall may be just an overall audit, a COBIT plus some customisation where I could add few more questions. If I want to say an overall audit plus specific eh, detailed audit for example security audit I would choose 27001 and 27002. So you keep the generic COBIT one embedded within 27001 so that one security auditor or lets say generic*

auditor, you see the same thing but when it comes to the security or you can go into more detail.

Table 4.53: Table showing the summary of the theme 'other standards' for NZ 3

Issues	• The model is based on COBIT and thus the users cannot work with other controls
Evaluation	• The model is rigid and based only on COBIT
Suggestions	• There needs to be provision to add more standards so that users can choose one or a blend of two or three standards • The users should be given the choice to modify the goals, objectives of these standards. • There should be a provision to work with one standards within another standard

4.2.2.3.7 Similar tool or method

The user uses a similar set of questions developed using his own audit methodology. Hence this model has some similarity with the method auditors use to audit IS systems.

> *"But surely people have developed – like at the moment I am using a same set of questions ah, I mean, set of objectives that I would go and verify the findings with their, with different clients, and I reuse some, some similar questions   some other questions I would devise from - depends on their environment."*

The user being an experienced auditor has seen a similar automated application of COBIT that can produce a report and even do risk management and does incorporate the CMM, but cannot generate metrics:

> *"From my memory long, long time ago back in the year 2002, 2001 I had a.. I tried this ... I got a trial copy from Methodwork you know Methodwork is huge company that basically automate COBIT **OK right.** You can generate report at the end. Maybe it is worth looking at it. That's an application developed by a company and you can even do risk management, eh, but it doesn't have metrics **it doesn't have metrics** it only has .... they use the CMM. They use the CMM into the objective................... It's the CMM to my memory for the objectives."*

The methodology of the application is similar to the first stage of the researcher's model (where you have goals, then questions around these goals) minus the metrics generation method:

> *"It's hard to remember. I think, you know, for the each objective if you have the areas and then the areas that it covers. **Yeah the DCOs**. Yeah so, maybe they ask question around each DCO possibly, I think to be honest. But I remember in the end……….. similar thing you said this and gives it an indication of, if that's this level or that level……… how you say…. but again all this on CMM at the end it generates reports."*

Thus the basic methodology of IS audit is same as the model and the model has added the metrics generation ability.

Table 4.54: Table showing the summary of the theme 'similar tool or method' for NZ 3

Issues	• NA
Evaluation	• The questions in the model is similar to the IS audit questions, but generated in a different manner
	• The model has some similarity with an automated COBIT application minus the metrics generation capability. While the application (Methodworks) used CMMI of COBIT the researcher does not use CMMI into the model
Suggestions	• There may be an inherent need to incorporate CMMI into the researchers model

4.2.2.3.8 Ranking

Currently all the questions and metrics are given equal weightage, but regarding the use of the scale the user is satisfied. Hence the need to prioritize by giving an option to the user to add a weight to the question:

> *"if you want to prioritize may be you can add a field what do you say the weight of this question, but the weight, the rate you are weighing all the metrics are OK. I think it's OK to have the same scale 1-5. I think it is better to have a one uniform scale, but you could, may be add the weight of the question ……………Yeah, I am not sure at this stage, but it is better to give an option if they want to use it they can use it. Certainly, If there is a need to prioritize, but I mean out, yourself, I mean you trying to cover the security area. You have say 10 questions and you think well not all relevant. Seven are*

of them are important, but you think some of them are more important than

the other ones.”

For prioritising, the questions can also be explained, contextualised and detailed so that the user is in a better position to weight the questions. The weight can be assigned to questions or metrics or both:

> *“If you want to detail it or, or well we agreed it gives some kind of guidance for these questions or metrics but and you’re giving an option to choose which applicable questions from the set of questions. And then I think, it would be good to weigh the whole question as the question is more important.* ***So which questions is more important*** *So may be I think maybe I’m trying just to think of a way how you should whether you want put that weight on the questions or on the metrics. I guess it’s a good area to think about it.*

Table 4.55: Table showing the summary of the theme ‘ranking of the questions and/or metrics’ for NZ 3

Issues	• Currently all the questions and metrics are given equal weightage
Evaluation	• The respondent is satisfied regarding the use of a scale but not the equal weightage given to the questions and metrics
Suggestions	• A provision should be added to the application whereby the users can input a weight to the respective questions and/or metrics • The questions and metrics should be contextualized and explained so that the users can know how relevant are these questions and metrics to the organisation or context

4.2.2.3.9 Clarification of goals and questions

The goals, questions and metrics developed and used currently in the application needs to be explained to the context, as a mere number 1 to 5 may not be objective enough for the users to select the appropriate number:

> *“Because as an application how it looks very ah I mean (long pause) when you show the metrics, all the metrics you showing that 1 to 5* ***yeah,*** *which is rating scale, that you are not giving an example of how this objective is met or not.* ***OK.*** *If you see what I mean and that I think is not easy.”*

This means that the metrics should be explained in a sentence or two to make each of the scores clear and accurate: “That’s what I think it’s more accurate.” The respondent explains that the purpose of this model is to quantify and reduce the

subjectivity, but the scores 1 to 5 are highly subjective without any guideline. Hence the whole objective of this model is lost if the scores are not explained:

"Again and the, you why are you ahm, quantifying the....I mean why do you designing the metrics in the first place? You try to quantify it as much as possible right? And, and if you leave that again to who others conducting the review or the audit and then you, you keep it in the same loop. I think you are not achieving the objective of the whole process of quantifying I think that's my, my idea."

From an auditors perspective, if there is an explanation of each score or question, then it provides easy guidance for auditing:

"Say for example I have some similar things, similar I have number of controls and I need to check with the clients whether they are for certain areas do they, do they, are they achieving this what do they have in place. So I have some guidelines I have some questions regarding that you know, what are, how can I, what are the areas I need to ask or check about, that would give me answers for - you know I mean.."

Table 4.56: Table showing the summary of the theme 'clarification of goals and questions' for NZ 3

Issues	• Currently all the questions and metrics are given equal weightage
Evaluation	• The respondent is satisfied regarding the use of a scale but not the equal weightage given to the questions and metrics
Suggestions	• A provision should be added to the application whereby the users can input a weight to the respective questions and/or metrics • The questions and metrics should be contextualized and explained so that the users can know how relevant are these questions and metrics to the organisation or context

4.2.2.3.10 Alignment of the model

Regarding the alignment of the model, whether the metrics are linked to the questions and the questions to the control objective the respondent states:

"Can we say that, just having metrics certainly its a good thing, and eh because it gives a guidance of ……………………so I think the more metrics I derive, derived, and the more accurate are they to reality. It helps to judge you know how far or close to the objective rather than, you know aligned to the objective rather than thinking on applying. That's what I think…."

According to the respondent accuracy is directly proportional to the amount of metrics generated as it helps in aligning the metrics to the goal.

Table 4.57: Table showing the summary of the theme 'alignment of the model' for NZ 3

Issues	• NA
Evaluation	• The more metrics generated the more it helps to accurately audit IS systems
Suggestions	• NA

4.2.2.3.11 Model evaluation

The model being basic needs a lot of additions and modifications to be done to be used in a practical manner:

> *"Ahm, to be honest I think it has some, some certainly good things good things in it, but I think its need a bit of more work. Not all, I don't mean how the module or the functionality etc. But even as it needs to be revised for the…"*

The method used in the model to audit IS systems using metrics generated scientifically is a better way as it provides a methodology to derive questions/metrics and ensures consistency:

> *"Yeah, I think this is a better way certainly. Again I think you know, certainly having a model like this, ah, certainly it's a lot better, for many reasons among them, is to reduce the subjectivity you know. It will not be a replacement for an auditor, no it will not be a replacement, **OK**, but it again provides a methodology and consistency along, you know when meet definite lines."*

Table 4.58: Table showing the summary of the theme 'model evaluation' for NZ 3

Issues	• NA
Evaluation	• The model being basic needs a lot of additions and modifications to be done to be used in a practical manner • The method used in the model to audit IS systems using metrics generated scientifically is a better way as it provides a methodology to derive questions/metrics and ensures consistency
Suggestions	• NA

4.2.2.3.12 COBIT in the model

For the model to be of use, it is not appropriate to use only COBIT, as other standards are required since organisations use a blended approach:

*"Because COBIT itself ahm, you know is a generic one. **Generic one yeah yeah yeah**. So if you want to really, so if you want to have this to be sufficient for the security audit, you would surely need to incorporate at least ISO 27001 or 27002 attached to it, yeah, because, that will allow you to go into more detail. And then there are different, in now a days other standards or compliance, you know, for example PCI is gaining popularity. PCI, is payment card industry, organisation that's have online payment using credit card they are trying to be………..complied to with this type of standard."*

Table 4.59: Table showing the summary of the theme 'COBIT in the model' for NZ 3

Issues	• NA
Evaluation	• The use of COBIT only in the model makes it very narrow focussed
Suggestions	• There is a need to incorporate more standards as some standards are generic (COBIT) while others are specific. So a blended approach is preferable like as told by NZ 2.

4.2.2.3.13 Commercializing the model

The respondent stated that the model can be commercialised:

*"At some stage, you decide later on, I don't know you choose to commercialise it you establish your market. You have already all the market over there. You put just small charge on that it pays off. **Yeah.** And don't forget me (laughs). That's how many of the application you know, evolve along time. I think you are doing the right thing, the session, you know that's the basis."*

Table 4.60: Table showing the summary of the theme 'commercialising the model' NZ 3

Issues	• NA
Evaluation	• The model can be commercialised subject to modifications as it is too basic
Suggestions	• The suggestions provided by all the respondents need to be incorporated before it is commercialized

4.2.2.3.14 Input to the model

Regarding providing input to the model the respondent states that the auditor should decide on the questions and metrics for users to input as "the auditor should be" the person to decide.

4.2.2.4   SG 1 (Stage -2)

Table 4.61: Table showing the extend of coverage of the topic for SG 1

	Nodes level 2	References	Coverage
1	Contextual layer	13	16.37%
2	Current IT audit, governance, control models	6	12.72%
3	COBIT in the model	7	8.59%
4	Auditing perspective	9	8.45%
5	Functionality	5	5.26%
6	GQM	2	5.01%
7	Clarification of goals, questions and metrics	5	4.89%
8	Scoring system	3	4.07%
9	Bench marking	4	3.93%
10	Input to the model	2	3.47%
11	CO or DCO?	3	3.46%
12	Compliance and measurement perspective	1	1.42%
13	Model evaluation	3	1.18%
14	Similar tool or method	1	1.07%
15	Alignment of the model	1	0.81%
16	Ranking	1	0.38%
17	Context of the goals, questions and metrics*	See 1	See 1
	Commercializing the model	0	0
	Alignment and understanding with COBIT	0	0
	Application of the model	0	0
	Automation	0	0
	Tracking progress of a goal	0	0
	Other standards		

* Discussed in great depth in the 'contextual layer'
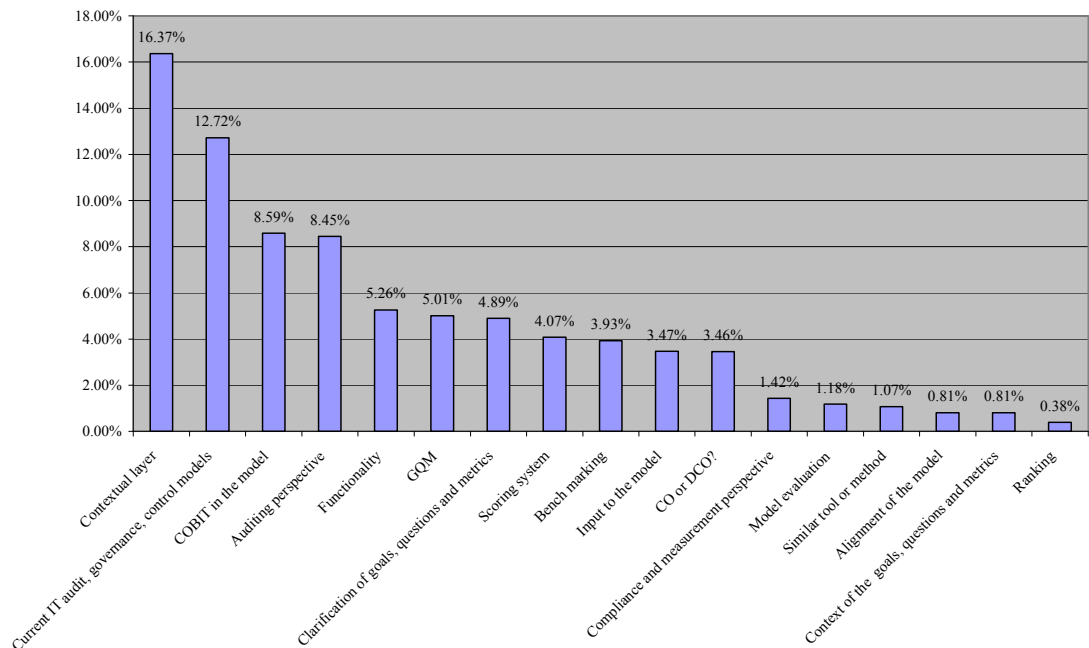
Figure 4.7 Chart giving a graphical extent of coverage of the node for SG 1

Table 4.62: Table showing the number of times the topic have been cited by SG 1

	Nodes level 2	References	Coverage
1	Contextual layer	13	16.37%
2	Auditing perspective	9	8.45%
3	COBIT in the model	7	8.59%
4	Current IT audit, governance, control models	6	12.72%
5	Functionality	5	5.26%
6	Clarification of goals, questions and metrics	5	4.89%
7	Bench marking	4	3.93%
8	Scoring system	3	4.07%
9	CO or DCO?	3	3.46%
10	Model evaluation	3	1.18%
11	GQM	2	5.01%
12	Input to the model	2	3.47%
13	Compliance and measurement perspective	1	1.42%
14	Similar tool or method	1	1.07%
15	Alignment of the model	1	0.81%
16	Ranking	1	0.38%
17	Context of the goals, questions and metrics*	See 1	See 1
	Commercializing the model	0	0
	Alignment and understanding with COBIT	0	0
	Application of the model	0	0
	Automation	0	0
	Tracking progress of a goal	0	0
	Other standards	0	0

* Discussed in great depth in the 'contextual layer'
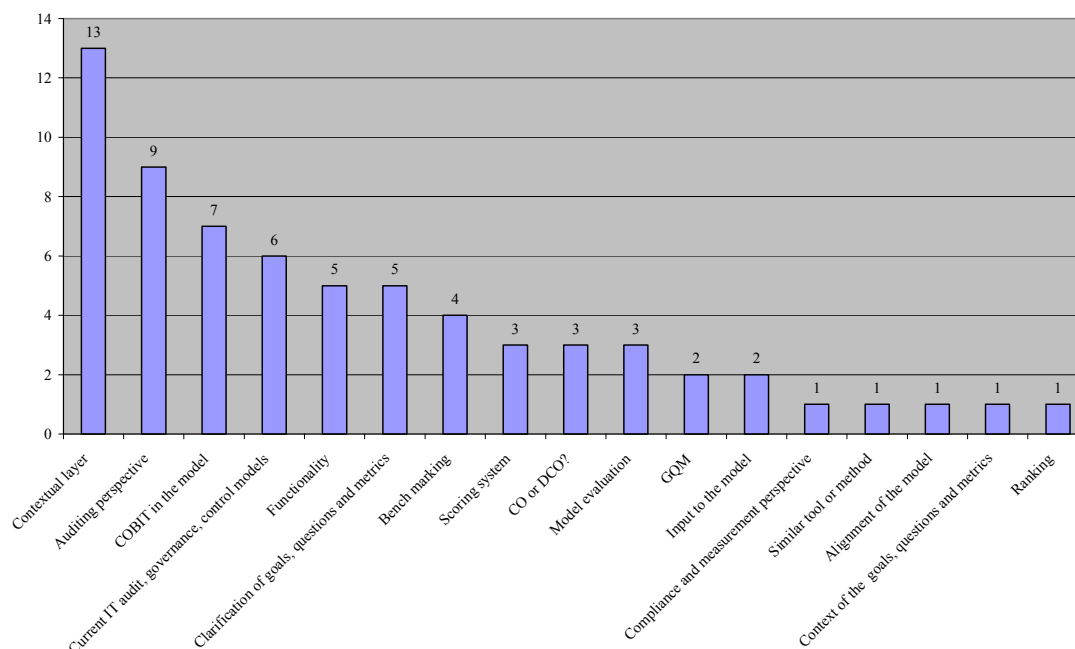
Figure 4.8: Chart giving a visual account of the number of times a particular theme has been cited during the discussion with SG 1

The most significant and unexpected topic that had emerged is the 'contextual layer' followed by the discussion on 'current IT audit, governance, and control models'.

4.2.2.4.1 Contextual layer

Since this being a major topic (unexpected theme) and is a relevant step in the IS audit process, this is explained in much detail here. This is a topic that had been given much importance, has been discussed in much detail and was the first issue cited by the respondent. To make this point clear to the researcher, this issue has been illustrated by the respondent to the researcher by drawing on the board. According to him a layer (a set of qualifying audit questions) is missing if this is to be viewed as an audit model:

> *"Probably what is missing is another layer, I don't know what you call it all right? - the environmental factors **ok** -- all right – that have an impact on how the measurement results is to be interpreted........................ So when we mean 'measure', all right? We would measure taking into account which kind of environmental factors, those kind of environmental factors. In fact I don't know how the model can incorporate that kind of expert judgement in this type of question. If this organisation is in this industry and the server - is it for - what? (purpose), then this set of questions apply. OK. In this is a kind of topography for instance, which I think - a very strong control may not apply ......I say, we may do a measurement for a particular entity…."*

The term 'contextual layer' has been coined by the researcher as the suggested term 'environmental factors' and 'expert system' may be very broad and generic. According to the respondent any result or report generated by the model without a context is not meaningful and there is a need to 'separate' or make the results more meaningful using a context:

> *"And we find that in this particular model if you could help separate that statement it would be useful, and taking into a/c certain environmental factors of consideration… ……... . So I think the most useful, and perhaps can be quite difficult is the interpretation of the result that comes out of the model. So I think some kind of expert system is needed, is needed to be embedded somewhere, to bring that to a conclusion. That is my idea."*

The score generated by the model does not have meaning without the context:

> *"The one that is difficult to expand into a further set of questions, but to the user would think of the perspective to decide and what score to put. For you I'll give you a score of 3; for you at the same kind of questions I'll give a score of 4.* ***So depending on*** *.. I mean it's a contradiction……no? both are using the cryptography, using the same thing and still you seem to penalise the other one because of the context. How you bring that context into place is a bit challenging."*

The model should help the user to interpret the scores using a contextual layer as without the context it would be difficult to give a right score.

> *"So the model should interpret ….. to help him, all right? Help him … help him to initiate thinking in this particular process. So I think, I would not say that it is a weakness, but I would say that something that we may have …. need to be added…. an additional layer can be embedded into it, …… into account."*

Two things are implied here. The first is that there needs to be a layer - a contextual environmental layer where a mandatory set of questions needs to be answered before you actually go and answer the questions in the model. These set of mandatory questions reveal the criteria or need whether to go further down and pick the question/questions in the metrics to answer. Secondly the respondents have mentioned that this model is similar to audit model and then in this statement he mentions that this is not an audit model. So he implies that audit models should have this layer -a set of mandatory questions that act as a gatekeeper. So he suggest a modification of the architecture where this layer can be added so that a set of questions acts as a layer where if it is answered in the affirmative then only a set of questions in the database that related to this particular context is shown or pops up:

> *"In our work as auditors we normally are required to answer this line of questions, questions which is mandatory that have to be answered regardless of the industry …. like a minimum benchmark, and if they don't mean that they are going to ask further questions, you will see, in the measurement. So, but that is not an audit model or anything, this audit model is like all right?*

*,but this one, for this look at they way these questions. Even in audit, to complete the whole question and give it a particular barrier; in practice, I think what the practicality of that - we want it to like stop in goal in kind of decision. This question is answered – it is no good, so that question is irrelevant, **oh, right.** Ah, all right, you don't reflect that - in the illustration, (goes through the questions in the model) the fifth question whether you have a business entity, planning ..... more development, to talk about effectiveness of the .... the, the failure, **ah yeah** to the point, you could do the measurement. No need to ... go on to eh ... as a request. So it .... except in modified such that, all right? If I did answered to that type of questions that are no longer relevant. So may be in terms of architecture or hierarchical model which stops if you don't answer, you don't need to go into the details, don't need to go into the details, **into like metrics,** questions whether to go down, from one questions to another.."*

The contextual layer has a set of questions and depending on the questions it can be multilayered so that for every layer there is a set of questions:

*"This is for ... for every layer ... **so for every layer there is a set of questions?** Something, most likely every level **The questions are at this level** Because for this set of questions, then you will decide whether you need further questions, **further questions, based on this. Oh!** In other words, if they say No, then no longer be expected the user to answer - not relevant, because those questions .... this questions may be linked, for instance on architecture construction, all right? This means, question may be linked to parameters all right? So depending on the ..."*

This above mentioned layer is missing in the model. The layer consists of qualifying questions where the user needs to input values/answers and depending on these answers a set of questions are selected:

*"Ah, this layer is missing **(OK Now I got it)** and this is where ... the ..a user would like to be a input a set of statements **statements**, into the..... into this system to support some of this particular area."*

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The respondent gives some examples of questions that characterise the context into the layer:

*"may be a set of the questions in terms of the room, the placement of the room, **even that one**, placement of the room, then, construction of the room, **that means the server room,** ah, the server room where you locate this thing, and the entrance to the room, through the use of combination lock or simple lock, then whether there is any CCTV, all right? Whether you, support that question, simply another set of question. All these series of questions would be influenced by actual things like the question, and this is very important right? What is the exact server used for? When where you want to ask the questions for? And this sort of questions above ……. What is the purpose for the user? What kind of detailed functions are in that particular server? Is it meant for mission critical systems of the organisation, where the organisation depends on it to detect core functions and all these set of questions and this server is used for ….. what purpose? Is it for industry? Is it military, education or what? all right? Then we ask certain question to support the - which criteria? How important are the data here is to be protected, from you know confidentiality, ah, how critical is it to be protected from that type of staff, because from this set of questions, and then you'll know how hard the system need to be …….(protected) because we don't want to be overprotected or under protected."*

These responses to these questions determine whether to answer more questions or to stop right there:

*"Yes/no/yes/no, all right? If it is yes, we do this questions, and if it is a no, we do another set of questions. So logically in the big auditor system all right, we always ask these kind of set questions. There is always a condition that, we call it a qualifier, all right? If the server contains in this group, then this questions apply. This question will only be asked if we… (condition) and this one is where the layer … environmental .. that's the word, yeah? The environmental factors, that influence the decision. **OK.** The set of questions that is influenced by the context…. OK? **The context, w**here people, because*

ultimately, all right, we have the metrics - most challenging is the context
where it applies,

Framing these set of questions in the contextual layer requires the opinion of experts in that field:

"because in order to, design, you really have to get the inputs from the experts as to how…"

Table 4.63: The summary of the theme 'contextual layer' for SG 1

Issues	• A layer is missing from the model
	• This affects the way results are interpreted
	• The given questions and metrics does not provide any context
Evaluation	• The model cannot be used as such for IS audit
	• The model need further improvements to use for IS audit
Suggestions	• There is a need to add a layer to the model called the 'contextual layer' that provides the context for asking the questions and assigning values for the metrics (This contextual layer is a set of qualifying questions that determines whether there is any need to go further and answer the questions and metrics)
	• This layer can have many layers depending on the relevance and context

4.2.2.4.2 Current IT audit, governance, control models

They undertake three types of auditing namely financial audit, economic audit and program audit, and all these three overlap with each other:

*"There are only three types of audit, OK? Use financial audit, use the financial statements for control…………We have only what you call the economic audit, the value for money, **OK, yeah**, all right? Ah, audit and all right? And this basically do these financial aspect …. and use of resources……… I'll give you an illustration - economy, efficiency. It (economic audit) doesn't deal with financial issues, **OK**. It deals with utilisation of resources and ……….economic, economically, in other words the best price you call……………………….and then the other audit, all right, because eh.. program audit, all right………"*

Here the respondent explains the audit process undertaken by them in each ministry of the government, where each ministry runs different programs that are audited based on key performance indicators acting as a business goal without any IT component:

*"So you have a set of ministries like ministry of finance, ministry of law, ministry of ……..all right? We have a number of programs, a bunch of programs, all right? For instance, like the ministry of law there could be a program for land management, all right? There could be a program for copyrights and patents, all right? So a number of programs, and for each program, we have what we call….have is key performance indicators, and each ministry we have the performance indicators. **Oh the KPI,** how well the land management is being done. So this actually is business goals and business, without the IT, all right?,*

The concept of IT audit is only a component of the program audit. This IT audit can be in any of the three audits (financial, economic and program) and is not conducted separately:

*"So this concept of IT audit actually, all right, is a component, where the programs of computerisation of IT audit would apply, where the areas that you look at, for the manage of money for procurement of IT equipment of software then apply; where the special financial statement of ….special like completeness of data, authorisation, all right? I mean, in other words, IT audit, all right? may be in any of these three areas. It is not an audit, **a separate audit**, a separate audit on its own right. It is basically like a supporting or a component that wanting to address the cost of doing this audit. In other words there could be audit special 2 to address IT issues because the organisation, the aim of the IT is to starting to do with IT, whereby IT is to be addressed, you said IT audit comes in. So I just said our ... I just said in particular these structures, and I think a close example of how IT audit applies in the context of financial is SOX (Sarbanes Oxley Act). all right? In SOX, we have financial statement objectives, **oh, transparency**, ah transparency whatever it is all right? Then we have the control, IT control objectives which are relevant with that particular issue, status. So it links."*

COBIT is applied in the context of these audits and they select areas of relevance of COBIT to fit their audit needs:

*"So coming back to the question of how we apply COBIT, we apply COBIT in the context of these audits, and I think the quick challenge is to fit in COBIT **into this**, into this, and we have actually in the course of our audit tried to selectively use which is relevant, which is not relevant….."*

The use of COBIT in auditing comes way down the audit process where IT is used since IT regarded as a support resource. This is another indication that instead of using COBIT to start the model it is better to start with the business goals, IT goals, broad KPI, contextual layer, etc as is given in the figure. :

*"go down, trickle down, all right? Where IT is used or where the onus is on IT to achieve its business objectives or in order to achieve the KPI/goals. So that's all we do.. start the IT goals, objectives, **IT service support,** for supporting the functions, it's a business driver, it's not the …. that's it. It's not the main thing or **So you don't start with COBIT controlling everything**. Yeah, and obviously when we use the financial program, the COBIT will come only when it has to, ……………………..So in fact we don't particularly address the information systems ….. We need to link the other systems ultimately with the business goals. So really we start with the higher level business goal. It is irrelevant to us to refer to COBIT."*

Regarding the effectiveness of COBIT in helping these three audit areas the respondent replied:

*"To think right, I think that we use COBIT to develop our audit program. **OK.** How do you know when challenged that an audit programs is adequate like this or comprehensive enough, lets say we use COBIT, because COBIT, it address all activities or aspects."*

So wherever IT is involved, they use COBIT, and from the COBIT set of products they use the high level control objectives:

"Then you put in, so ultimately, all right? This (COBIT) is not the ultimate……………. we are only using the COBIT control objectives, for the purpose of this particular project and the rest actually, into, all right?"

Table 4.64: Table showing the summary of the theme 'current IT audit, governance and control models' for SG 1

Description of IS audit	- They have three types of audit namely financial audit, economic audit (value for money) and program audit (for specific programs) - These three audits overlap with each other - IS audit can be any part of the three audit where there are IT resources used to support the organizational functions - Whenever there is IS audit COBIT comes into play - They don't have an independent IS audit and they don't start the IS audit with COBIT - The use relevant control objectives form COBIT but not the DCOs - COBIT is customised to fit their organizational needs - For them COBIT is comprehensive enough to address all of there is activities - Whenever IS is involved they use COBIT

4.2.2.4.3 COBIT in the model

Since there is considerable element of overlap between this theme and the previous theme much of these have already been discussed in the second half of the previous theme.

As discussed earlier they don't start the IT audit with COBIT but rather it is only a part of the larger audit:

> *"So the starting point really is not the COBIT control objectives, it is actually something different, something different and from that people would select the control objectives which is relevant to the, to the, business goals."*

4.2.2.4.4 Auditing perspective

In this section the respondent discuss the perspective of the auditors regarding IT auditing. According to him auditors normally like to work with just two extremes that is - adequate or not adequate and there is hardly any in between areas:

> *"There are a number of control objectives, **OK** ah, detailed control objectives, that has to be achieved, **ok** that has to be processed for that particular goal, but in terms of auditors making a judgement let's say, on security how, of a particular org, it is an expression of opinion of what is adequate, what is not adequate………………….. We auditors normally would least require to make a judgement; based on that, what is your conclusion? Is it adequate; is it ok,*

Regarding the utility of this model by the auditors, it should fit in with their audit perspective and the model should not force them to overdo the process, implying that currently it does not fit in:

> *"for auditors, if they want to use this model they have to see where it fits in, to its methodology, its where ... sometimes it is comfortable in doing things, and we don't want to do more than it is necessary .... the minimum to achieve the measurement – to complete work or the assignment of the measurement.*

In the above statement, the respondent questions the need to go deep into the audit process by using the DCO rather than the CO. Hence instead of the DCO the model should use the CO and add the layer of qualifying questions to suit the audit perspective. Moreover the model should not force the auditor to choose among a repository of indicators, questions and metrics:

> *"So generally what tools in the audit methodology, they'll ask direct audit questions, audit questions of the organisation with respect to the business goals, which is also linked to IT goals, the business goals transferred into the IT goals all right….but there are also key performance indicators for each area, and the organisation will have to ... have that kind of a – what's that - performance indicators to establish, for them to monitor or to track. So we do not force any kind of indicators for them. They would have to come up with their performance indicators.* **Right***. And from that one indicators it is translated into, to lower levels indicators and so on. So we want a certain kind of linkage. So the starting point really is not the COBIT control objectives, it is actually something different, something different and from that people would select the control objectives which is relevant to the, to the, business goals."*

The model should reflect the thinking process of the auditors:

> *"I think in the real world it should reflect more of the real world …. of the thinking process of how auditors would look at things, what would they be influenced by."*

Moreover auditors don't have quantitative measures:

"As auditors we don't have this measure like 1 or 5. It's all yes/no…………….

It is a measure of financial statement all right? Yes/no/yes/no, all right? If it

is yes, we do this questions, and if it is a no, we do another set of questions.

Even though from an auditing perspective they rarely measure, the respondent agrees that ultimately they have to come up with some sort of measurement.

"In our audit we rarely measure. As I just said at the start of the problem, is it

necessary? **Is it necessary?** *OK, May be it is necessary because we are*

actually, nearly quantifying, all right? As I mentioned it earlier, what is the

interpretation? Ultimately you have to commit to a yes or no; **yes/no that's**

right, *adequate or not adequate, decision or not decision,* **there is no in**

between, *effective or not effective, because we have to ah …… normally have*

to come up with a kind of measurement."

Auditors also do have a qualifying set of questions (discussed earlier under 'contextual layer') that they use in the auditing process that this model is lacking:

"So logically in the big auditor system all right, we always ask these kind of

set questions. There is always a condition that, we call it a qualifier, all right?

If the server contains in this group, then this questions apply. This question

will only be asked if we…. (satisfy the condition)"

Table 4.65: The summary of coverage of the theme 'auditing perspective' for SG 1

Issues	- The model does not have an audit perspective - Currently there is no provision in the model for giving a compliance answer (like adequate/not adequate, effective/not effective) - Auditors rarely measure - The linkage between the metrics and the goal/key performance indicator is broken due to the missing layer of qualifying questions - The model is forcing the auditors to choose form a set of goals, questions and metrics
Evaluation	The model cannot be used as such for IS audit as it does not reflect the normal audit process of IS auditors
Suggestions	- Add a contextual layer , a set of qualifying questions to the model - The model should do only the necessary steps that is normally done in an audit process and not more than that to make it simple - The model should have the facility where the auditors can add or modify the goals, questions and metrics - The model should have the facility where the auditors can also give a compliance answer - The model should fit in with the auditors needs

4.2.2.4.5 Functionality

There should be feature in the model where the users have the flexibility to add. And modify the goals, questions and metrics which ensure the usability of the model:

*"The system shouldn't/ should not force the person to select one, or questions, or metrics from the system. I think that the system shouldn't force the user to select metrics from the repository of metrics given in the system. **OK, yeah, yeah**. You (the user) select, don't force the user to select your answer (the metrics) for the measurement to compute the score. I think it should allow more .. friendly for the user to look at the metric… I did or relevant or that interest to me (the user), I want to use .. **Select the metrics, modify it, and input,** and input in it, yeah, I think it would be better like this .... In modelling the system"*

Moreover the reports generated by the model should have the feature where it can be aggregated for the use of senior managers. If the model give a report of the DCOs then the model should have the facility to aggregate the scores of all the DCOs for that particular CO:

*"For reporting to high level or further high level board, **yes, high level board,** you know composite in terms of the aggregate of the model, but actually one need to control the details, **the details, OK**, in terms of implementation, or insert, corrected. In fact I do not, I, a composite/aggregate all right? is not very useful. I'd rather that you come out with two or three indicators. In other words you got aggregate, aggregate at the physical layer, DCOs, **the detailed control objective, not more than that.** Medium, average layer, right, more meaningful **More meaningful,** which can be linked."*

Table 4.66: Table showing the summary of coverage of the node 'functionality' for SG1

Issues	• The system currently force the users to select the goals, questions and metrics from the system database • The reporting structure does not cater to different user groups
Evaluation	• The model is rigid
Suggestions	• There should be a facility in the system whereby the users can add/modify the goals, questions and metrics • The model should have different reporting structure to give an aggregate report to high level, normal report of medium level and detailed report to lower level managers

4.2.2.4.6 GQM

This is the only respondent who has given a detailed review of the GQM model and its use in IS auditing. Taking the goal template the respondent suggest to change the terms from its original terminology to something more easily understood by the audit audience:

> "These are the prescriptive meaning? (Looking and evaluating the GQM model template) **Yeah,** I suggest you to change it. **It is better to change it.** OK. Something that is untouched…… by the way from the intent …….. If you can, "quality perspective" very difficult to understand. Look at it all right?"

The respondent suggested simplifying the template to suit the target audience as currently it can be understood by an audit practitioner, but not the normal user. Moreover deriving the questions is the most difficult part according to him:

> Nor rewritten, but find a word – simplify. Simplify or understandable, **then that is more easy**, more friendly, ………………that conceptual, quality perspective (looking at the goal template). It takes very active….. actual people like you ah …. to understand exactly what you need…………………….. For a practitioner all right? exactly what you ….. (they'll understand) ……………………………. So this one actually is the most difficult part, the most difficult part…………"

Regarding the context to be added to the goal template of the GQM model, the respondent suggested to use the term 'program' rather than 'project'

> "because in real life, except we do get audit of a similar program or audit, you don't derive direct benefit by project. **OK.** It is by program **OK,** It is by program. **It's by programs**. And a program is comprise of a number of projects. **It is a higher level** It is interrelated and interdependent. So each project more like eh..like a part of something, like a pack of …………….. So it is a series of projects that really comes in to achieve the results of the program. Very difficult to justify benefits at the project level, but in a customer relation management or financial systems all right? These actually

are projects where the outcome is used by another project. So the indirect

benefit…………is inducted a particular program, rather than a ……"

Table 4.67: Table showing the summary of coverage of the theme 'evaluation of GQM' for SG 1

Issues	• A practitioner or an expert can understand the GQM template and its terms and the guidelines for setting the questions but not the normal users who may use and/or input values to the model
Evaluation	• The GQM template in the model is not easy to comprehend in terms of terminology and structure
Suggestions	• The terms in the goal template of the GQM model should be simplified to suit the general IS audit audience • Some detailed guidelines may be provided in the model for using the templates (Implied)

4.2.2.4.7 Clarification of goals, questions and metrics

The scores provided in the model for the metrics are not meaningful. They are subjective and subject to different interpretations:

> *"So this measurement would come up with a particular quantified figures. So let's say for an organisation that score 3.8, **3.8 yeah**, in a score of 5, in another organisation would score 3.8, similar score, all right? A third organisation the score is 3.2, just an illustration? So what do we really make out of your score figures, those figures to be meaningful and to report?" `*

The scores by itself does not reveal any meaning unless the scores are relative to a particular industry:

> *"Organisation A, we have 1, and in another org we have 4, in the illustration, all right? OK? It does not mean that 1 is bad ……..**It is subjective?** If it can be a 4 it's also a good number,   because it reveal that organisation will require a score higher than 4, in this organisation, because the nature of its business, if it is a research institution, or if it is a particular   non military organisation, the need for protection, audit confidentiality is not high, so we cannot say that this score might be better."*

The questions are not clear and it needs to be interpreted and fit to industry needs. These questions needs to be clarified and detailed to be understood by the target audience:

"I like the model because it does help to ultimately come up with some certain figures with a set of questions, but those set of questions need to be interpreted, - fit, relevant into to its needs, industry needs or majority needs of the organisation."

Table 4.68: Table showing the summary of coverage of the theme 'clarification of goals, questions and metrics' for SG 1

Issues	• The questions and metrics are subject to different interpretations • The relative importance of the given questions and metrics as well as the five point scales differ between industries and even between organisations
Evaluation	• The questions, metrics and the scales are not clear to the audience
Suggestions	• This issue may solve when the 'contextual layer' is added (Implied) • The questions, metrics and scores need to be explained in detail in the model/application (Implied)

4.2.2.4.8 Scoring system

The respondent does not favour the idea of a metrics with a 1 to 5 rating scale as it (a scoring system does not provide a yes/no answer but only a performance index) does not help in linking to the key performance indicators:

"So this type of metrics that is generated you need to ask - is it necessary?.............is it necessary? ………………because that type of questions .....because ultimately all right, those control objectives we have to link to broader, indicator of higher level key performance, key performance indicator of a particular organisation."

For the respondent the current scoring system does not present any advantage over the existing audit system, but still favours the idea as an additional feature to be incorporated apart from the compliance yes/no perspective:

*"I don't know the advantage of having a scoring system, rather than this particular system because, this really, this really ... affect the new…. but quantifying also help, all right? **Making it a bit objective;** making more and more objective, but there is a co-relation yeah? **There is a co-relation, yes, there is a co-relation**, I am not quite…… but may be there is a co-relation because, at the end of the day all right? What's ..call you, assign the inputs than those….**yeah,** rather than those factors. Similarly this one, all right? So*

suppose it is a judgement …… even this have combination, whether yes or
no."

The problem with the current scoring system used for measuring metrics is its subjectivity and its lack of linking to the context:

*"That's the problem, we have probably, we have ....subjectivity, subjectivity. That's the questions. That is depending on what the metrics all right? Ah, "Is the data well protected from OK, unauthorised viewing, fine all right?" He may say it's 1, all right? But I will tick a NO, NO because I said, as far as it is concerned, what's our view - It's irrelevant, or not important, very low, very low requirement. So 1 is not bad. **1 is not bad**. (Since the question is irrelevant 1 is not a bad score) So you are taking into the context, **OK**, that …. for you the layer… that results you whether it's adequate or not adequate, influence by the needs…… the specific needs of the situation."*

The respondent is also not happy at the idea of assigning relative weights to the metrics to reduce its subjectivity as auditors they are so used to the compliance (Yes/No) and doesn't like the idea of scores:

*"Put a weightage, 1 and then **Just 1, 1 by 10, so it equal 1. In that case**. It's is a challenge all right? Because, we are so used to this one, **a**nd I think it all figures and we don't like these figures and because this, its exactness, its preciseness in delivery may need not reflect the real one."*

Table 4.69 Table showing the summary of coverage of the theme 'scoring system' for SG 1

Issues	• The respondent does not favour the idea of a metrics with a 1 to 5 rating scale as it • A scoring system does not provide a yes/no answer but only a performance index which does not help in linking the key performance indicators • The scoring system is prone to high subjectivity • Even a scoring system (1 to 10) to assign the weightage of the questions/metrics is not advisable • The quantitative figures being to exact and precise may not reflect the real situation or state • Even if the model use two types of input method (scores and compliance) it may or may not correlate
Evaluation	• The performance oriented method of IS audit (used in the proposed model) is not suitable
Suggestions	• There is a need to add another feature where the users can also have the

| | option to provide a compliance answer that touches two extremes |
| | • The questions, metrics and scores can be detailed and contextualized using a similar feature used in VD called the 'tooltip' where when the curser is placed over it a box pops up explaining the object |

4.2.2.4.9 Bench marking

For a report generated using the model to be relevant and meaningful it needs to be relative to the industry:

> *"we know we could not have a model that is one site report, which could apply, and that model cannot have the benchmark because the security requirements for ABC may be different for one segment………. that relate that the extend of the how well data is protected from confidentiality from social……….. just an illustration."*

Organisations in different sectors have levels of controls and standards and so the scores need to be benchmarked as the nature of business will reveal the priority of a particular control:

> *"Organisation A, we have 1, and in another org we have 4, in the illustration, all right? OK? It does not mean that 1 is bad ……..***It is subjective?*** If it can be a 4 it's also a good number, because it reveal that organisation will require a score higher than 4, in this organisation, because the nature of its business, if it is a research institution, or if it is a particular non military organisation, the need for protection, audit confidentiality is not high, so we cannot say that this score might be better. So that it might help to have a kind of benchmark to allow people to interpret it……………. I like the model because it does help to ultimately come up with some certain figures with a set of questions, but those set of questions need to be interpreted, - fit , relevant into to its needs, industry needs or majority needs of the organisation"*

It is not a good idea to apply the same standard for all organisations due to differing industry requirements:

> *"In other words, we cannot use the same standard to apply for all organisations, like all judged with the same yardstick – like this organisation is better… So if two organisations has same score, it does not mean that in this area they are*

same, equally good - not necessarily. So I think the most useful, and perhaps can be quite difficult is the interpretation of the result that comes out of the model. So I think some kind of expert system is needed, is needed to be embedded somewhere, to bring that to a conclusion. That is my idea."

Table 4.70 Table showing the summary of coverage of the theme 'benchmarking' for SG 1

Issues	• The report generated using the model is not meaningful to the organisation • The same standards cannot be used to apply to all organisations
Evaluation	• The model does not have any provision to benchmark
Suggestions	• An expert system being suggested may point to the contextual layer • The relevant industry benchmarks values can be added to the application (implied) • The COBIT CMMI maybe used (Implied)

4.2.2.4.10 Input to the model

Regarding the input to the model by the users, the respondent favours the idea of a panel of more than one person either through a consensus or through multiple entry by taking an average of two or three entries:

*"This one is a matter of policy. **Policy, OK** I don't think the tool, ah! I don't know how the tool is going to work in the particular area. But what is quite important is ah, the inputs that can be inputted in a way of consensus, and not by a single user, by through a panel of reviewers, for measurement. Otherwise it only reflects a one person judgement, **one person** – you know, so it might be good that as a matter of policy of how to implement the tool there, to pick up a measurement, whether it is possible for the tool to actually to take the measurement, audit it by three or four users, form a panel of users for specific measurement, and then indicate the input, all right? average it out, that would be very good………………… I think that would be fairer, more objective. **More objective** I mean it depends …They may come out with the best option, the state of applying for just one person is not relevant, need view of the institution. So it reflects the consensus of a number of people, but that it is really an implementation issue, **implementation,** how that tool, help, the tool but it could have a …another tool that allow multiple inputs from a …… They*

don't need to use more than 2 or 3 persons, request to complete them, and then come up with average, use that figures, and use whatever is for ... whether metrics or.."

Table 4.71 Table showing the extend of summary of the theme 'input to the model' for SG 1

Issues	• The results generated using the input done by a single person is not meaningful
Evaluation	• The questions of the source of input to the model is not clear in the model
Suggestions	• A panel of two or three peoples can reach a consensus and input the values to the system • Multiple users from different locations can input and when the scores reach the viewer it does an average of all the values and assigns that value

4.2.2.4.11 Use of CO or DCO

Even though the respondent uses only the control objectives for the IS audit, he still is not averse to the idea of using the detailed control objectives:

"So the starting point really is not the COBIT control objectives, it is actually something different, something different and from that people would select the control objectives which is relevant to the, to the, business goals. That is really not a big problem, but ultimately what you look for are the control objectives that are certified in COBIT, the detailed control objectives, the detailed control objectives of COBIT. And that's fine, we don't have problems in that......"

Using the high level control objectives help in reporting to the high level board as they want to view the summary of a report without going into much details:

*"For reporting to high level or further high level board, **yes, high level board,** you know composite in terms of the aggregate of the model, but actually one need to control the details…......"*

Table 4.72 Table showing the summary of the theme 'using control objectives or the detailed control objectives' for SG 1

Issues	• When using COBIT auditors normally use the high ;level control objectives
Evaluation	• The model relies on the DCO for IS audit
Suggestions	• There is a need to use the control objectives as well as the DCOs

4.2.2.4.12 Compliance and measurement perspective

IS auditing follows the normal compliance (Ex. yes/no, effective/not-effective perspective for audit and does not measure in terms of a scale. This being a new concept to the respondent he is not sure of its advantage, but still he see a correlation between the two:

> *"I don't know the advantage of having a scoring system, rather than this particular system because, this really, this really ... affect the new…. but quantifying also help, all right?* ***Making it a bit objective;*** *making more and more objective, but there is a co-relation yeah?* ***There is a co-relation, yes, there is a co-relation****, I am not quite…… but may be there is a co-relation because, at the end of the day all right? What's ..call you, assign the inputs than those….****yeah,*** *rather than those factors. Similarly this one, all right? So suppose it is a judgement …… even this have combination, whether yes or no…."*

The respondent is very uncomfortable even in the case of assigning a weight, as it quantifies the questions or metrics. As an experienced auditor doing auditing in the normal manner this method is quite foreign to him:

> *"Put a weightage, 1 and then* ***Just 1, 1 by 10, so it equal 1. In that case****. It's is a challenge all right? Because, we are so used to this one. And I think it all figures and we don't like these figures and because this, its exactness, its preciseness in delivery may need not reflect the real one.* ***The subjective*** *OK, I agree with you. It is a challenge having yes/no yes/no what will be your overall situation? Yes or No. As an the expert you have to find out."*

Table 4.73: Table showing the summary of the theme 'compliance and measurement perspective' for SG 1

Issues	• There is no advantage of a scoring system in IS auditing • IS auditors are so used to the compliance form of evaluation
Evaluation	• The model takes a performance measurement orientation to IS audit
Suggestions	• Compliance feature can also be added into the system (Implied)

4.2.2.4.13 Model evaluation

Even though the respondent like the model as it gives a quantitative perspective, some additions and modifications need to be done to make the model usable:

> *"I like the model because it does help to ultimately come up with some certain figures with a set of questions,"*

The model is too complex and need to be simple so as to reflect the thinking process of the auditor:

> *Your model needs to simple, ok? all right? ? Another issue is it is too complex, **it should not be complex**, it should not be because, in order to be friendly and usable, simple, flexible, it should not be too complicated, too complex……………I think in the real world it should reflect more of the real world .... of the thinking process of how auditors would look at things, what would they be influenced by."*

Table 4.74 Table showing the summary of the theme 'evaluation of the model' for SG 1

Issues	• The model is not simple
Evaluation	• The model is good as it gives a quantitative output but needs to be simple
Suggestions	• The model should be modified to suit the methodology adopted by the IS auditors

4.2.2.4.14 Similar tool or method

According to the respondent the model is not unique, but the concept is unique in the way the areas have been broken down into finer units for the purpose of measurement:

> *"Because there are a quite number of similar models like this, **like .. OK** . And this is not unique, **right**, all right? there could be well variations in terms of concepts. Ah, it is not entirely original, obvious enough, all right? But you have done, actually to made it more modular, because of the way that certain questions are being broken up, all right?   Made it and structured into a set of questions. So it's helpful in that sense, but again I think which we………."*

Table 4.75: Table showing the summary of the theme 'similar tool or method' for SG 1

Comments	• The model is not unique as there are similar models • The difference is in its 'concept' • The difference is that the model takes a modular approach where goals are broken down into questions that are further broken down into metrics

4.2.2.4.15 Alignment of the model

The only mention of alignment of the alignment of the metrics to the questions and to the goal is indirectly mentioned. According to the respondent the model does not have a contextual layer and does not have a broad key performance indicator at the top. In fact the model starts with COBIT which is not the way audit is done. Hence there are problems in alignment:

> *"So this type of metrics that is generated you need to ask - is it necessary?* **It is necessary,** *is it necessary? …………. because that type of questions …..because ultimately all right, those control objectives we have to link to broader, indicator of higher level key performance, key performance indicator of a particular organization"*

Table 4.76: Table showing the summary of the theme 'alignment of the model' for SG 1

Issues	• The metrics that is generated does not helping liking the control objectives to broader level key performance indicators
Evaluation	• The model does not helps in aligning the metrics with the goals
Suggestions	• Since there is no contextual layer and the process starts with COBIT control objectives rather than the high level key performance indicators a restructuring of the model may help (implied)

4.2.2.4.16 Context of the goals, questions and metrics

Discussed in detail in the contextual layer section (4.2.2.4.1).

4.2.2.4.17 Ranking

There is a need to prioritise the questions since each of these questions may have different levels of importance depending on the needs of the organization:

> *"I think which we have mentioned before, is the importance of each question, which may have a direct impact and we like to control the, that thing need to be embedded."*

Even though the concept of weightage may be associated with quantitative figures the respondent is averse to the idea of figures:

> *"We need to give a weightage. In fact like this one, although we don't give a figure in a way - which question are important, which not relevant, more important, in a way, already the idea of weightage has been incorporated the idea of weightage inside the …."*

This is because as auditors they are so used to the compliance perspective:

> *"Put a weightage, 1 and then* ***Just 1, 1 by 10, so it equal 1. In that case****. It's is a challenge all right? Because, we are so used to this one, and I think it all figures and we don't like these figures and because this, its exactness, its preciseness in delivery may need not reflect the real one.* ***The subjective*** *OK, I agree with you. It is a challenge having yes/no yes/no what will be your overall situation? Yes or No. As an, the expert you have to find out."*

Table 4.77: Table showing the summary of the theme 'ranking of questions and metrics' for SG 1

Issues	• All the questions and the metrics are not equal
Evaluation	• The model does not have any facility to prioritise the questions or metrics
Suggestions	• A weightage (in figures) may be assigned for the questions and metrics • A relative weightage may be assigned (more important, important, neutral, less important, least important)

4.3   CONCLUSION

Out of the five stages outlined in the analysis, two stages have been reported and discussed in this chapter. In the next chapter (5) the following three stages of LeCompte's analysis will be reported. Significant findings that have emerged from this chapter includes new themes (benchmarking, use of relevant control standards, audit perspective). The common thread among all the respondents and themes (new) that are significant have been highlighted, illustrated and explained in detail by the respondents (contextual layer and risk-ranking). The findings that have emerged in this chapter have implied that the influences to the model are multifaceted and that the next three stages will help to reveal the patterns and linkage of the data. While this chapter looked at the data from a more descriptive and a less analytical perspective, the next chapter will look at the information derived from these two stages from a deep analytical and interpretive perspective so that a holistic view of the final model can be obtained.

Chapter – 5

Discussion of the Findings

5.0   INTRODUCTION

While the previous chapter focussed on a case by case analysis with a reasonable element of interpretations in the form of implied statements, this section will go a step further by undertaking an intra and inter case analysis and uncover the various implied statements by following the last three steps of the proposed analytical framework (presented in section 3.6). Hence this chapter is divided into three major sections. The first section (section 5.1) involves creating stable sets of items that includes comparing and contrasting the derived themes (involving themes within the cases and between the cases) and assembling a taxonomy of items. Section 5.2 focuses on similarity and analogy, co-occurrence, sequence, hypothesised reasonableness and corroboration. The main emphasis of the section is the corroboration of the findings with the theory and propositions. Section three (5.3) being more creative and displays of assembling structures, the main thrust will be on the various variations to the model and the presentation of the final model.

5.1   CREATING STABLE SETS OF ITEMS

This stage (third among the five) has been further subdivided into two distinct sub-phases namely comparing/contrasting and assembling taxonomy. After going through the transcripts, the last chapter and the proposed plan it was found that due to the nature of data, the original plan (the five step process of analysis) could be followed only with some deviation in both of these sub phases.

5.1.1   Comparing and Contrasting

In the original plan, the coding of items would have taken at this phase, but as stated in section 4.3 it was done immediately after stage one as it was quite difficult to move to stage two without coding. Hence the coding part of this stage has already been done in the previous chapter (4.3.2). The remaining sub steps at this stage are outlined in table 5.1

Table 5.1: Steps in 'creating stable sets of items' (Audit of analysis stage - 3)

Strategies	Action taken
1. Comparing and contrasting within the case and between the case will be undertaken	This step is being done at this stage
2. Mixing and matching the coded themes will be undertaken only if it is deemed necessary	This step was considered a repetitive step since a similar manner of analysis is done in the previous step (comparing and contrasting). Thus this step is considered unnecessary and repetitive
3. Spradley's list for assembling taxonomy will be used wherever it is deemed necessary (Table 3.15)	This step is modified and the nature and the extend of modifications with the rationale is outlined below in table 5.9

The nodes of all the four cases have been compared with each other to present an overall view of the outcome. Table 5.2 gives an overview of all the themes that have emerged from the four cases.

Table 5.2: Comparison of themes for all the four cases (based on coverage)

	Nodes level 2	NZ 1	NZ 2	NZ 3	SG 1	Total coverage
1	Commercializing the model	0.25%		1.52%		1.77%
2	Current IT audit, governance, control models	4.28%	9.23%	18.25%	12.72%	44.48%
3	Functionality	19.49%	1.31%	5.83%	2.85%	29.47%
4	Scoring system			2.15%	4.88%	7.03%
5	Alignment of the model	3.45%	0.74%	4.46%	0.81%	9.46%
6	Alignment and understanding with COBIT	0.26%	0.20%			0.46%
7	Application of the model	3.03%	0.93%			3.96%
8	Automation		1.48%			1.48%
9	Bench marking	4.51%	8.43%	6.53%	3.93%	23.4%
10	CO or DCO?	2.05%	1.27%		3.46%	6.78%
11	COBIT in the model			2.43%	8.59%	11.02%
12	Contextual layer	0.35%		7.62%	16.37%	24.34%
13	Clarification of goals and questions	3.22%	14.13%	4.62%	2.83%	24.8%
14	Context of the goals, questions and metrics		3.45%	Covered in 12	Covered in 12	3.45%
15	GQM		0.78%		5.01%	5.79%
16	Auditing perspective			3.90%	8.45%	12.35%
17	Compliance and measurement perspective	2.97%	1.29%	2.15%	2.49%	8.9%
18	Model evaluation	0.14%	5.94%	2.48%	1.18%	9.74%
19	Other standards		2.33%	5.43%		7.76%
20	Ranking		6.95%	5.01%	2.05%	14.01%
21	Tracking progress of a goal	1.26%	5.80%			7.06%
22	Similar tool or method	2.43%	0.14%	5.09%	1.07%	8.73%
23	Input to the model	5.64%	9.44%	0.09%	3.47%	18.64%

Unlike in the previous chapter (which showed the descriptive statistics with less emphasis on the underlying factors), the purpose of this section is to explain the rationale for the themes to be included and stated by the cases, thus providing a qualitative comparison of inter and intra case themes. Even though the percentage of coverage provides an overall view of the extent of coverage of the topics, being a qualitative study it is not easy to conclude anything based on these figures. The reason is that it was quite difficult to separate the themes into different silos as themes do overlap considerably, and when answering a question the response may not only touch more than one theme, but may directly refer to one or two (themes) and indirectly to several themes. Another issue with the percentage of coverage is that only direct mention of the discussion to a particular theme has been grouped into a named theme, but there are numerous high level, medium level and low level indirect and implied references that have not been included under the themes. All of these will be covered in these sections.

Table 5.3: Ranking of all the themes for the four cases (based on coverage)

Nodes level 2	NZ 1	NZ 2	NZ 3	SG 1	Total coverage
Current IT audit, governance, control models	4.28%	9.23%	18.25%	12.72%	44.48%
Functionality	19.49%	1.31%	5.83%	2.85%	29.47%
Clarification of goals and questions	3.22%	14.13%	4.62%	2.83%	24.80%
Contextual layer	0.35%		7.62%	16.37%	24.34%
Bench marking	4.51%	8.43%	6.53%	3.93%	23.40%
Input to the model	5.64%	9.44%	0.09%	3.47%	18.64%
Ranking		6.95%	5.01%	2.05%	14.01%
Auditing perspective			3.90%	8.45%	12.35%
COBIT in the model			2.43%	8.59%	11.02%
Model evaluation	0.14%	5.94%	2.48%	1.18%	9.74%
Alignment of the model	3.45%	0.74%	4.46%	0.81%	9.46%
Compliance and measurement perspective	2.97%	1.29%	2.15%	2.49%	8.90%
Similar tool or method	2.43%	0.14%	5.09%	1.07%	8.73%
Other standards		2.33%	5.43%		7.76%
Tracking progress of a goal	1.26%	5.80%			7.06%
Scoring system			2.15%	4.88%	7.03%
CO or DCO?	2.05%	1.27%		3.46%	6.78%
GQM		0.78%		5.01%	5.79%
Application of the model	3.03%	0.93%			3.96%
Context of the goals, questions and metrics		3.45%	Covered in 12	Covered in 12	**_3.45%_**
Commercializing the model	0.25%		1.52%		1.77%
Automation		1.48%			1.48%
Alignment and understanding with COBIT	0.26%	0.20%			0.46%

For the purpose of discussion, table 5.3 has been sorted and presented to give an overview of the relative importance of the themes (table 5.4). Being a qualitative study even though the extent of coverage may not always necessarily reflect the importance, the coverage still reflects importance.
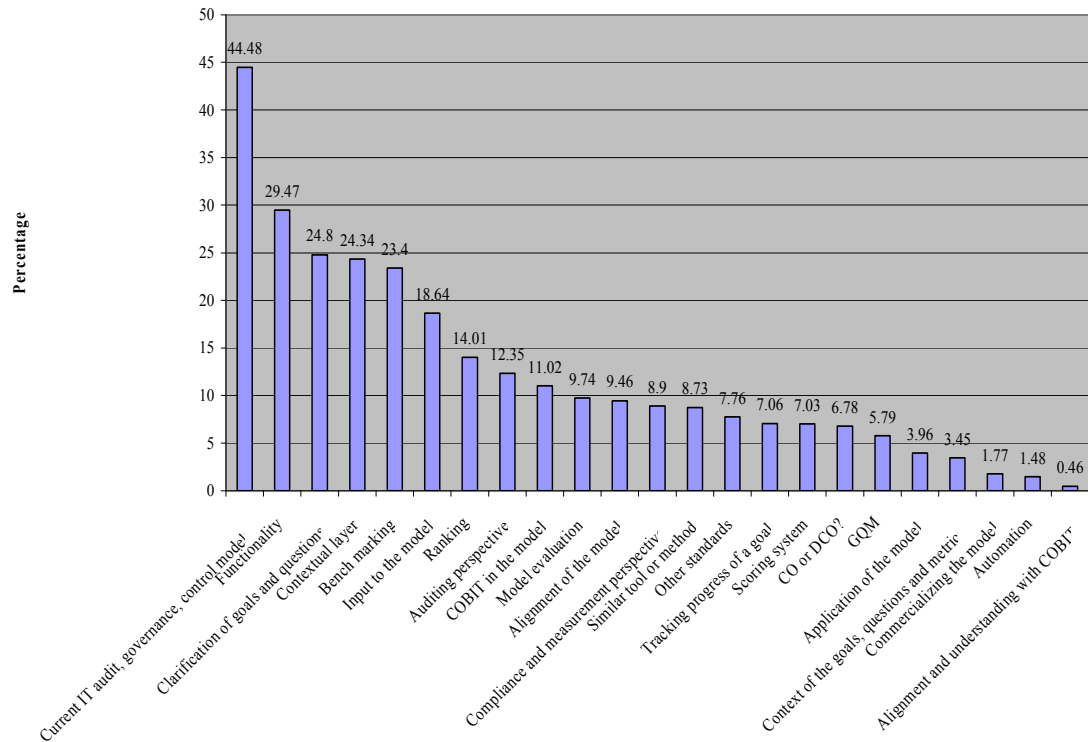
Figure 5.1: The coverage of all themes for all the respondents

A case-by-case analysis as well as inter case analysis is undertaken to discuss the themes and analyse the underlying factors for the presence of these themes. For the purpose of intra case discussion, the themes outlined in the table and chart have been divided into four categories depending on the percentage of coverage themes with major coverage (coverage of 10% and above), themes of average coverage (5% – 9.99%), themes of low coverage (1% - 4.99%) and themes with very low coverage (less than 0.99%). The categorization is arbitrary and follows the guidelines of Miles and Huberman (1994) who stated that the researcher can use innovation in the analysis of qualitative data

Interpretation of themes: NZ – 1

The following table illustrates the themes and it's coverage in terms of the percentage of coverage.

Table 5.4: Comparison of themes based on the extend of coverage for NZ 1

Coverage	(Above 10%)	(5% – 9.99%)	(1% - 4.99%)	(less than 0.99%).
	Functionality	Input to the model	Benchmarking	Contextual layer
			Current IT audit, governance and control models	Alignment and understanding with COBIT
			Alignment of the model	Commercializing the model
			Clarification of goals, questions and metrics	
			Application of the model	
			Compliance and measurement perspective	
			Similar tool or method	
			Use of CO or DCO	
Themes			Tracking progress of a goal	

Even though the respondent's awareness of IT governance and audit is quite high, and undertakes auditing of IT security, there are no overall IT governance programs running in the organisation. But it is of significance that he does measure the performance of their IT systems (focusing on IT security). Hence it is expected that the topic of great interest would be the various functionalities of the application rather than the model. During the interview session, he took a software application view of the model rather than a method or model perspective. Another major topic of interest is benchmarking since the organisation would rather prefer to know where they stand in relation to their IS systems than measure their own performance even though measuring performance is a major factor during the discussion. There is negligible mention of a contextual layer as he is not an expert IS auditor. Alignment is mentioned in terms of only 'not aligned' and mainly concerns the wording of the questions and metrics and thus the context of alignment is narrow.

5.1.1.2 Interpretation of themes: NZ – 2

The first point raised by the respondent in this case and also the most important one is the lack of clarification of questions and metrics. Even though the approach to this problem taken by the respondent is from a contextual point of view the main emphasis is the target audience whereby different target users may perceive these differently necessitating the need for contextual questions and metrics. Since the organisation has already implemented COBIT along with ITIL and ISO 17799 and so it is expected that the topic of the organisations implementation and use of these would be discussed. But unlike the respondents, NZ 3 and SG 1, the respondent in this case, manages the IT governance framework in the organisation but leaves the implementation to the external consultants. Even though she is happy with the work, since it gives an overall picture, she commented that these reports generated by external consultants "does not go into details" and is manual, implying that there is an inherent need for an automated model that can go into details like the model being researched. Since she has found the need for a model like this, she is also the respondent who has given the most positive feedback regarding the model. A significant information that had emerged during the discussion was the usability of the GQM model. While none of the four respondents knew about the model, and numerous critics of the model (explained in section 2.9) have criticized the GQM as being difficult to understand, this was not so in this case. So when asked whether it is advisable to change the 'questions;' in the model to 'features', she respondent by staying that it is workable in the current format.

Table 5.5: Comparison of themes based on the extend of coverage for NZ 2

Coverage	(Above 10%)	(5% – 9.99%)	(1% - 4.99%)	(less than 0.99%).
	Clarification of goals, questions, metrics	Input to the model	Context of the goals, questions and metrics	Application of the model
		Current IT audit, governance, control models	Other standards	GQM
		Bench marking	Automation	Alignment of the model
		Ranking	Functionality	Alignment and understanding with COBIT
Themes		Model evaluation	Compliance and measurement perspective	Similar tool or method
		Tracking progress of a goal	CO or DCO?	

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5.1.1.3 Interpretation of themes: NZ – 3

This respondent is unlike the other three, since he is the only IT audit consultant among the four. Even though he works for large consulting firm, the feedback that he has given does not represent a single organisation but comes from his experience of auditing numerous organisations. He knows a great deal about COBIT as he had done the COBIT certification program from ISACA in 2004. He moves around the country (NZ) to do the IT audit work as an external consultant representing the consulting firm where he is based. Due to his nature of job, certainly the most discussed aspect is the way he goes around and do IT audit in client organisations. For him also the context and benchmarking is important for the model to be of any use. The most striking statement that had come from this person is "like at the moment I am using a same set of questions ah, I mean set of objectives that I would go and verify". Here the terminology 'same' mean 'similar' and thus the literal meaning cannot be taken for granted. Hence it implies that the GQM is not too difficult for an IS personnel to understand (provided it is demonstrated).

Table 5.6: Comparison of themes based on the extend of coverage for NZ 3

Coverage	(Above 10%)	(5% – 9.99%)	(1% - 4.99%)	(less than 0.99%).
Themes	Current IT audit, governance, control models	Contextual layer	Clarification of goals and questions	Input to the model
		Bench marking	Alignment of the model	
		Functionality	Auditing perspective	
		Ranking	Model evaluation	
		Other standards	COBIT in the model	
		Similar tool or method	Compliance and measurement perspective	
		Ranking	Scoring system	
			Commercializing the model	

5.1.1.4 Interpretation of themes: SG – 1

He is the most experienced of all the four, a senior IT audit personnel, an expert in COBIT and a well known IT governance expert throughout the world. Even though he is the harshest critic of the model (taking great deal of time to point out the issues), where he had come to the extent of telling "your model will not help", he is also the person who stated "I would not say the weakness of the model, but basically it's the area that needs to look into for further improvements". The latter was the opening sentence of the discussion. Being an experienced auditor the most

significant aspect pointed out was the "missing layer" in the model which he termed as 'environmental factors' 'contextual layer' and 'expert system'. Hence according to him "you don't start with COBIT", but with a broad performance indicator followed by the mentioned layer. He had gone to great length in illustrating this layer with examples and drawing on the board. Hence the alignment of the model is of less issue because without this layer there is no alignment.   Also this is the only respondent who had also discussed the GQM in great depth and suggested some slight modifications in terms of using IS friendly terminology, but he has not criticized the GQM model implying that the GQM model can be easily understood by an IS personnel.

Table 5.7: Comparison of themes based on the extend of coverage for SG 1

Coverage	(Above 10%)	(5% – 9.99%)	(1% - 4.99%)	(less than 0.99%).
Themes	Contextual layer	COBIT in the model	Scoring system	Alignment of the model
	Current IT audit, governance, control models	Auditing perspective	Bench marking	
		GQM	Input to the model	
			CO or DCO?	
			Functionality	
			Clarification of goals and questions	
			Compliance and measurement perspective	
			Ranking	
			Model evaluation	
			Similar tool or method	

5.1.1.5 Inter case analysis

Taking all the cases into consideration, 'Current IT audit, governance, control models' takes the topmost spot in terms of coverage since the research context is around this topic. In all the interviews, this was the last topic that was raised by the researcher for discussion. Even though 'clarification of goals, questions and metrics', 'contextual layer' and 'context of the goals, questions and metrics' are classified as three separate themes, the underlying idea is same namely the questions and metrics need to be clarified and contextualized. If taken together then this will form the largest theme (49.14%) among all. Hence if interpreted further to find out which

component of the model (COBIT or GQM) is being analysed, then this is more of an analysis of the GQM method of developing questions and metrics for the IS entities.

Automation is one of the least discussed topics, but three points that are in favor of this are that first of all this is an automated model that was given to the respondents to evaluate, secondly if all the issues are to be sorted out and incorporated it would be impossible without automation and thirdly commercializing the model would be impossible without automation Hence automation is an implied concept while discussing all the issues and suggestions. Another two topics that have similar perspectives are 'auditing' and 'compliance and measurement perspective'. Combined, this would be covering 21.25% of the discussed topics and this is expected since the objective of the model is to present a model that can measure as well as audit.

Table 5.8: Comparison of themes based on the extend of coverage among all the respondents

Cove-rage	(Above 40%)	(20% –39.99%)	(10% - 19.99%)	(5 - 4.99%)	(0.46 - 4.99%)
	Current IT audit, governance, control models	Functionality	Input to the model	Model evaluation	Application of the model
		Clarification of goals, questions and metrics	Ranking	Alignment of the model	Context of the goals, questions and metrics
		Contextual layer	Auditing perspective	Compliance and measurement perspective	Commercializing the model
		Bench marking	COBIT in the model	Similar tool or method	Automation
				Other standards	Alignment and understanding with COBIT
				Tracking progress of a goal	
				Scoring system	
Themes				CO or DCO?	
				GQM	

5.1.2 Assembling Taxonomy

This is a sub task of the third stage of analysis and not all the tasks are relevant based on the nature of response given. Hence after going carefully through Spradley's list

of 11 tasks, it was observed that the tasks 1, 3, 10 and 11 (table 3.21) had already been followed for deriving the themes in section 4.2.2. Out of the remaining (2, 4, 5, 6, 7, 8, and 9), item 2 is irrelevant for the collected data while tasks 4, 5, 6, and 9 may be relevant for this part of the analysis. An intensive search through the themes revealed that three types of task (5, 6 and 9) are among the ones (4, 5, 6 and 9) that have emerged as a tool to present a visual scenario so as to provide an analytical and interpretative view of the themes from a taxonomic perspective. Out of these four, tasks 5 and 6 have been combined since the analysis part of the empirical data necessitated the need of using a single term 'issue' that embodies both these terms 'cause' and 'reason'; and the term 'suggestions' for the term 'way'. The rationale for taking this approach is that there are issues and positive evaluations of the model, and reasons were provided by the respondents along with some solutions to solve some of these issues.

Hence, in this section the issues being faced by the model will be outlined as well as the suggestions and the positive evaluation of the model. Unlike in the previous chapter, here direct, indirect issues/reasons that have been implied in the statements will be presented followed by direct, indirect and implied suggestions to the model. The whole process will be undertaken intra-case wise and inter-case wise. The following table (5.9) will illustrate the nature of analysis that will be done at this sub phase.

Table 5.9: Change in the list for 'assembling taxonomy'

	Tasks	Actions taken
1	X is a kind of Y	Done
2	X is a place in Y	X
3	X is a part of Y	Done
4	X is a result of Y	Will be used if necessary
5	X is a cause of Y	Will be used if necessary
6	X is a reason for Y	Will be used if necessary
7	X is a place for doing Y	X
8	X is used for Y	X
9	X is a way to do Y	Will be used if necessary
10	X is a stage or step in Y	Done
11	X is a characteristic of Y	Done

In the following sections, each of the case are taken one by one and for each case two types of illustrations are provided. The first figure is the positive evaluation of the model that incorporates the actual positive oriented statements (verbatim) commented on the model. The second figure is just the opposite where the issues that have been pointed out regarding the model are presented on one side (left) while

suggestions have been presented on the other side. While most of the suggestions given are direct comments some of them are implied and interpreted by the researcher.

Assembling taxonomy for NZ – 1

Considering the positive evaluation of the model, the respondent is of the opinion that the model is good provided some of the issues mainly the wording of the questions, metrics and benchmarking issues are sorted out.
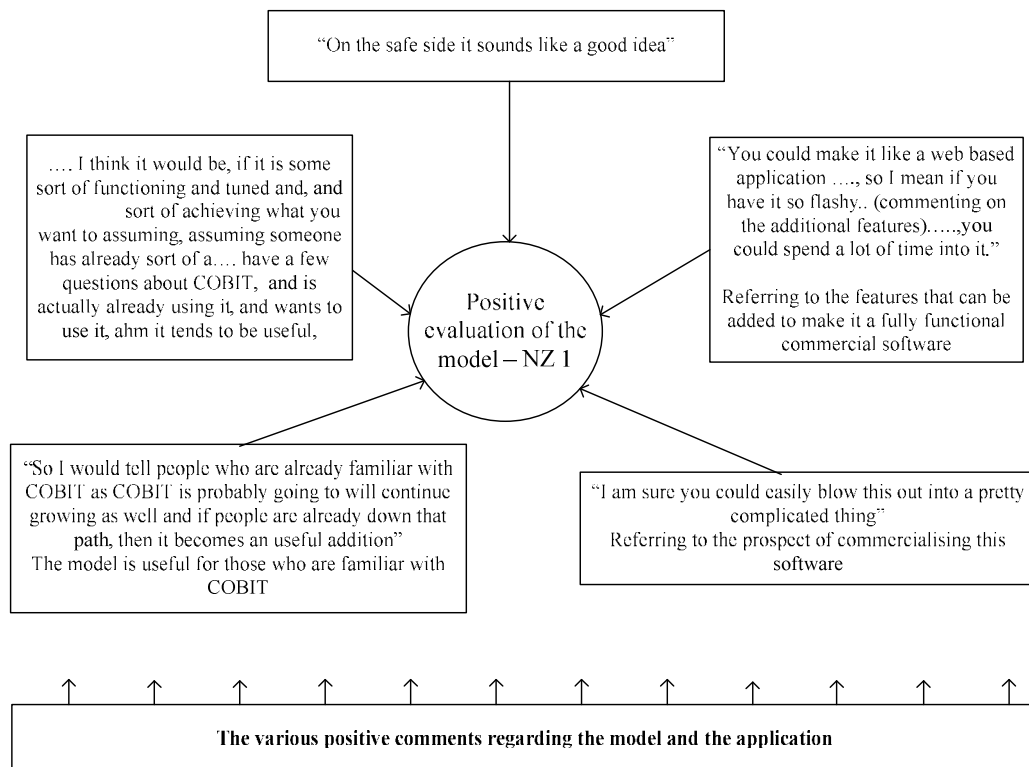
Figure 5.2: Positive evaluation of the model by NZ 1

The major issue with the model from NZ 1 perspective is more technical and functional based rather than the structural issue with the model. Most of the issue from this perspective can be solved by incorporating these as added or modified features into the application. But there some issues that are common and important to all of the respondents. These major issues are the lack of context and clarity of the questions and metrics, the absence of relevant industry benchmark, and the inability of the users to customise the questions and metrics. Other relevant ones are the lack of alignment between the questions due to the 'fuzzy', non specific terminologies used and assigning access rights. Apart from the suggestion given, the researcher has also provided the implied suggestions (outlined in figure 5.3).

No alignment between the questions and metrics

The model does not have provision to store the results

Currently there is no facility where multiple users can log in and create a profile

The questions and metrics are not clear and is highly subjective

The questions in the dataset may not be relevant to the organisation

The questions and metrics are given equal weightage

The model is too basic in terms of features

There is no method to compare the results of the control objectives with similar industries

There is no provisions for giving a benchmark value in the application for the measured control objectives

The model is static and thus not flexible enough for users to customise the questions and metrics

There is no context for the questions or metrics

There is no provision for assigning different access rights to different users in the model

There is no provision to track the progress of a goal

The model targets only the users of COBIT and thus may not suit all organisations

No other relevant standards are incorporated

No provision for baselining a goal or objective or report

Issues with the model for NZ 1

There is a need for tying the questions and metrics to some sort of standard or benchmark

The questions and metrics need to contextualised

The fuzzy terminology for the questions and metrics should be clarified or done away with

The application should be managed by the auditor. The questions/metrics should be selected by them

Different categories of users should be assigned different access rights to the model for accuracy and security purpose

There should be a provision to create profile for each user for storing the user context and reports

The model should be able to generate different levels of reports for different levels of managers

The model should have a provision whereby the users can add and modify their own goals, questions and metrics

The generated scores should be able to be tracked over time using graphs and visual charts

The application should be made web based

Need to incorporate commonly used IT audit and control frameworks into the model other than COBIT

There is a need to add more features to make the model commercially marketable

Each of the scores should linked to relevant standards or explained

The reasons/causes for the various issues with the model. -------------→ Suggestions or the way to solve the issues

Figure 5.3: Issues with the model from NZ 1 perspective

5.1.2.2 Assembling taxonomy for NZ – 2

This is the respondent who have provided the most positive evaluation of the model and implied the need for such a model that they can use in their organisations on a continual basis without relying too much on external consultants. The various comments are given in figure 5.4

Figure 5.4: Positive evaluation of the model by NZ 2

The various issues and suggestions provided by NZ 2 are presented in figure 5.5

| The questions/metrics are unclear, not detailed enough and target audience are not taken into consideration |
| There is a high level of subjectivity in the questions |
| The users may not fully understand the implications of the questions and/or metrics |
| The questions and metrics are generic and not specific to the context |
| The model is not clear about who should manage the application |
| The questions and metrics are given equal weightage |
| The reports generated are subjective |
| There is no method to compare the results of the control objectives with similar industries |
| There is no provisions for giving a benchmark value in the application for the measured control objectives |
| The model is static and thus not flexible enough to customise the questions and metrics |
| The generated report using the model is subjective |
| The model does not have any provision to track the progress of a goal over time |
| The model does use only COBIT which may not suit many organisations |
| Knowledge of COBIT is necessary to fully understand the model |
| There is no provision to aggregate the results of the DCOs for the high level CO |
| There is no provision for multiple reports for different levels of management |

Issues with the Model for NZ 2

| The questions need to be contextualised and explained with the target audience in mind |
| Each of the metric scores (1-5) should be explained so that users can know what each score mean |
| Training session should be conducted for the users for making the goals, questions, and metrics clear as well as the scores |
| The application should be managed by the auditor. The questions/metrics should be selected by them |
| The users who input the values should not have the facility to select the questions or metrics |
| More than one person should provide input to the metrics (either as a consensus or an aggregate) |
| The questions and metrics should be assigned proper weightage |
| Risk factor should be added for the questions and or metrics. A two dimensional system can be incorporated for the purpose |
| There should be a provision to incorporate the relevant industry benchmark along with the result which should be visible only to the auditors and not the users |
| The model should have a provision whereby the users can add and modify their own goals, questions and metrics |
| The generated scores should be able to be tracked over time using graphs and visual charts |
| The model should be able to generate different levels of reports for different management levels |
| Need to incorporate commonly used IT audit and control frameworks into the model other than COBIT |
| Apart from the performance measurement using scales, the compliance perspective feature can also be added |
| There is a need to use both the COs and the DCOs so that either high level or detailed level of reports can be generated |

The reasons/causes for the various issues with the model. -------------→ Suggestions or the way to solve the issues

Figure 5.5: Issues with the model from NZ 2 perspective

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While 16 issues have been outlined by the respondent all of these can be categorized into six major issues namely, the lack of context among the questions and metrics, equal weightage for these without the risk factor taken into consideration, not providing a benchmark value for comparison, relying only on COBIT and not other relevant standards, providing only one type of reports and the question of who should manage the application. Out of these six, the first one is a major issue and has been explained in previous sections. The second issue is the lack of addressing the risk factor in the model especially the questions, as risk management is an important component of auditing (also mentioned indirectly by NZ 3).

Benchmarking is a common issue among all the respondents with all of them giving almost equal weightage despite the fact that three of them are auditors with experience of IT governance frameworks, while one an IT security and audit personnel without doing any IT governance process. While the organisation does IT governance using blend of relevant standards certainly this is major issue since the model only showcase COBIT. One of the major issue cited, is the context of questions and metrics focusing on the target audience certainly the reports generated from the model is generic and not specific to any target audience. Lastly managing the application is an issue since one group of people decide which all questions/metrics are relevant while the input may come from another group.

Most of the solutions to these issue have been provided by the respondent while some have been interpreted (contextual layer; the facility for the users to add layers so that for measuring specific areas they can go into much finer details) by the researcher from the response. The issue of the context and targeting the right audience can be solved by adding a contextual layer. Regarding the second issue (that is unique) the respondent have come up with a two dimensional graph that she had scribbled on a sheet of paper that shows two coordinates which can solve the problem of prioritizing. Apart from the suggestions given, one issue that need to be solved is managing the application. For this a web based application suggested by NZ 1 can solve the problem of managing the application regarding the selection of question/metrics, and input   by the users.

5.1.2.3 Assembling Taxonomy for NZ – 3

The various positive evaluations of the model by the respondent is illustrated in figure 5.6. The respondent is quite happy at the prospect of having some metrics to

give a quantified figure and commented on the similarity of the questions with what he used for his audit work, but as he remarked this model is only an initial step in the right direction.

"Just having metrics certainly it's a good thing and eh, it gives a guidance of I'm an auditor to have some sort of benchmark"

"I could judge the level of the, what you call, to judge how far the objectives have been met... and I think that would reduce the subjectivity"

"So I think the more metrics I derive, derived, and the more accurate are they to reality. It helps to judge you know how far or close to the objective..."

"While at the moment there are a set of questions, set of controls, set of questions and metrics for each set objective. But that's I mean an an initial, it is a good step"

"At the moment I am using a similar set of questions ah I mean, set of objectives that I would go and verify the findings with their, with different clients"

"Certainly yes"
Regarding the query whether a model like this can be used for his regular IS audit

"Its good to have a scale"

"I think its OK to have the same scale 1 to 5. I think it is better to have a one uniform scale"

"I think it's a good start to keep developing the project in a way it would.."
Suggesting that the empirical research in the thesis is an initial step to develop this into a commercial application

"The auditor would decide whether this question is relevant or not. That's why you are ticking which is a good thing"
Comment regarding the feature whereby the users can tick and select the questions

"At some stage you decide later on, I don't know you choose to commercialise it"

"I think you preferably use for both: The model can be used for both internal and external audit

"Why do you designing the metrics in the first place? You try to quantify it as much as possible"

"Yeah, I think it is better way, certainly.... to reduce the subjectivity"
Manner of generating metrics from goal

"It provides a methodology and consistency" (The model – for generating metrics)

"It will not be a replacement for an auditor" (the model)

"To be honest I think it has some, some certainly good things, good things in it, but I think it need a bit of more work"

"I think you are doing the right thing"
In terms of evaluating the model from cases to get more information to improve it"

Positive evaluation of the model – NZ 3

The various positive comments regarding the model and the application

Figure 5.6: Positive evaluation of the model from NZ 3's perspective

The model do not have a qualifying set of questions to start the audit process. Current set of questions may suffice

The five point scale may not correlate with the 6 point scale used by COBIT CMMI

The users does not have the facility to input compliance values

The model does not go into finer details (for measuring or auditing specific areas)

The questions in the dataset may not be relevant to the organisation

The questions and metrics are given equal weightage

The model is too basic in terms of features

There is no method to compare the results of the control objectives with similar industries

There is no provisions for giving a benchmark value in the application for the measured control objectives

The model is static and thus not flexible enough for users to customise the questions and metrics

The model does not have a provision for the users to add or modify the goal, questions or metrics

No guidance is provided for the questions and metrics

There is no provision of a risk factor for the questions and metrics

The model does use only COBIT which may not suit many organisations

The features provided in the model are basic

The database (metrics) is narrow

Issues with the model for NZ 3

There should be a layer or multiple layer called qualifying questions for starting the audit process

Each of the metric scores (1-5) should be explained so that users can know what each score mean

Apart from the performance measurement using scales, the compliance perspective feature can also be added

The application should be managed by the auditor. The questions/metrics should be selected by them

The questions need to be contextualised and explained with the target audience in mind

The questions and metrics should be assigned proper weightage

There should be a provision to incorporate the relevant industry benchmark along with the result which should be visible only to the auditors and not the users

The model should have a provision whereby the users can add and modify their own goals, questions and metrics

The generated scores should be able to be tracked over time using graphs and visual charts

Risk factor should be added for the questions and or metrics. A two dimensional system can be incorporated for the purpose

Need to incorporate commonly used IT audit and control frameworks into the model other than COBIT

There is a need to add more features to make the model commercially marketable

Where ever possible there should be a facility for the users to add layers so that for measuring specific areas they can go into much finer details

The reasons/causes for the various issues with the model --------------→ Suggestions or the way to solve the issues
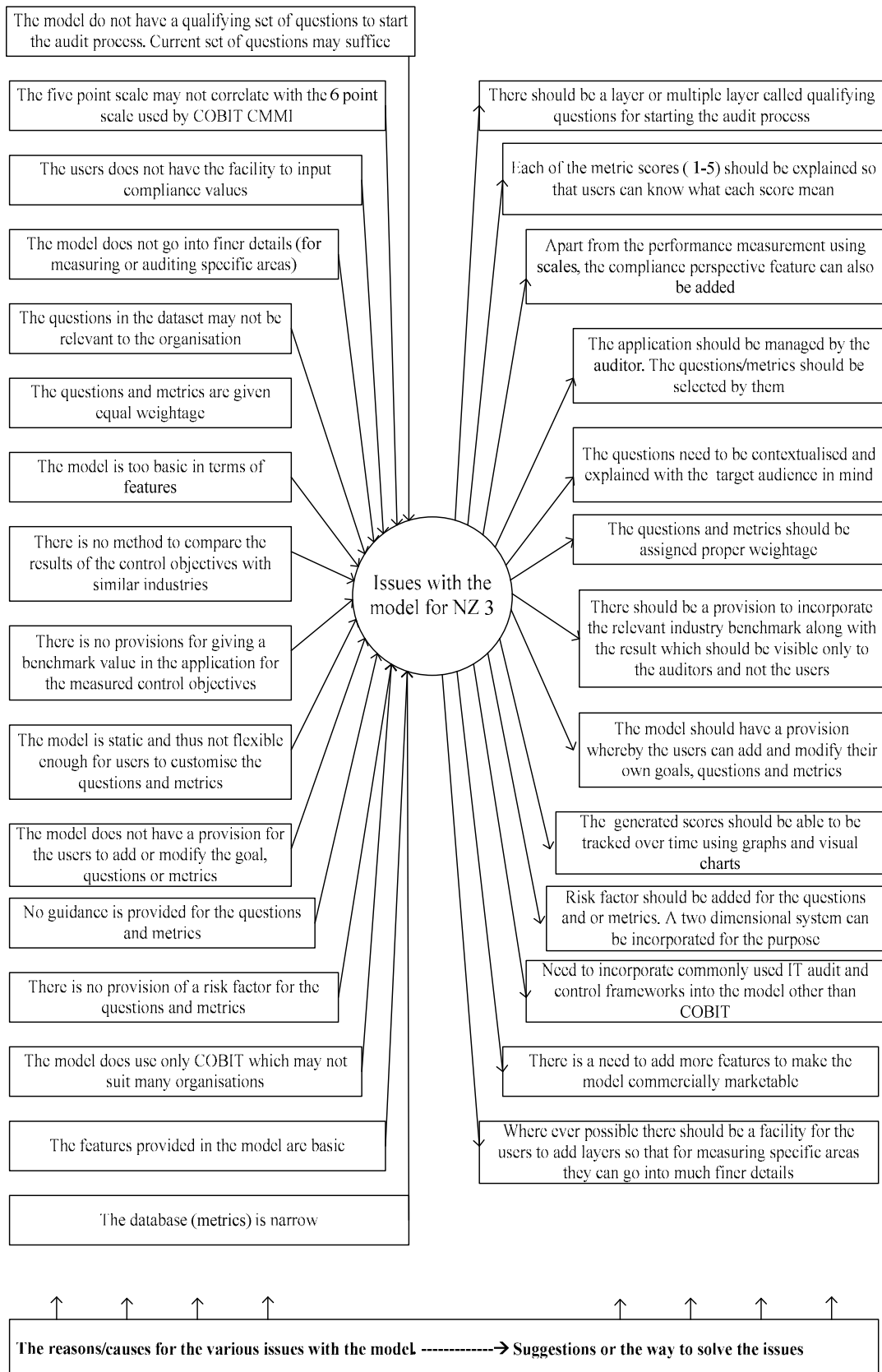
Figure 5.7: Issues with the model from NZ 3's perspective

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The respondent did not point out any issue of particular importance as most of the issues are more or less given similar emphasis. Being an audit consultant, he is viewing it from that perspective, and mentions about the missing contextual layer. Only two respondents have directly mentioned about the contextual layer and these two are IT auditors and the respondent does not evaluate the model from the perspective of the organisation that he works but rather from the perspective of the clients whom he audit, he has touched on a lot of aspects giving more or less similar importance to these.

The major issues can be categorized into four namely, the absence of context for the goals, questions and metrics, the absence of relevant benchmarking standards, the absence of other standards and the issue of functionality. This implies that he has looked at the model from two equal perspectives, where one is from a software application point of view and the other is from a model or methodology point of view. This was quite evident from the discussion the research had with the respondent and this implies that he certainly would like to use this application for his audit work provided the issues have been sorted.

The suggestions can be categorized as mentioned directly and implied, and those that have been interpreted by the researcher from the response. These are illustrated in the figure 5.7. Even though the suggestions provided covers most of the issues, there are some issues that need to be sorted out namely the expansion of the five point scale to 6 to correlate with COBIT CMM, the addition of a box whereby the users can also input a compliance value rather than a score, and the addition of a risk factor. From the nature of response given by the respondent, the researcher interpreted this as risk factor (which is similar to the one mentioned by NZ 2) where every relevant question have to evaluated on a two dimensional metric, where on one axis the weightage is given and on the other axis the risk factors are provided. Moreover relevant features and functions need to be added (based on the given suggestions) to make the model usable.

5.1.2.4 Assembling Taxonomy for SG – 1

This respondent being the most voracious critic of the model has also come up with positive evaluations of the model but to a less extend than NZ 2 and NZ 3. These are illustrated in figure 5.8.
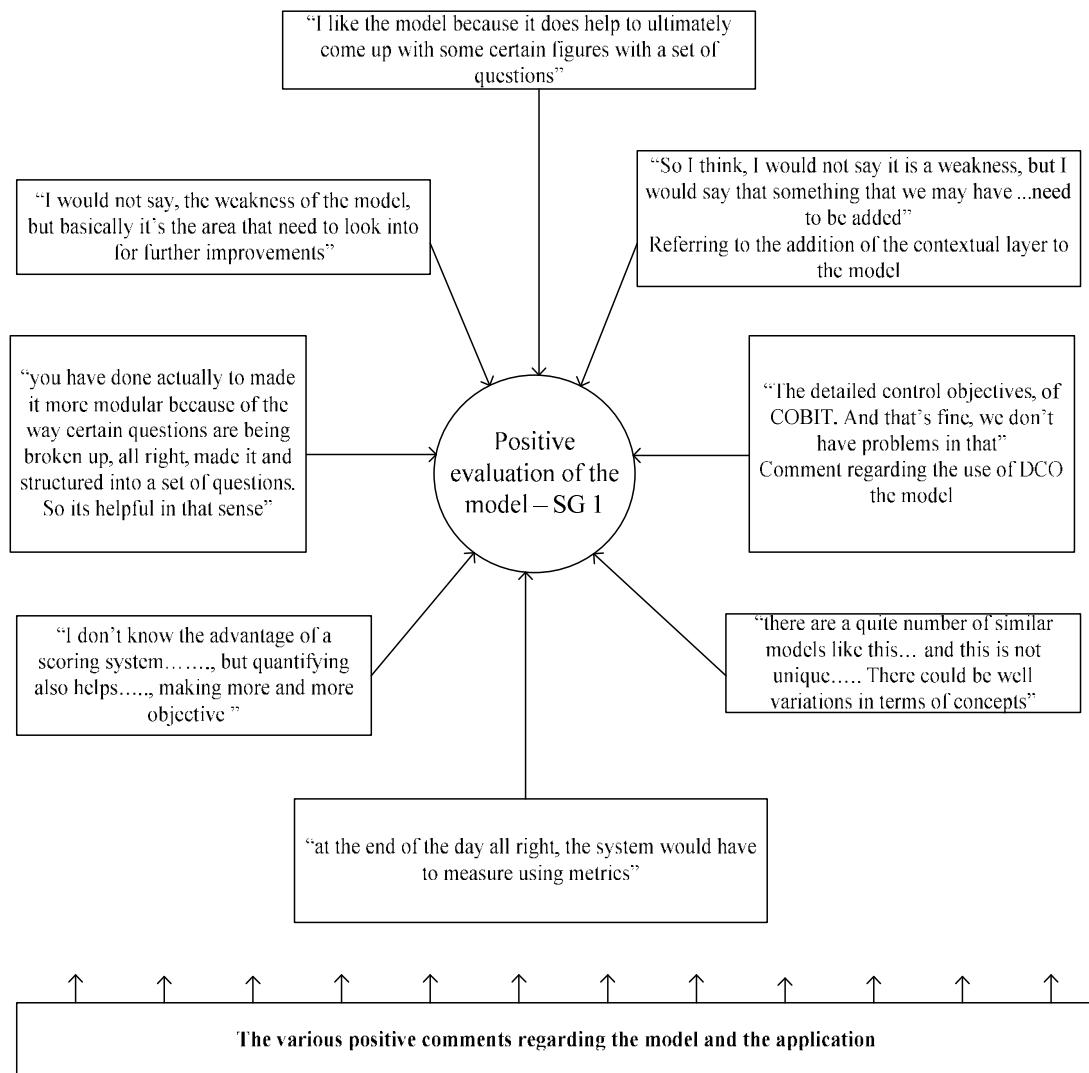
Figure 5.8: Positive evaluation of the model from SG 1's perspective

Regarding the issues the first, foremost and the main issue is the lack of a layer called the contextual layer that acts as a set of qualifying question that IT auditors normally ask to identify the area that are relevant for audit. Benchmarking is certainly linked with this issue as it also provides a context from an external perspective. The topic of 'clarifications of goals, questions and metrics got entangled in the contextual layer such that only those statements directly referring to the former had been included while the rest found its way into the latter issue. Another major issue that was discussed in great depth is the lack of auditing perspective in the model. This means that the model does not represent the method of auditing normally done by auditors and unless this is sorted out the "model will not help".

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Left column boxes (top to bottom):

A layer is missing in the model. The model do not have a qualifying set of questions to start the audit process. Current set of questions not sufficient

The interpretation of results is subjective/interpretive as the values provided may not give a meaningful picture of the measure of the control objective

The questions and metrics do not provide any context and thus subject to different interpretations

The model cannot be used as such for IS audit

IS audit does not start with COBIT. It comes in only at the lower level where IT is involved

IS audit use COs rather than the DCOs

The questions and metrics are given equal weightage

The model can be used for IS audit only with further improvements

The model does not have an audit perspective. No provision to give a compliance answer

The model is not simple

The reporting structure does not cater to different user groups

Only a practitioner/expert can comprehend the GQM template

The model does not have a provision for the users to add or modify the goal, questions or metrics

IS audit process does not use a scoring system but use a compliance system

The is no provision for multiple input as input provided by a single person may be biased

The model does not help in aligning the metrics to the goals as the contextual layer is missing

A 5 point scale does not suit when comparing different industries

There is no provisions for giving a benchmark value in the application for the measured control objectives. Hence the report is not meaningful

Center:

Issues with the model for SG 1

Right column boxes (top to bottom):

There should be a layer or multiple layer called qualifying questions for starting the audit process. These qualifying questions does the job of selection and contextualising

Once the contextual layer/layers are added the results will be meaningful

There should be a level above the 'goal' in the model to accommodate the KPI that auditors measure. The contextual layer should be juxtapositoned in between these two

Apart from the performance measurement using scales, the compliance perspective (yes/no; effective/not effective) feature can also be added

The model should have the facility to give different levels of reports – detailed to highly summarised reports

The GQM template should have guidelines for users to understand/training can be imparted to the users to use the model

The questions and metrics can be assigned proper weightage

There should be a provision to incorporate the relevant industry benchmark for the controls along with the result

The model should do only the necessary steps required for auditing and should reflect the auditor's thinking process

The terminologies used in the GQM template should be understandable to IS people

The questions, and metric should fit the relevant industry and target audience

The model should have the provision where the users can select either the CO and/or the DCO

The model should fit the needs of the IT audit people

The users should have the facility of adding and modifying the questions and metrics

There should be a provision where the model aggregates a score from multiple users or a panel of users give a score through consensus

Bottom legend box:

The reasons/causes for the various issues with the model. -------------→ Suggestions or the way to solve the issues

Figure 5.9: Various issues with the model from SG 1's perspective

Considering the suggestions, certainly the main focus is the addition of the contextual layer, and to incorporate the "thinking process of the auditors" into the model. Furthermore there are two areas where the respondent is in a dilemma. One is the use of scales and the other is the assigning of priority. In the case of assigning priority for the questions and metrics, he states that already the issues will be solved once the contextual layer is incorporated. Interpreting this statement the researcher believes that this can be done if the question in the contextual layer is classified into relevance categories. The respondent is highly averse to a quantifying scale but at the same time he has stated that quantifying really helps. Even at the end of the discussion he did not reach a conclusion as to whether compliance or a quantifying method is more appropriate. Thus it would be advisable if both a scale and a compliance method were incorporated into the model. Lastly all the four respondents have directly or indirectly mentioned that the model should have the feature where the users can add or modify the questions and metrics.

5.2 CREATING PATTERNS

This is a vital section (stage 4 of the five stage analysis) as this mainly involves comparing the data with the propositions. Since the cases are few, much of the tasks/strategies have already been covered in the previous section and thus this section is primarily devoted to audit the emerged themes against the propositions. Table 5.10 illustrates the planned strategies, the deviations and the rationale for these deviations.

Table 5.10: Steps in the 'creating patterns' stage (Audit of analysis plan – stage - 4)

Strategies	Actions taken
1. Sets of items that are identical or serve the same purpose will be identified wherever necessary	These two aspects have already been covered in section 5.1.1 while doing 'comparing and contrasting'. Since the cases are few there is no point to devote a separate sections for this
2. Themes that occur at the same time will be identified wherever necessary	
3. The propositions will be compared against the emerged themes	This being a critical section, will be discussed in great depth in this section
4. Looking for corroboration or triangulation may not be possible since only interviews are conducted. But wherever possible the researcher may look for any similar responses repeated in the transcript	This is not applicable since there is only a single type of source

Hence out of the four strategies only one will be discussed in this section. This section is divided into three sub sections for the purpose of comparing the emerged

themes with the propositions outlined in chapter 3. The first sub section deals with the extent of coverage of themes among the four propositions and this is quite similar to the second stage (section 4.2) of the proposed analysis and interpretations, but different because interpretations are presented. The second sub section looks at the links of other emerged themes with the proposition and how these have influenced the propositions. The third sub section deals with the explanation of each of the proposition on a case-by-case basis, for the purpose of comparing propositions to find out how far the responses have confirmed or denied the propositions. The similarities and differences are also analysed and interpreted within context.

5.2.1 Coverage of Propositions

This section that deal with the extent of coverage of the four propositions looks at the underlying reasons for the significance or the reduced coverage of the propositions among the four respondents. The purpose is to find out the variations if any and to provide the rationale for the variations in coverage for each case.

Table 5.11: The extent of coverage of the four propositions during the entire discussion with all the participants

	NZ 1	NZ 2	NZ 3	SG 1	Total
Proposition 1	16.36%	4.88%	0.67%	5.37%	**27.28**
Proposition 2	7.87%	12.17%	13.22%	16.73%	**49.99**
Proposition 3	4.00%	9.81%	8.43%	6.04%	**28.28**
Proposition 4	20.18%	44.56%	34.35%	46.02%	**145.11**

5.2.1.1 Coverage of Propositions for all the cases

The above table (5.11) gives the coverage of the four propositions (in percentage) based on the extent of coverage each of the propositions has been covered in the entire discussion with the respondents, while the table below gives the percentage of each of the proposition among the four propositions.

Table 5.12: The percentage of coverage of each of the four propositions among the total proposition coverage, with all the participants

	NZ 1	NZ 2	NZ 3	SG 1	Total %	Total NZ1+NZ2+ NZ3+SG4
Proposition 1	34%	7%	1%	7%	**10.88%**	49
Proposition 2	16%	17%	23%	23%	**19.94%**	79
Proposition 3	8%	14%	15%	8%	**11.28%**	45
Proposition 4	42%	62%	61%	62%	**57.89%**	237
	100%	100	100	100	**100%**	

Out of the four propositions the last one is the most comprehensive and the main one and hence the coverage of 57.89% is highly justifiable. Proposition 1 is the least discussed since the concept of measurement rarely comes into focus among IT auditors. Likewise the concept of scoring method (P3) is also discussed less because only three of the respondents found it worthwhile to discuss it. The second proposition is quite significant since it refers to alignment and the purpose of IT governance is to align IS goals with organizational goals. But here the concept of alignment refers more to the alignment of the metrics with the questions and the questions with the goal that it measures.
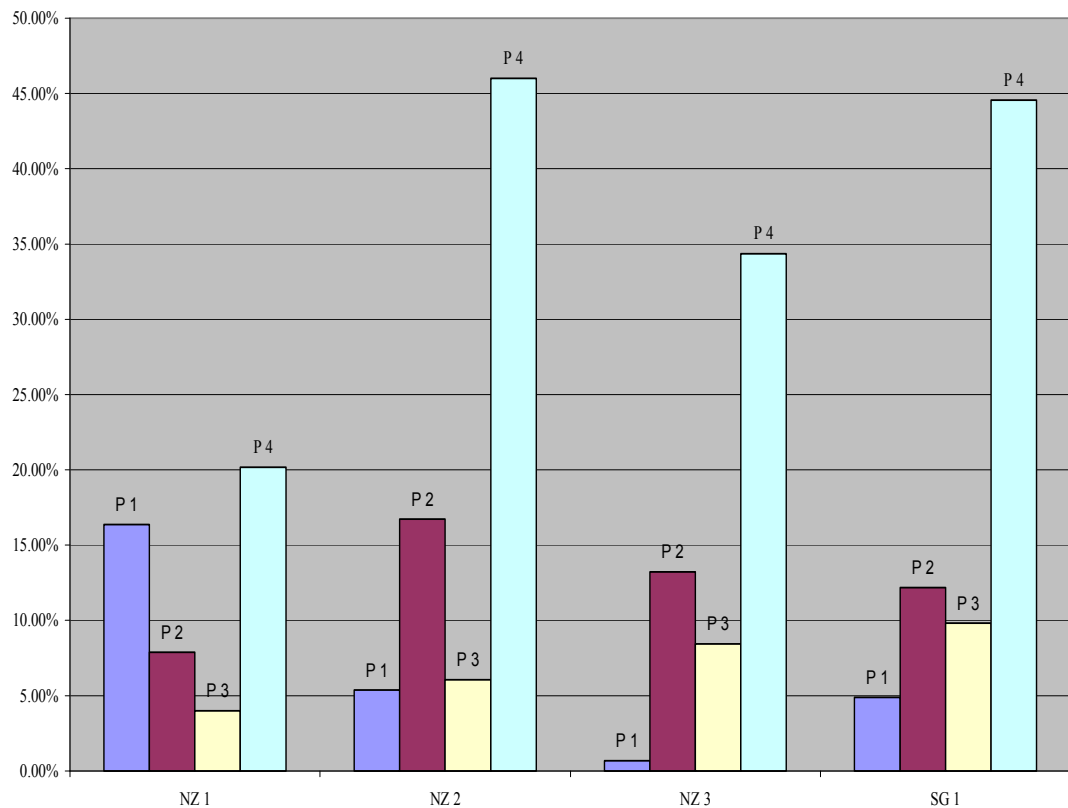
Figure 5.10: Chart showing the percentage of coverage of the four propositions for all the participants

5.2.1.2 Coverage of Propositions for NZ – 1
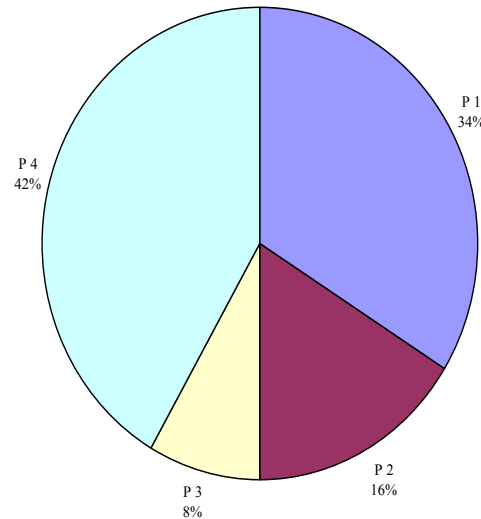
Figure 5.11: The coverage of each of the proposition for NZ 1

In terms of percentage the coverage of P1 within other 4 propositions, it is 34%, while in terms of other three respondents it is 69.38% ((34/49) * 100) this is the highest. The reason for the topic being discussed among all the other themes is that the respondent is not an IT auditor, but rather incorporate IT audit in IT security which is his main job. Hence they do give importance to the performance of hardware and software with less emphasis on audit. This is also the reason why for this respondent this is a leading factor among the four respondents.

For P2, the coverage of 16% among the four propositions, is still significant because a major issue cited by the respondent regarding the model is the problem of context and alignment of questions with the metrics and this is also the first comment in the discussion. Among the four respondents, ((16/79) * 100) = 20% can be regarded as average.

In the case of P3, the coverage of 8% is quite less both in the discussion and among the other four respondents. This may be due to the fact that, he being a IT security personnel and not an IT auditor, may not be in a position to compare and discuss in length the scoring method and the compliance method even though they

use both in their program. P4 is certainly a major factor as this is the main proposition and the whole research is about this.

5.2.1.3 Coverage of Propositions for NZ – 2
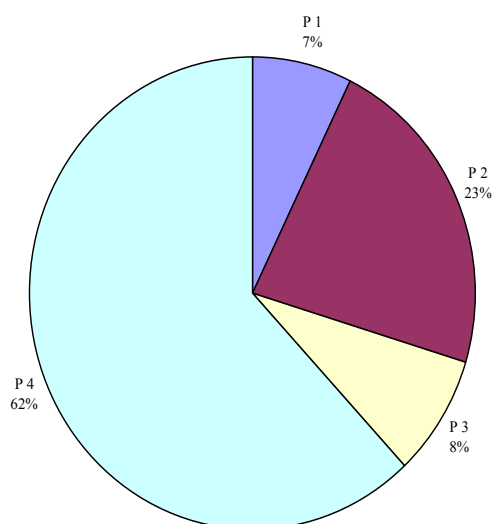
Figure 5.12: The coverage of each of the proposition for NZ 2

While a coverage of just 7% within the discussion is quite less, ((7/49) * 49) a coverage of 14.28% among all the four respondents denotes that this aspect was given due coverage. Since they do audit on a continuous basis, this was discussed to some extent. With a percentage of 17 within the discussion and ((17/79) * 100) 21% among all the four respondents this topic was given due weightage and there was nothing unusual about this. The problem of context is a major issue cited and the first one to prop up during the discussion. For P3, 14% coverage within the discussion is not less, but a coverage of 31% ((14/45) * 100) among all the rest is significant. Taking into account all the four respondents, this respondent has given the most importance to this proposition. This is due to the fact that currently they do not have a scoring system but would prefer to have one and the nature of discussion implied this point. The coverage of P4 is the maximum within and between the discussion and the respondents respectively. They spend huge sums of money to hire external consultants to do audit on a regular basis and thus the discussion centered on the model to a great extend.

5.2.1.4 Coverage of Propositions for NZ – 3

Even though it is quite unusual for this respondent to devote only 1% of the discussion to the first proposition, and ((1/49) * 100) 2% among the four respondents, a deeper look into the respondents background will reveal the real reason. All the three respondents represent their organisation and is in charge of the IT audit/governance functions, but this respondent is an audit consultant so there is no need for a tool that can measure the performance of IS on a continual basis. He goes around NZ and conducts audit in client organisations and give report and there is no guarantee of continuity for further audit in the same organisation. In the case of P2, while it seems that a coverage of 23% within the discussion is quite normal, the coverage of 29% ((23/79) * 100) among all the other respondents is significant. The clarification of questions and metrics is certainly a major point of discussion since he uses a similar set of questions for his audit process, but not the metrics. A coverage of 15% for P3 is significant considering the fact that among the four respondents this covered ((15/45) * 100) 33%. The discussion was mostly centered on the use of both the compliance and scoring method for audit. P4 is still the major point of within the discussion.
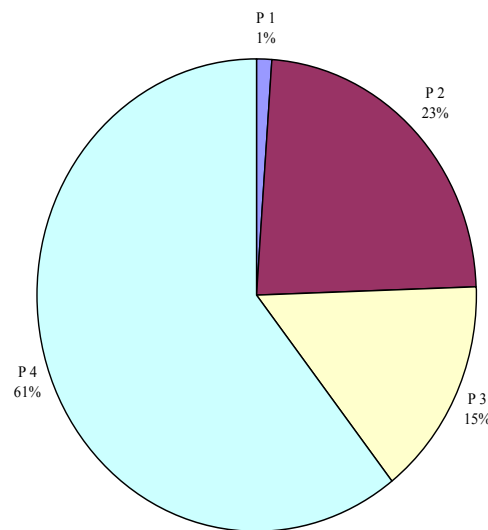
Figure 5.13: The coverage of each of the proposition for NZ 3

5.2.1.5 Coverage of Propositions for SG – 1
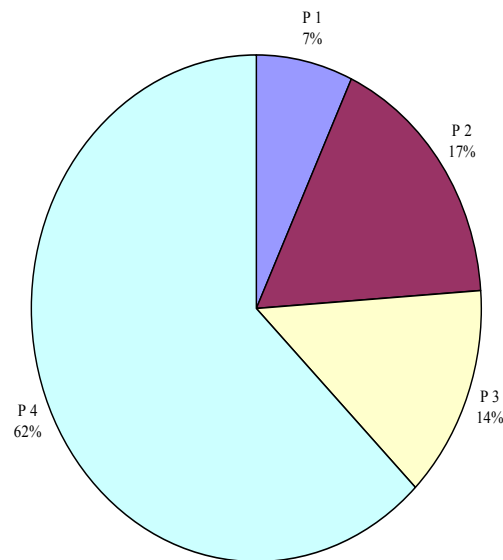
Figure 5.14: The coverage of each of the proposition for SG 1

With a coverage of 7% within the discussion and 14% ((7/49) * 100) among all the four this proposition have been given its due weightage in terms of the discussion of the topic but from a different perspective. Instead of measuring/evaluating IS effectiveness they would rather audit them on a continual basis. Regarding P2, with a coverage of 23% within the discussion and 29% ((23/79) * 100) among the other three respondents, this aspect have been discussed from the perspective of a missing layer called the 'contextual layer'. According to the respondent without this layer this model cannot be used for IS audit. P3 has been discussed comparing the relative merits and demerits of a scoring system when compared to the normal compliance method of auditing and since this proposition is not a major one a coverage of 8% within the discussion and 17% ((8/45) * 100) is significant. P4 is a major topic of discussion with this respondent.

5.2.2 Influencing Themes on the Propositions

This subsection looks at the direct and indirect themes that have an influencing effect on the four propositions (direct in bold and indirect in doted line boxes).

5.2.2.1 Influencing themes on the propositions for NZ 1
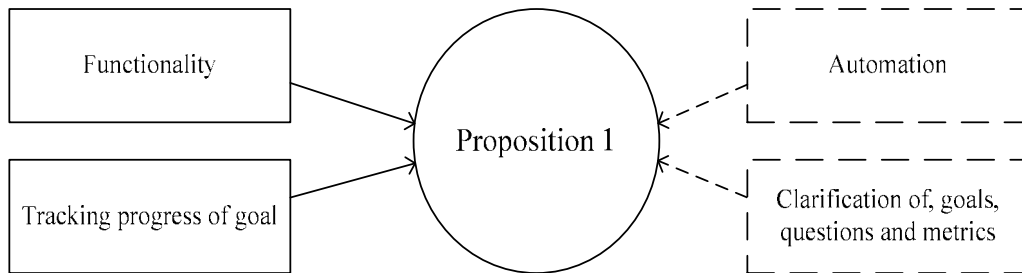
Figure 5.15: Influencing themes (direct and indirect) on proposition 1 for NZ 1

Even though, these two influence the proposition, indirect influences are automation, clarification of the goal, and benchmarking. Functionality is linked because to make the model usable on a continuous basis, some features need to be added to the model (which the respondent have suggested). Likewise without automation the process will be very tedious. The respondent have linked the clarification of goals, questions and metrics since this is necessary for continuous measurement, as people come and go in an organisation and consistent meaning to these are required.

The main theme in this proposition being the context based on which the questions and metrics are developed, this along with the clarification of goals, questions and metrics is a major influencing factor. Since measurement using benchmarked data and relevant standards are components of the context this is also an indirect influence on the proposition.
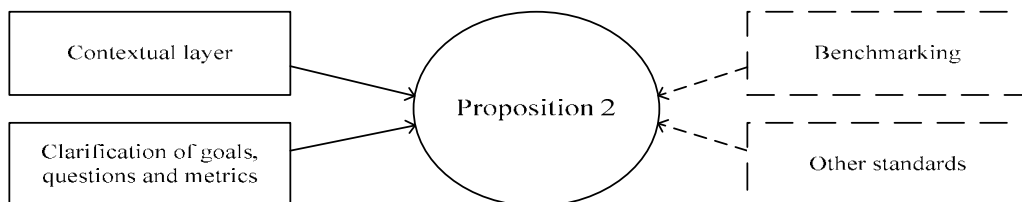
Figure 5.16: Influencing themes on proposition 2 for NZ 1
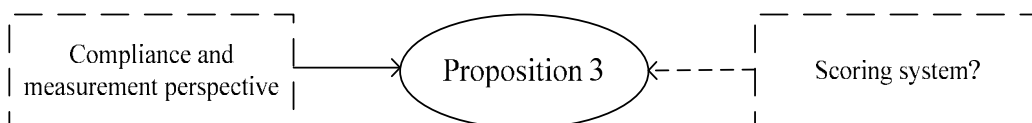
Figure 5.17: Influencing themes on proposition 3 for NZ 1

Since this proposition has not been given much weightage in the discussion, the only two indirect references are the reference where he remarked that they use both scoring and compliance in their audit exercise, and the reference to the scoring system (linked to COBIT CMM) when he stated that he is not an expert on comment on this matter. Hence the use of '?' regarding this theme. P4 being the main proposition almost most of the themes are directly or indirectly linked.
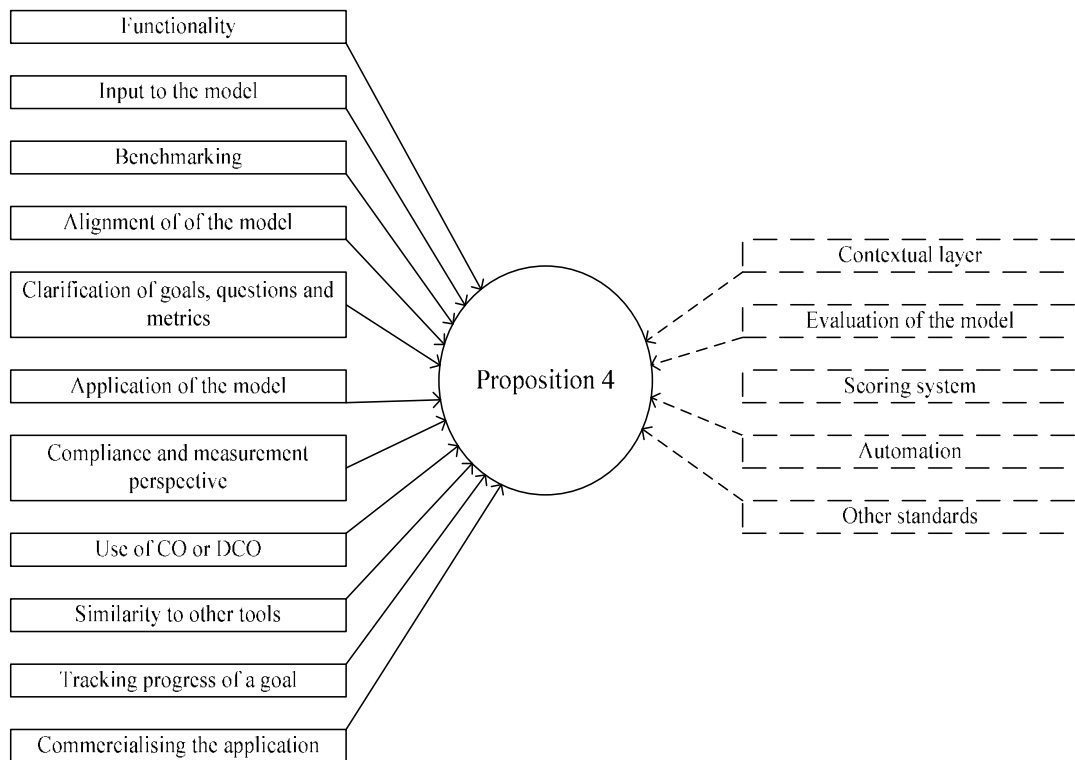
Figure 5.18: Influencing themes on proposition 4 for NZ 1

5.2.2.2 Influencing Themes on the Propositions for NZ 2

This is the respondent who emphasized that it is important for them to measure the performance of there is entities on a continuous basis. She pointed out the weakness of the current system as not continuous as they have to pay for external auditors who comes on an annual basis to do the work.
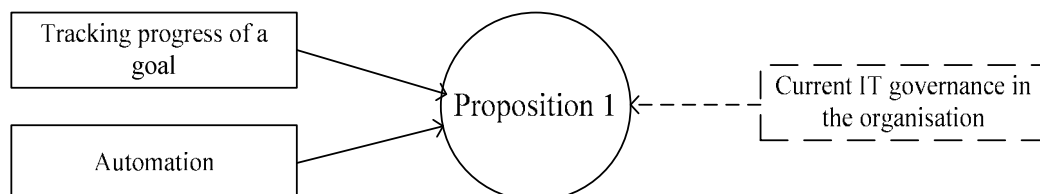
Figure 5.19: Influencing themes on proposition 1 for NZ 2

A major percentage of the discussion focused on the context and the need for clarity of the goals, questions and metrics. The incorporation of the benchmarked values of standards from relevant industries were also discussed and it was implied that these would certainly add context along with the incorporation of relevant standards..
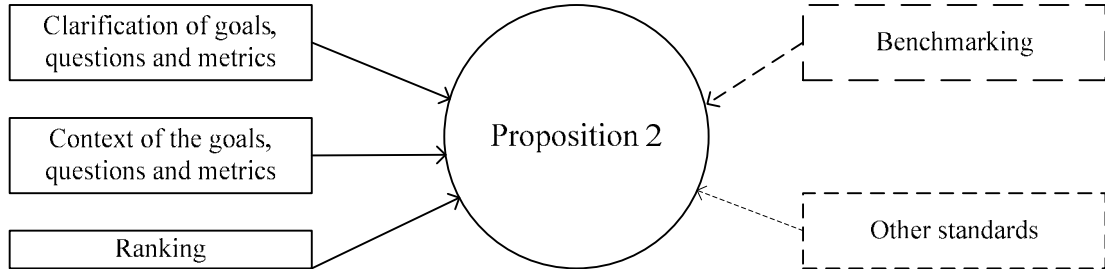
Figure 5.20: Influencing themes on proposition 2 for NZ 2

For proposition 3, the issue of a scoring system was discussed from the point of view of ranking and quantifying thus stressing the need for this aspect in the audit process. The indirect reference to 'clarification of goals, questions and metrics' was from the point of view of detailing the meaning of the scores (metrics) so that the users can know what each value denote.
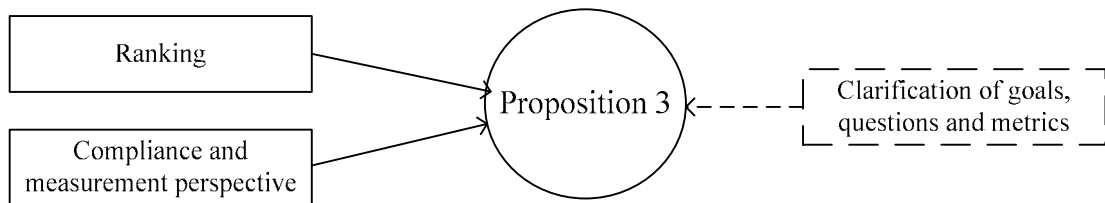
Figure 5.21: Influencing themes on proposition 3 for NZ 2

Being a major topic, this proposition has been discussed in great depth from various perspectives. While discussing the context of the goals, questions and metrics (which is major issue), the researcher deduced the need for a contextual layer even though this was not directly mentioned. Likewise the evaluation of the model implied the satisfaction with the current GQM format, and alignment depends on context.
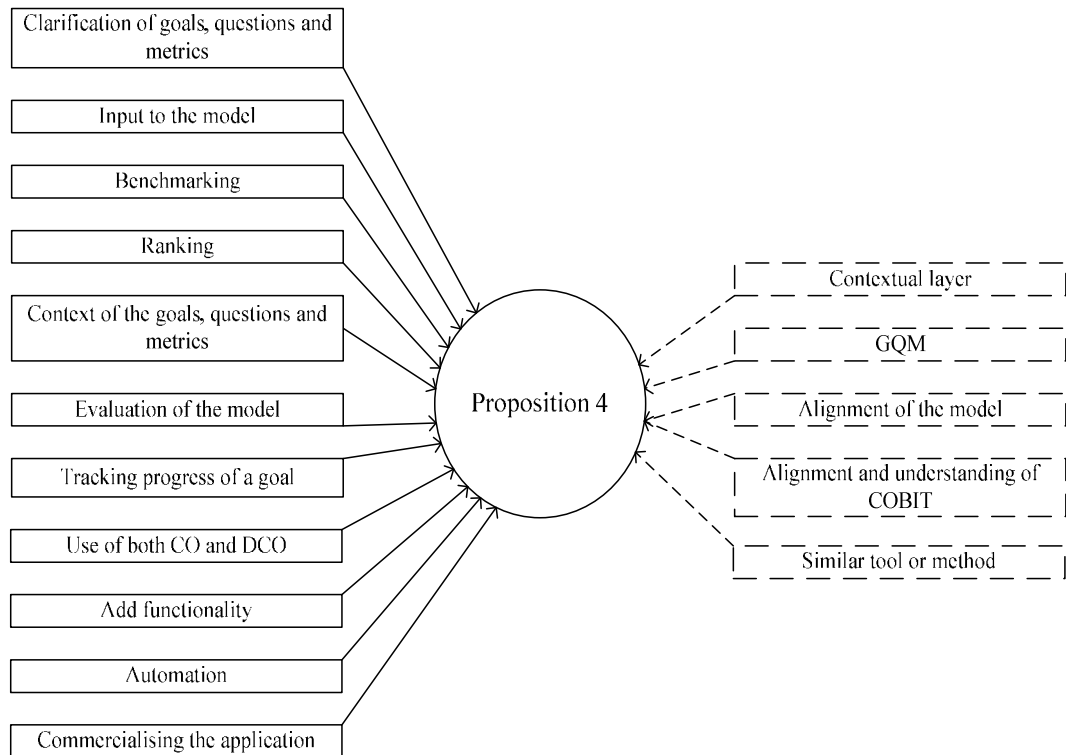
Figure 5.22: Influencing themes on proposition 4 for NZ 2

5.2.2.3 Influencing Themes on the Propositions for NZ 3

Being an audit consultant, the respondent might not have expressed the need for a system like P1.
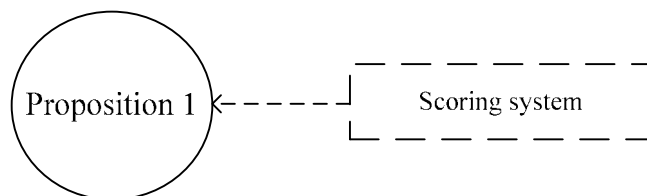
Figure 5.23: Influencing themes on proposition 1 for NZ 3

Contextual layer and the need to detail the questions and metrics are indeed relevant irrespective of audit being viewed from an external or an internal perspective. The ranking of the questions and metrics provides relevance (weightage) to see which is relevant and which are not, while benchmarking and the incorporation of other standards also provides a comprehensive context for measurement or audit.

235
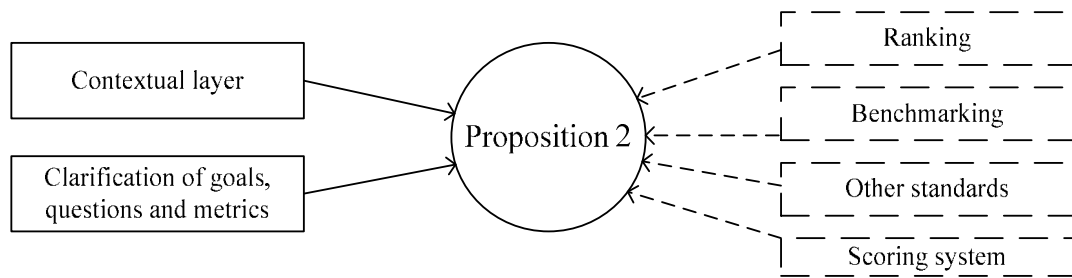
Figure 5.24: Influencing themes on proposition 2 for NZ 3

A scoring system is influenced by the ranking provided to the questions and metrics and the presence of 0 – 5 scale of COBIT CMM gives a basis for using this. Subsequently since the purpose of CMM is to find a benchmark, this aspect is also indirectly linked.
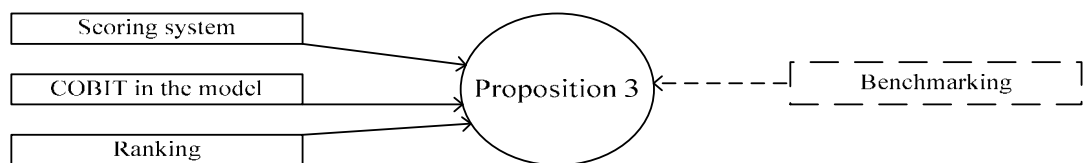
Figure 5.25: Influencing themes on proposition 3 for NZ 3

The issues are mostly discussed from the perspective of suggestions to be incorporated in the model. While the evaluation of GQM was not directly mentioned various cues pointed out the indirect reference of this in the model. If you need to commercialise the application then automation is required. Discussion of scoring method touched on the use of this in measurement and audit and the mention of looking at an overall picture to granular details in audit point to the use of both CO and DCO.
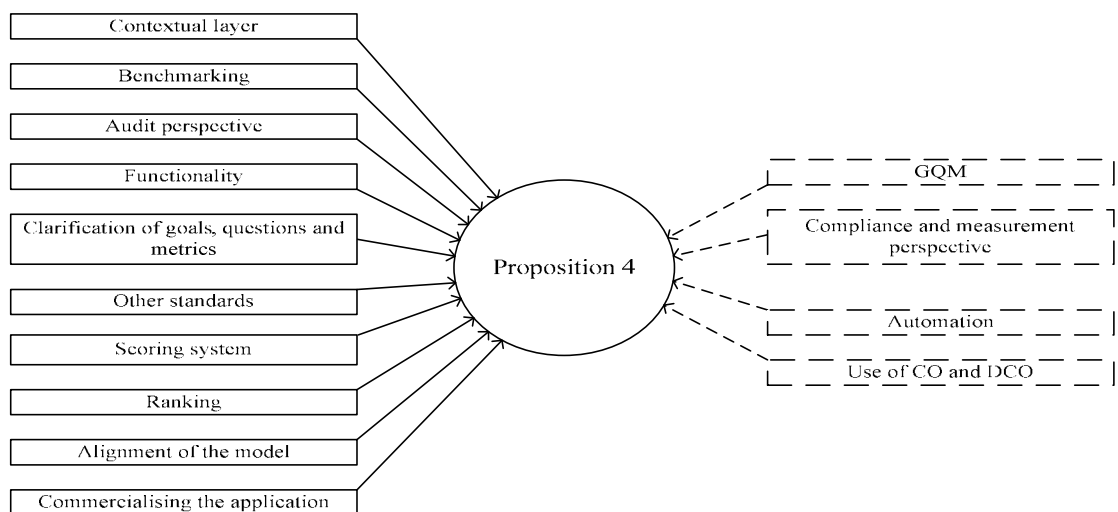
Figure 5.26: Influencing themes on proposition 4 for NZ 3

5.2.2.4 Influencing Themes on the Propositions for SG 1

Much of the discussion with this respondent was from the perspective of the way audit and IT governance is done in the organisation. Hence both the direct and indirect themes reflect this aspect.
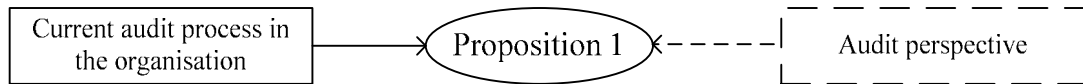
Figure 5.27: Influencing themes on proposition 1 for SG 1

He is the only respondent who emphasized the contextual layer and went to great depth in describing this drawing on the board citing numerous examples of its usage in their organisation.
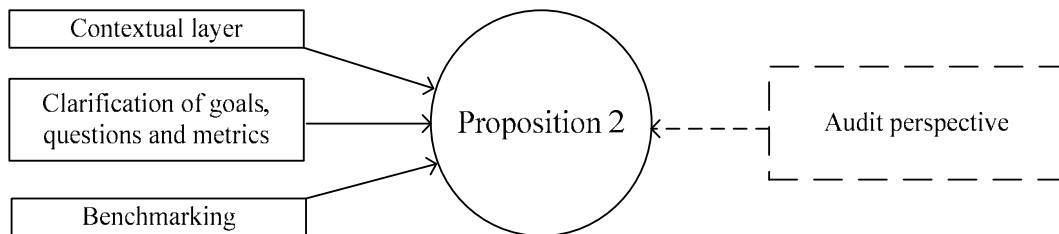
Figure 5.28: Influencing themes on proposition 2 for SG 1

The need or use of a scoring system was discussed directly from audit and measurement perspective. The non usage of a scoring system in their regular IT audit has also influenced his decision regarding this proposition.
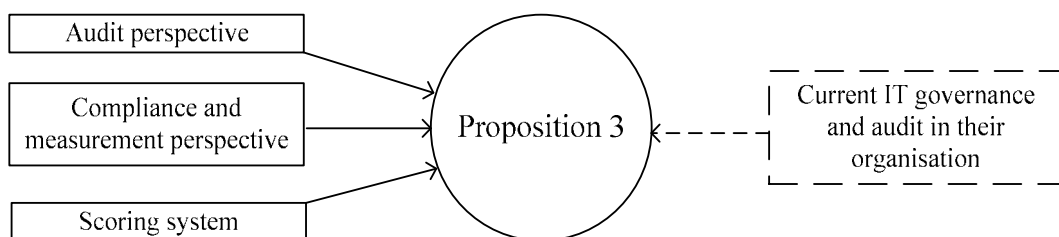
Figure 5.29: Influencing themes on proposition 3 for SG 1

The respondent being a very direct critic, most of the issues have been refereed to directly and to the point. Even though the point of automation was not touched, the incorporation of the suggestions and interpreted suggestions necessitate the need for automation. Like wise since their audit does not solely depend on COBIT, there is an implied need to incorporate relevant industry standards into the model.
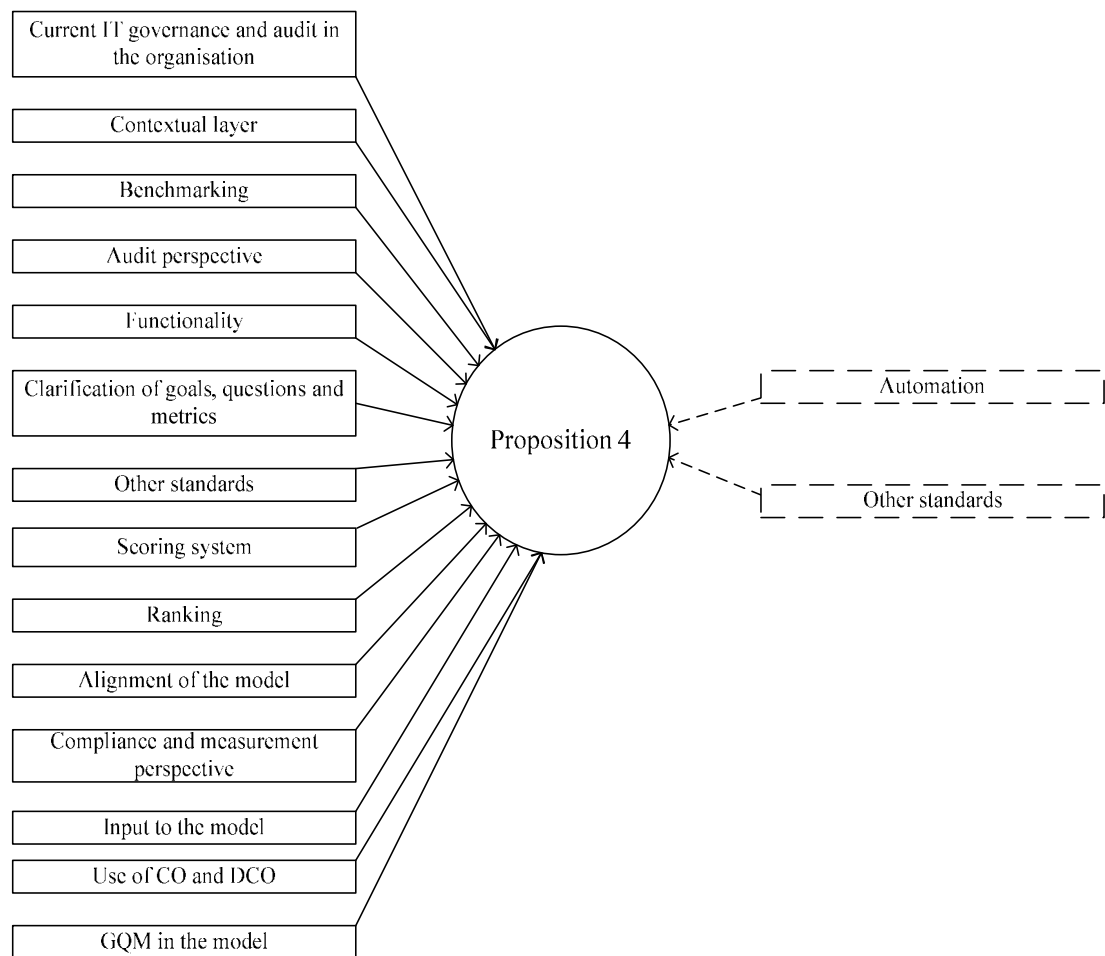
Figure 5.30: Influencing themes on proposition 4 for SG 1

5.2.3 Comparing Themes with the Propositions

This section takes into account the four propositions to compare it against the derived themes to find out how far the nature of statement in the themes support or reject the propositions. To give a very detailed view of the process, each proposition is taken and compared against all the four respondents taking the summary of statements that have supported or rejected the proposition.

5.2.3.1 Comparing Themes with Proposition 1
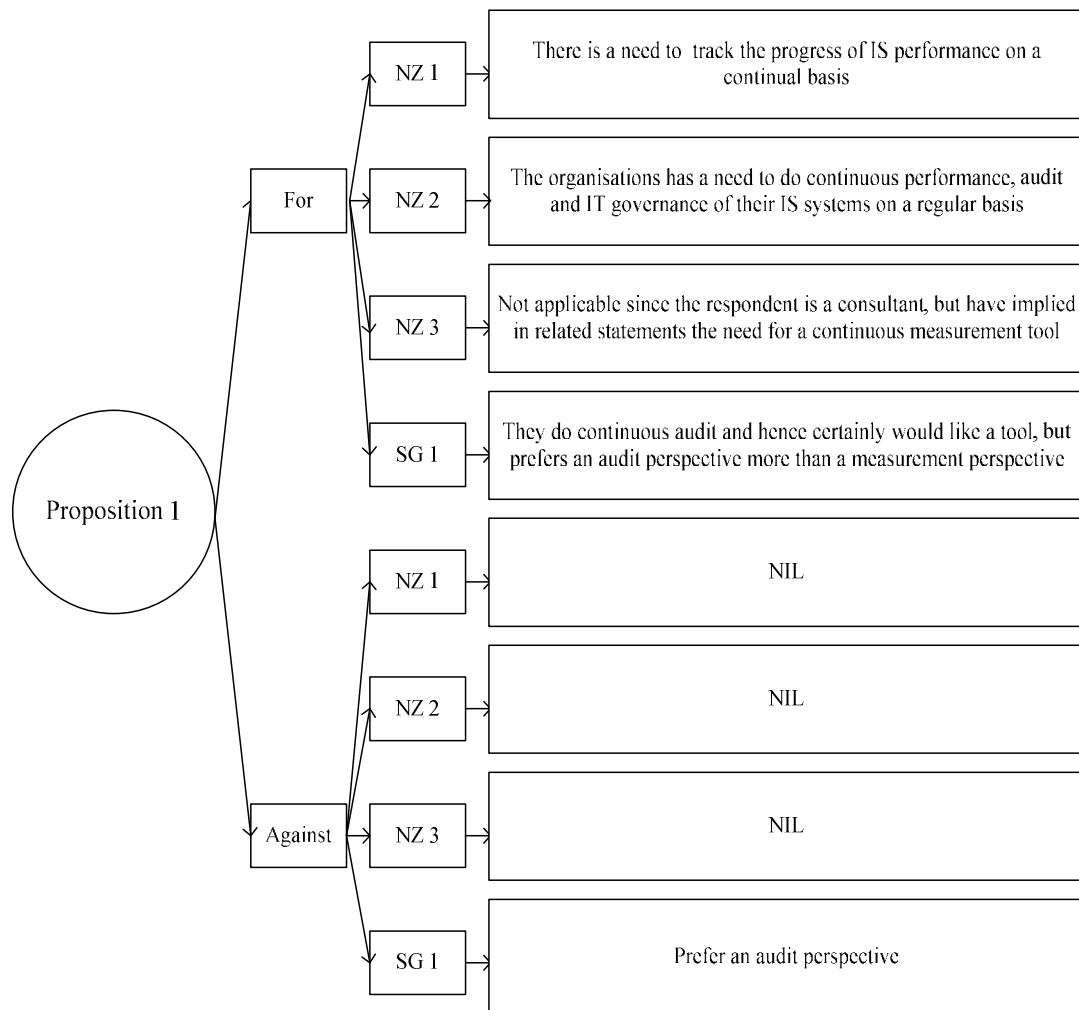
Figure 5.31: Correlating themes with proposition 1

Out of the four respondents two respondents have directly stated that they need to measure IS on a continual basis. Both are doing the process currently in their organisation manually. The third respondent being an audit consultant is not in a position to state the need directly because he does IS audit in a client organisation for a fixed period and then moves to another organisation. The fourth respondent who has very clearly detailed the whole IT governance and audit process in their organisation implied that they do need to audit but not measure the IS entities. In the light of the above responses the empirical research supports the proposition

5.2.3.2 Comparing Themes with Proposition 2
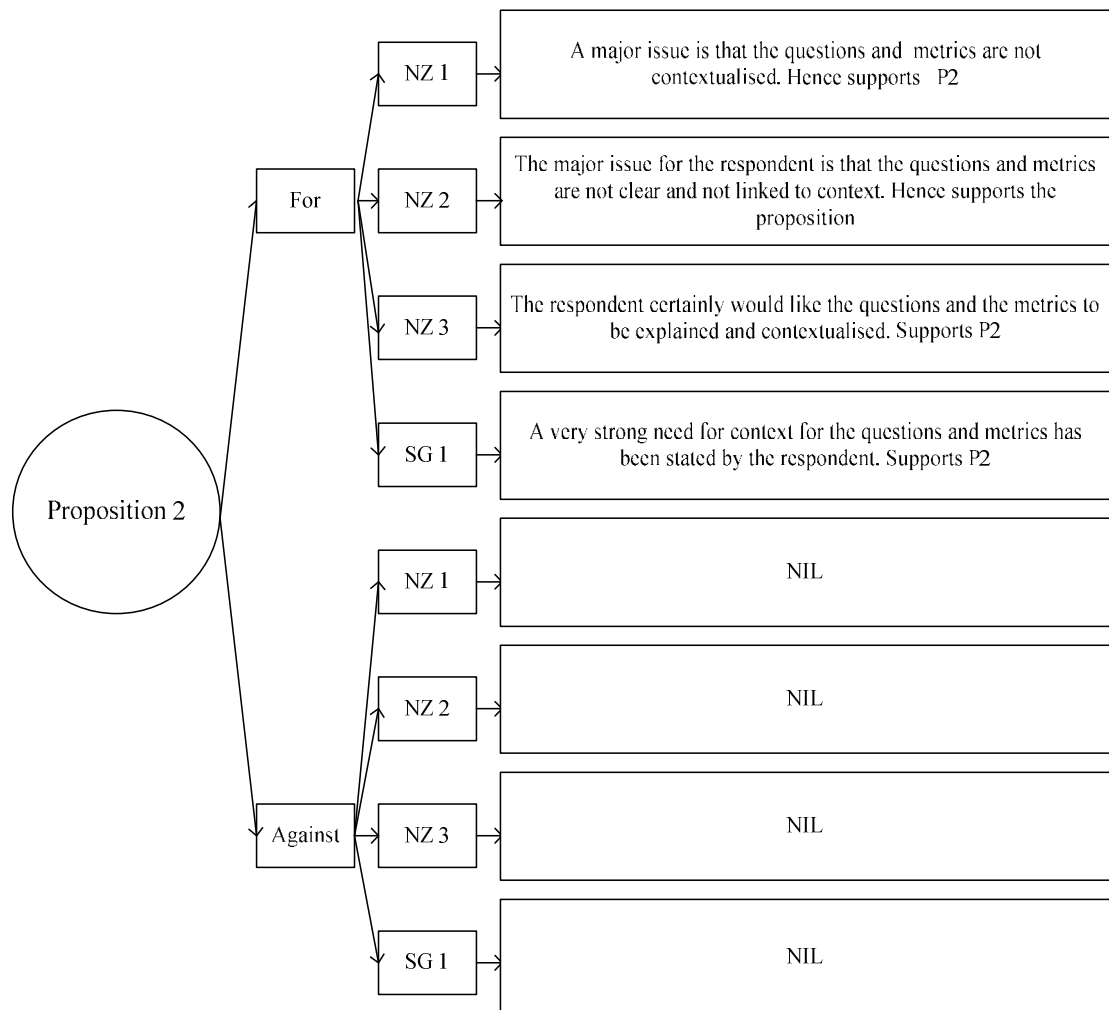
Figure 5.32: Correlating themes with proposition 2

Regarding position 2, there is a very strong need for a contextual basis for generating metrics. None of the respondents were quite happy with the metrics in the database even though these have been derived using the GQM method by the researcher without using any context. But three of them were happy with the way that metrics have been generated using the GQM method. Hence there is a strong need to customize the metrics to the organisation using context. Thus there is a very strong support to the proposition.

5.2.3.3 Comparing Themes with Proposition 3
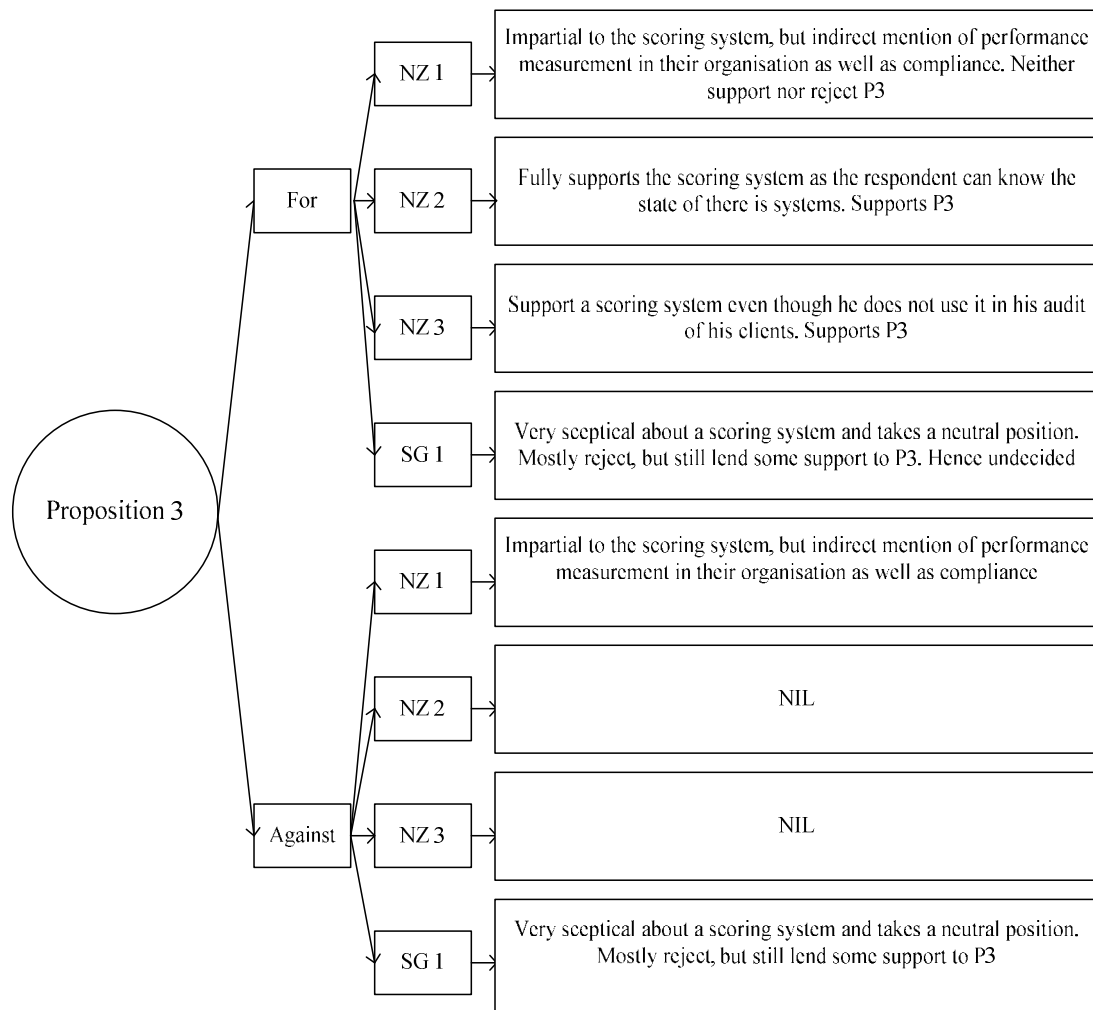
Figure 5.33: Correlating themes with proposition 3

There are mixed feelings to this proposition from various respondents. Out of the four respondents only two respondents (NZ 2 and NZ 3) fully lend support to this proposition and they both use COBIT in their audit work. Even though NZ 1 taken a neutral stand, he is not averse to the method and does quantifying in their performance measurement. The strong criticism of this method came from SG 1 who defends the current compliance method. But he does not give a complete response. On one occasion he tells that this method does not help in IT audit, on another occasion he does admit that quantifying does help. This discussion went on for some time without reaching a conclusion. Since this respondent is also fully knowledgeable about COBIT and use COBIT for their governance process, it is not easy to drive this proposition to a conclusion. Hence further focused research on this topic needs to be done to bring it to a conclusion.
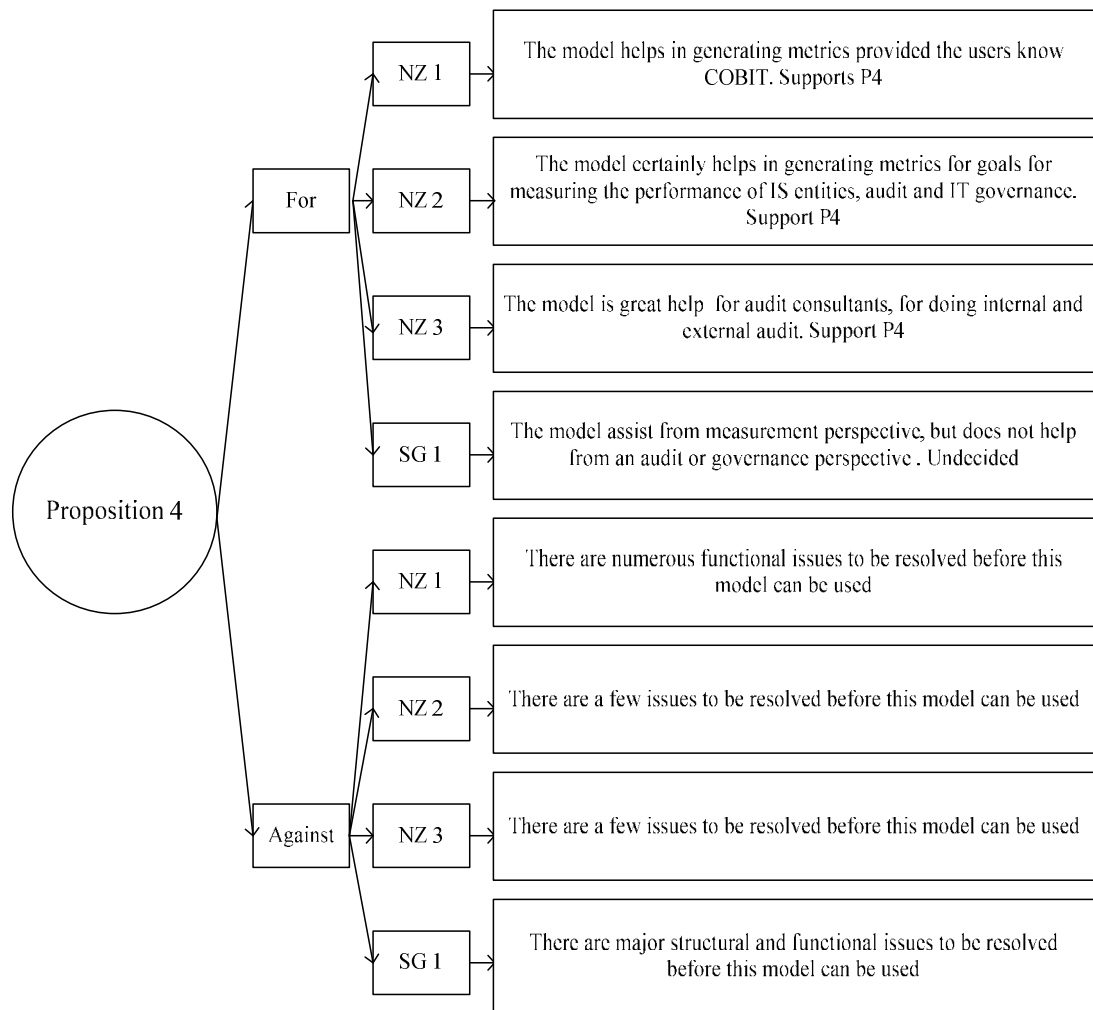
5.2.3.4 Comparing Themes with Proposition 4

Figure 5.34: Correlating themes with proposition 4

This is the main proposition as it encompasses all the other three propositions. The model is very basic and is an automated version of the theoretical model presented in the literature review. No additional features have been added to the model as it is the respondents who have to suggest the features. Hence all the responses were positive but subject to the condition that the issues stated by the respondents have to be resolved. Looking at the strength of issues from a quantifying perspective on a 1 to 5 point rating scale (with 1 being few issues and 5 being most issues with the model before it can be used by any organisation) the issues presented by NZ 1 can be regarded as 3, NZ 2 as 2, NZ 3 as 1, and SG 1 as 4.5). Hence based on the above the proposition 4 is fully supported.

5.3 ASSEMBLING STRUCTURES (ANSWERING THE RESEARCH QUESTION)

Even though this section is termed 'assembling structures' the research question is answered here. In this section the different cases and propositions are grouped and assembled into structures, and linked to provide an overall description of the outcome of the research. This step being a creative process and is a summary of the previous two stages the emerged ideas and patterns from these two stages will be grouped and linked together to provide a meaningful picture. Moreover advice for developing a matrix (referred to in section 3.6) will be followed.

5.3.1 Evaluation of the Model (Issues and Suggestions)

The figure 5.35 illustrates the overall issues and the suggestions regarding the model provided by all the respondents. The issues are given on the left side of the figure while the suggestions on the right side. All the issues provided by the four respondents have been summarised and combined to present an overall picture. Likewise the same has been done for the suggestions. Even though the purpose of the research is to find out the answer for the research question (How can an IT audit or governance framework be used to measure the effectiveness of IS entities in a scientific manner using customised and goal aligned metrics?), the answer is fully discernable only through the evaluation of the theoretical model. Hence it was deemed appropriate to illustrate this visual summary here in the last stage of the five stage analysis. Each issue has already been discussed separately in detail. Thus the text in the figure has been summarised and explained in detail to provide a detailed summary.
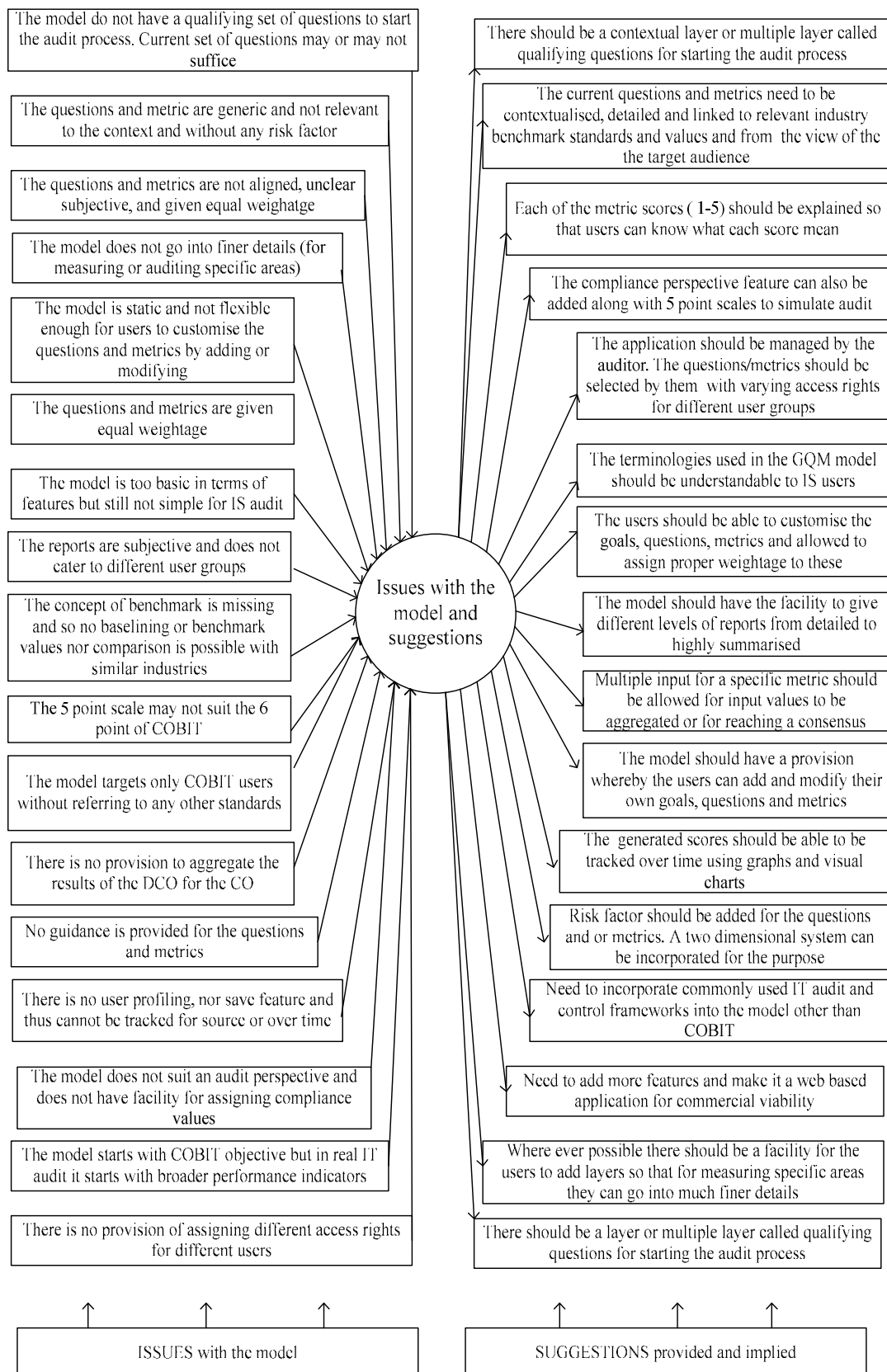
Figure 5.35: A detailed summary of major issues with the suggestions

5.3.2 Answer to the Research Question – The New Model

In this section the issues and suggestions have been taken into consideration and incorporated into the COBIT-GQM model. Since the resulting model is not specific to COBIT and incorporates the compliance perspective also, it has been renamed as the IS audit measurement model and since GQM is only a tool to generate metrics the name has been removed.
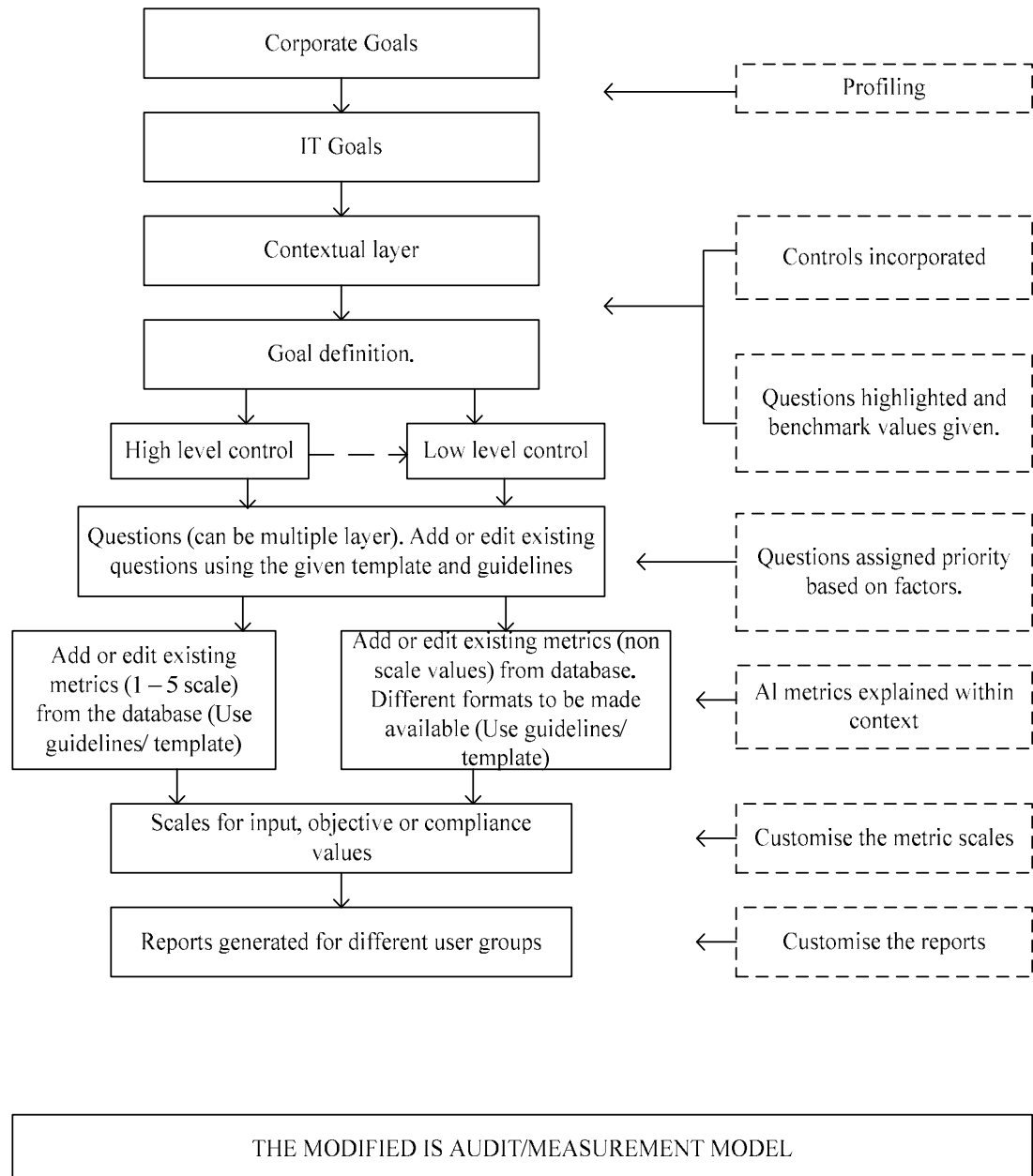

Figure 5.36: The modified model (based on the evaluation provided through the four propositions)

Four major changes from the existing model are: the addition of a multiple contextual layer (to start the audit process of identifying relevant areas), a multiple questions layer (to drill deep down for specific areas), the provision of using the CO or DCO or use DCO and an analytical engine will compute aggregate all the values of the DCO for the CO, and the addition of compliance perspective where they can add values like 'yes/no', 'effective/ineffective', as requested by the respondents. Other additions include the provision of not only GQM template but other relevant templates for generating audit oriented questions and metrics, providing detailed explanation of existing questions and metrics with context, the flexibility to customise the scales, and a two dimensional tool for assigning priority for questions along with risk ranking. Relevant industry standards are provided where the users can either make a blend of different controls from different standards or choose one. Industry relevant values for the metrics are also provided for comparison and benchmarking.

5.4 CONCLUSION

The resulting modified model (RM Model) that has been shown in figure 5.36 has been derived not only by resolving the explicit and implicit issues pointed out by the respondents, but also is the result of incorporating the stated and implied suggestions. While the initial attempt in this research was to incorporate a measurement perspective to the IT audit framework, to enhance the value of IT auditing, the resulting concept provided a multifaceted approach to not only IT auditing, but also aids in the measurement of IS standards. This presents a holistic view of IT governance to the organisations. Moreover the added attraction of automation of the composite process of IS audit and control, (given the fact that the audit process is currently being done manually) will provide further impetus for organisations to adopt the model. Thus from an industrial perspective the primary economic benefits in terms of productivity and efficiency are immense but not calculated in this research. Furthermore the divergent contribution of the knowledge to the IS domain can give rise to further research in the field.

The research method adopted being case study, involving four participating organisations, may not lent the model to be generalised unless and until the model is tested through a quantified approach with a moderately large sample covering

diverse organisations for different countries. The study limitations were sufficient that further research is possible and that many other interpretations are possible. However the proto-type (software model) has gone through proof of purpose and is now ready for further development.

Chapter – 6

Conclusion

6.0   INTRODUCTION

In chapter 1 a brief over view of some of the problems identified for research were outlined. In chapter 2 each of these areas of concern were researched in depth to identify specific issues to address. In section 1.1 the relevance of measurement to IS and to business performance was introduced. On page 4 the key problem of measuring IS performance was put into the scope of IS professionals and top management and the requirement for greater specifics to address the measurement issue in a "more exact manner" (p. 4) identified. The issue of the more recent control framework approaches to measuring IT performance was raised and framed as a problem of 'how to do'. The claim was that the finer aspects of doing the measurement activity were inadequate in these frameworks (p. 5).

Consequently the research question concerned measuring the effectiveness of IS entities in a scientific or more exact way. The purpose of the research was to work out a practical model for measuring dynamic information systems entities in enterprise systems using customised goal oriented metrics balanced towards an IT audit perspective. These metrics had a direct link to the enterprise goals and hence also addressed the concern of enterprise (business) - IT alignment. A software proto-type was developed from the principles located in the literature review and then tested in a set of enterprise systems. The outcomes reported in chapters 4 and 5 provide a clear summary of capability and limitation for the (software) model. Figure 5.36 gives a definitive summary of the findings. These findings concerned the proto-type and the need for further development.

The following sections are structured to conclude the thesis. In section 2 the contributions of this research to the body of IS measurement knowledge is summarised and potential further applications speculated. In section 3 areas for further research are elaborated. These include the possibility of adding capability

maturity measures to future software models and the enhancement of contextual layers to better serve the audit requirement.

6.1 CONTRIBUTIONS TO RESEARCH BODY OF KNOWLEDGE

To evaluate the contributions this study has made to the IS domain, a two pronged approach is taken in this section. One is to look at the findings from an academic perspective and the other through an organisational perspective and both of these are evident in these sub-sections.

6.1.1 Comprehensive Model for IT Governance

The most important contribution of the research is the presentation of a comprehensive model for IT governance measurement. The research pointed out the need for a comprehensive model that can do IT governance, audit, and control standards using customised and contextual information where the metrics can be aligned up to the highest level of goals. Thus this is an attempt to unify and bring together the disparate exercises done in the field of governance, audit, IT security, control standards and benchmarking. It has been observed from the research that in some organisations, IT governance is not done as a separate entity on its own, but rather it is part of a large audit where the IT governance framework only comes wherever IS, is involved. Hence an IT governance framework is modified to suit the respective audit exercise. In other organisations, IT governance is done as an audit exercise where a set of frameworks namely COBIT, ITIL and relevant IT security ISO and BS standards are combined and implemented simultaneously. The modified model serves the purpose of incorporating all of these into one audit exercise, including the provision of benchmarking, the additional of a contextual layer and compliance audit.

6.1.2 Automation

As per the responses from the respondents the current audit of information system is done manually and may take several days or longer. The entire process goes through a series of steps namely an initial overview of the areas to audit, deciding on the control objectives including modification if necessary, creating a set of qualifying questions, preparation of a set of metrics and templates. Thus even with the widespread usage of computers and softwares, an important aspect of the

audit exercise is that it is still done manually in all the target organisations and by the audit consultants. Thus an automated model would greatly aid in conducting an efficient and effective audit. It has also been noted that due to the expertise required for conducting the audit and the enormity of the exercise the audit is done only when it is mandatory and when the concerned personnel feels that it adds value. Thus external consultants are called to do this exercise, and also it is done only once a year or once in two years. With the modified model, the organisations have three options. First they can scale down the work of the external consultant by doing a pre-audit using the model. This will bring down the cost and to do the audit. Secondly small and medium organisations that cannot afford to bring in an external consultant can do the audit themselves with the help of the model. Thirdly once an external consultant has done the audit the organisations can import the templates, goals, questions and metrics used by the consultants into the model and can do the audit themselves saving them the cost for further audits.

6.1.3   Benchmarking

During the review of literature the concept of benchmarking was not considered an important aspect. However it is an important aspect of IT governance. The empirical research has shown benchmarking, its relevance and application in IT governance and audit.   With the exception of the audit consultant all the respondents had emphasised the importance and value of using benchmark values from the same industry or sector in arriving at meaningful value in the reports. The researcher has made sufficient provisions and options to incorporate benchmark values into the model to enhance its value.

6.1.4   Software Engineering

Contrary to belief that the GQM model is more suitable for software development and that it is not easily comprehensible to the IS personnel, none of the respondents have expressed any real difficulty in understanding the GQM model nor questioned its presence in the IT governance domain. Even though none of the personnel interviewed had any knowledge of the GQM model, it was observed that they use similar methodology to derive questions. This indicates that the GQM methodology can be safely used in the IT governance domain. When

questioned whether the model need to be changed to suit more of the IS perspective two respondents have suggested to leave it in the current state. One respondent expressed his desire to change the terminology to make it clearer to non IT personnel. One of the most startling statements came from an audit consultant who when asked about the inclusion of the GQM model into the proposed model under research, stated that he uses a similar set of questions for auditing but without using any known method.

6.1.5 Control Standards/ Framework

The idea of incorporating a control framework into the model give rise to the idea that the methodology of doing an IT governance audit and ISO standards are quite similar in operation. A common framework can be framed to incorporate standards and this has been done in the modified model.

6.2 AREAS FOR FURTHER RESEARCH

Even though there are numerous areas where the research can be pursued further to arrive at a quantitative outcome, five major areas of research have been indentified and summarised in the following sections. The key areas are the prospect of generalising the research, adding a scoring method to IT audit for the various perspectives, the methodology of linking the maturity model to the model, incorporating benchmarking values and standards, and the concept of the contextual layer.

6.2.1 Generalisation of the Model

The final model is the result of four case studies done in two countries. These cases aided in testing and evaluating the theory proposed in the literature review. However the results of few case studies are not intended to generalise the findings further. Hence to give a more objective and precise result for the purpose of generalising the model, it is highly recommended to test the revised model on a larger sample using a quantitative survey covering more countries and more relevant sectors and enterprise systems. The automated model can be sent to several organisations along with a survey. A more convenient methodology is to create a website for the purpose, with comprehensive details of the model and its purpose, along with a downloadable link to the automated model, with an online

survey form incorporated into the website. The identified participating organisations can be issued a unique number by email and access given to the application stored on a secure server for download.

6.2.2 Adding a Scoring System to IT Audit

The concept of incorporating precise measurement (using a 5 or 6 point scoring system) in IT audit has been approached differently by the four different cases respondents. While the two IT audit experts have an impartial view on incorporating measurement in IT audit, (On one side they said that they are so used to the current system that they don't see the need for a measurement approach while further down the interview they admitted that an objective view also helps), the IT governance respondent fully accepted the fact that this would add value to IT audit. A slightly different approach was taken by the IT security personnel (who is also in charge of IT audit) who saw value in measurement only if it is linked to industry benchmarks. Thus to generalise, a quantitative approach to this problem would greatly help in arriving at a conclusion. Secondly if a matrix can be generated with the categories of IS personnel on one dimension and the relative acceptance or non acceptance to this scoring method on the other dimension, rich and valuable information can be obtained. To do this a quantitative survey with a large sample would be preferable.

6.2.3 Linking a Maturity Model to The Model

The focus of this study was to research incorporating a measurement focus to IT audit, and thus the concept of incorporating the maturity model into proposed model was quite unexpected. This being a separate area of research on its own, it was not pursued further as this would deviate the focus of the research. The levels in the COBIT maturity model (MM) or the CMMI are entirely different from a simple scoring system. Even though one respondent has suggested modifying the scoring system to reflect the COBIT MM, and the other two respondents indirectly implying the need for the incorporation, the methodology of incorporating a COBIT MM or a CMMI model has not been provided by them and thus it is an unclear area. It would be of great interest to explore this further and to find out the methodology of incorporating capability maturity, and whether

like COBIT MM the levels should remain at six or should reflect the five levels of the CMMI.

6.2.4 Incorporating Benchmarking

All the four respondents were unanimous in echoing the need for incorporating a tool for benchmarking against similar sectors and/or organisations. Distilling the responses relating to this theme, the respondents stated the necessity to compare the score of an internal control or control objective of similar organisations with theirs. In a perfect world this would seem possible, but in reality, if it has to happen, then most of the similar organisation should be using the same internal controls/control objective, using the same five point scoring systems and the respective scores are available to competitors, which is not easily possible. Hence, there is a need to research the aspect further to elicit further information in this regard. There are solutions and one such solution is an internal target that has been decided by a consensus by the company experts and the other is a value provided by large consultants (who are in a better position to know due to their wide experience in auditing numerous organisations in most of the sectors) or even industry experts can be consulted to arrive at a figure. This is a promising and possible area for future research.

6.2.5 Contextual Layer

A major factor in undertaking the IT audit is qualifying layer/layers of questions that determine whether the area of audit is relevant and that helps in converging on the area of audit. One respondent defined this as a contextual layer (a list of questions that define the context) that is asked for the purpose of choosing the right areas for audit. The layer has been described in much detail through illustration and diagram, and the exact position of the layer in the model has been pointed out by the respondent. The layer is also multiple which means one, two or three layers of qualifying questions can be asked. When quizzed about when to stop the questions, the respondent replied that when it is detailed enough. But this is very subjective as different personnel have different perspectives of the term 'detail'. Hence it would be worthwhile to further research this layer and define a method or set of factors that can be applied to all contexts that determined when to stop asking the questions and when deciding on the area of audit.

6.3   CONCLUSION

The research and the subsequent model that have emerged shows that the model will greatly aid an organisation's ability to perform an IT audit and the measurement exercise. Like a pilot of an airliner constantly updating herself/himself of the various level of performance/state of the aircraft's controls and equipment by looking at the scores of dials in the cockpit, so would a manager (top, middle or lower) like to update herself/himself with the performance/state of the relevant IS entities in the organisations. The feedback loop not only provides valuable information for correction, control and decision making but also aids in the plan-do-check-act (TQM) cycle.   This research leads towards a comprehensive model for continuous improvement and alignment of the IS and IT function with the enterprise system goals.

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2. Nicho, M. (2004b). CRM Implementation Success Factors. In B. Cusack (Ed.), *The Proceedings of the NACCQ 2004 Post-Graduate Symposium* (pp. 43-48). Auckland: Trumps Ltd.

3. Nicho, M. (2004c). Optimising Software Integration for Effective Customer Relationship Management. *Unpublished M.Bus. Thesis*. Auckland University of Technology**.**

4. Nicho, M. (2005). The Quest for a Deterministic Model for IT Audit Compliance Using Software Metrics. 2005 International IT Governance Conference, Auckland *(Held at the Copthorne Hotel, Auckland on the 15th and 16th of November, 2005).*

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6. Nicho, M. (2006). *COBIT as an Effective Measurement Framework for Measuring Information Systems.* Paper presented at the Third International IT Governance Conference: IT Risk - Strategic Measures for Performance, Value & Quality.

7. Nicho, M., & Cusack, B. (2007, January 3-6). *A Metrics Generation Model for IT Audit.* Paper presented at the 40th Hawaii International Conference on Systems Sciences, Hawaii

M E M O R A N D U M
Auckland University of Technology Ethics Committee (AUTEC)

To: Brian Cusack
From: **Madeline Banda** Executive Secretary, AUTEC
Date: 19 June 2007
Subject: Ethics Application Number 06/241 **Information Technology audit: systems alignment and effectiveness measures.**

Dear Brian

Thank you for providing written evidence as requested. I am pleased to advise that it satisfies the points raised by the Auckland University of Technology Ethics Committee (AUTEC) at their meeting on 22 January 2007 and that on 1 May 2007, the Chair and I as the Executive Secretary of AUTEC approved your ethics application. This delegated approval is made in accordance with section 5.3.2.3 of AUTEC's *Applying for Ethics Approval: Guidelines and Procedures* and is subject to endorsement at AUTEC's meeting on 9 July 2007.

Your ethics application is approved for a period of three years until 1 May 2010.

I advise that as part of the ethics approval process, you are required to submit to AUTEC the following:

- A brief annual progress report indicating compliance with the ethical approval given using form EA2, which is available online through *http://www.aut.ac.nz/about/ethics*, including when necessary a request for extension of the approval one month prior to its expiry on 1 May 2010;

- A brief report on the status of the project using form EA3, which is available online through *http://www.aut.ac.nz/about/ethics*. This report is to be submitted either when the approval expires on 1 May 2010 or on completion of the project, whichever comes sooner;

It is also a condition of approval that AUTEC is notified of any adverse events or if the research does not commence and that AUTEC approval is sought for any alteration to the research, including any alteration of or addition to the participant documents involved.

You are reminded that, as applicant, you are responsible for ensuring that any research undertaken under this approval is carried out within the parameters approved for your application. Any change to the research outside the parameters of this approval must be submitted to AUTEC for approval before that change is implemented.

Please note that AUTEC grants ethical approval only. If you require management approval from an institution or organisation for your research, then you will need to make the arrangements necessary to obtain this. Also, should your research be undertaken within a jurisdiction outside New Zealand, you will need to make the arrangements necessary to meet the legal and ethical requirements that apply within that jurisdiction.

To enable us to provide you with efficient service, we ask that you use the application number and study title in all written and verbal correspondence with us. Should you have any further enquiries regarding this matter, you are welcome to contact Charles Grinter, Ethics Coordinator, by email at charles.grinter@aut.ac.nz or by telephone on 921 9999 at extension 8860.

On behalf of the Committee and myself, I wish you success with your research and look forward to reading about it in your reports.

Yours sincerely

Madeline Banda
Executive Secretary
Auckland University of Technology Ethics Committee
Cc: Mathew Nicho mathew.nicho@aut.ac.nz

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Appendix 2

Empirical Research: Stage - 1

INTRODUCTION

The first part of the research mainly involves identifying the frequently used control objective and the detailed control objective of COBIT by the audit community in New Zealand. Six experts were identified through the ISACA Auckland chapter who has practical knowledge of COBIT and IT auditing. Another objective is to find out whether the respondents can use the GQM model to derive questions from the stated control objective/detailed control objective and subsequently derive metrics from the questions. The entire 6 selected sample were emailed the COBIT-GQM template, and only three experts responded. Out of the three respondents only two of them were able to fill the entire template by selecting a control objective from COBIT, deriving the questions and the metrics to an acceptable GQM standard. The other one respondent could only email back the template with just the selected control objective.

Analysis

Since the request was send in the form of email attachment, and there was no questionnaire, but just a COBIT-GQM template the only information available about the background of the respondents were the position they held in the respective organisations. Here the main objective being the identification of the control objectives to include in the database of the model, not much analysis is called for. Table 4.1 below gives the profile of the respondents and the nature of response:

Respondents	Industry	CO/DCO selected	Filled template
1	IT Audit	AI 2	Yes
2	IT Audit consultant	DS5	Yes
3	IS Quality Assurance	AI 7.3	No

The response rate of completely filled up template points to the difficulty of deriving metrics using the GQM model. Even though it is not proper to generalise with such a small sample the fact that the respondents are senior and middle management levels in the IT audit/security and assurance departments, helped the researcher to select the control objectives to derive questions and metrics for the database of the model. An interesting feature observed in the responses was the selection of the control

objectives rather than the detailed control objectives for deriving metrics by the majority of them. Since this was not an interactive exercise there was no way to find out the reason for this, but by asking this in an appropriate context during the interview session in the second stage of the data collection.

The two filled up GQM template was analysed to see if the questions and metrics have been derived as per the guidelines attached. Since the questions conform more to the IT audit these are slightly modified to conform to the GQM format. Likewise the provided metrics have been modified to suit a rating scale to ensure uniformity to conform with the proposed conceptual model. Contrary to expectations, two of the responses were high level control objective rather than the detailed control objectives. And since the questions and metrics (as per the GQM model) would rather suit a low level goal, it was decided by the researcher to create questions and metrics for the 11 DCOs of DS 5.

CREATING THE DATABASE

The front end of the model that was developed using VB 2005 Express Edition was attached to MS Access database for the back end. The first step in creating the database involved incorporating the goals, questions and metrics given by the experts with suitable modification to ensure compliance with the GQM model. The two COs that came back fully filled up were slightly modified to suit the GQM guidelines and the proposed model. Since DS 5 was selected by one expert, the researcher decided to develop the goals, questions and metrics for the entire 11 DCOs of the DS 5. Thus the second step involved developing questions and metrics for the 11 DCOs of DS5 and AI 7.3 by following all the three criteria. This exercise took a full three months and 48 modified questions, 265 new questions, 34 modified metrics and 460 new metrics were developed. The goals (COs and DCOs) provided by the experts and those taken from COBIT were also restructured to suit the goal template of the GQM model. These set of goals, questions and metrics were entered into the database and finally connected with the VB front end.

Appendix - 3
Templates for Using the GQM Model to Generate Questions

(A filled up sample [below] is provided for guidance. This is a product related goals since the object is 'PLAN')

1. Goal template

DCO/Goal
Assess the performance of the existing plans and information systems in terms of contribution to business objectives, functionality, stability, complexity, costs, strengths and weaknesses (PO1.3)

Object to be measured	Purpose of measurement	Measured property (quality focus)	Subject of measurement (viewpoint)	Measurement context (environment)
Existing plans	Performance	Functionality, stability, complexity, costs, strength, weakness	Business Executive & CIO	Organisation/ department

2. Question template

Three major sub-goals	Guidelines to be followed for developing questions	Sample Questions
Definition of the product	Physical attribute Cost Changes & defects	- How far is/are the plan/plans clear, effective and user friendly in conveying information? - How far are the costs reasonable? Was it within budget? - How many times in an year was the plan modified? - How many defects are evident in the plan/plans?
Definition of the quality perspectives	Major models used Validity of the model Validity of data Model effectiveness Model substantiation	- Does the plan/plans confirm to the business/IT objective? - How far is/are the plans functional? - Do the plan/plans provide stability? If so how far is it stable? - Is/are the plan/plans simple or complex? How far is/are the plans simple/complex? - Are the results consistent from various perspectives? - List out the number of weakness/defects in the plan/plans - Is clarity of objectives, functionality, stability, complexity, costs, strength and weakness the best way to measure the quality of the plan/plans?
Feedback for improving the product	Quantitative feature quality Quality problems Suggestions for improvement	- What is/are the quality level of the present plan/plans? - What are the problems regarding quality of the plan/plans? - How can we improve the quality?

3. Metrics template

Question	Q1	How far is/are the plan/plans clear, effective and user friendly in conveying information?
Metrics	M1	Rating scale for evaluating clarity
	M2	Rating scale for evaluating effectiveness
	M3	Rating scale for evaluating user friendliness
Question	**Q2**	**How far are the costs reasonable? Was it within budget?**
Metrics	M4	% of cost overruns from the budgeted amount
Question	**Q3**	**How many times in an year was/were the plan/plans modified?**
Metrics	M5	Number of times the plan was modified
		Number of times requests were made to change the plan/plans
Question	**Q4**	**How many defects are evident in the plan/plans?**
Metrics	M6	Number of defects in the plan/plans
Question	**Q5**	**Does the plan/plans confirm to the business/IT objective?**
Metric	M7	A rating scale that measures the level of conformance to business objective
Metric	M8	A rating scale that measures the level of conformance to IT objective
Question	**Q6**	**How far is/are the plans functional?**
Metric	M9	A rating scale that measures the level of functionality
Metric	M10	% of functionality problems encountered in the plan/plans
Question	**Q7**	**Do the plan/plans provide stability? If so how far is it stable?**
Metric	M11	A rating scale that measures the stability of the plan/plans
Metric	M12	The time span/duration when the plan/plans are stable
Metric	M13	The number of times in a period where the plan's stability was questioned
Question	**Q8**	**Is/are the plan/plans simple or complex? How far is/are the plans simple or complex?**
Metric	M14	A rating scale to measure, with simplicity on one end and complexity on the other end.
Metric	M15	% of complex areas in the plan/plans
Question	**Q9**	**Are the results consistent from various perspectives?**
Metric	M16	A rating scale that measures the consistency of the plan/plans

Metric	M17	% of inconsistency in the plan/plans
Question	**Q10**	**List out the number of weakness in the plan/plans**
Metric	M18	Number/percentage of major weakness in the plan/plans
Metric	M19	Number/percentage of minor weakness in the plan/plans
Question	**Q11**	**Is clarity of objectives, functionality, stability, complexity, costs, strength and weakness the best way to measure the quality of the plan/plans?**
Metric	M20	A rating scale that measures the extend to which clarity of objectives, functionality, stability, complexity, costs, strength and weakness is capable of measuring the goal/DCO "assess the performance of the existing plans and information systems"
Question	**Q12**	**What is/are the quality level of the present plan/plans?**
Metric	M21	A rating scale that measures the level of quality of the plan/plans
Question	**Q13**	**What are the problems regarding the quality of the plan/plans?**
Metric	M22	Number/percentage of problems regarding quality
Question	**Q14**	**How can we improve the quality?**
Metric	M23	The extend to which quality can be improved

The COBIT-GQM Template (Process*)

These are a set of three templates for generating metrics from goals. The DCOs of COBIT that are relevant to an organisation for measuring the information systems entities can be chosen for the goal. The template is based on the Goal Question Metrics model proposed by Basili and Rombach (1988) to generate metrics in the field of software engineering. The first step is defining the goal and these goals can be taken from COBIT. You may choose any one or more of the 316 DCOs for the purpose.   *(List of 316 goals attached)*

1. Goal definition template

Goals (DCOs) are defined according to five perspectives as detailed in the table below

(Some goals may not have five perspectives)

> *Please write the goal here. You may take it from COBIT or modify it or can create your own goal*

DCO/Goal				
Object to be measured	Purpose of measurement	Measured property (quality focus)	Subject of measurement (viewpoint)	Measurement context (environment)

> You may break up the goals into five perspectives and put these into the five boxes

Once the goals are defined, the next step is to define the goal into quantifiable questions. These questions are derived from the five perspectives.

* Process implies that the objective of the IT goals is to evaluate a process in the information systems domain (e.g., maintenance, risk management, procedure etc).

2. Questions generation template

In this process, quantitative questions are developed as the guidelines given.

(The five perspectives of the goal and the questions guidelines help in this process.

Three major sub-goals	Guidelines to be followed for developing questions	Sample Questions
Definition of the process	Quality of use *(an assessment of how well it is performed)* Domain of use *(an analysis of the process performer's knowledge concerning this subject)*	
Quality perspectives of interest *(e.g., reduction of defects, cost effectiveness etc.)*	Validity of the model/process *(Appropriateness of the model)* Validity of data *(Quality of data using this process)* Model effectiveness *(Quality of results produced using this process)* Model substantiation *(whether the results are reasonable from various perspectives)*	
Feedback *(Questions related to improving the product)*	Quantitative characterisation of process quality Quality problems Suggestions for improvement	

Once the questions are generated, these questions are converted into metrics.

3. Metrics generating template

The quantifiable questions provide the basis for generating metrics. Each question may provide one or more metrics that need to be written down. Both subjective as well as objective metrics can be used. There is no limit on the number of questions or metrics.

You may write down the question here if

You may write down the questions generated in the previous template in the corresponding column if required or proceed to write only the metrics

Question Q1	
Metrics	
Question Q2	
Metrics	
Question Q3	
Metrics	
Question Q4	
Metrics	
Question Q5	
Metrics	
Question Q6	
Metrics	

	279
Question Q7	
Question Q8	
Metrics	
Question Q9	
Metrics	
Question Q10	
Metrics	
Question Q11	
Metrics	
Question Q12	
Metrics	

If there are more questions, then you may add more questions

The COBIT-GQM Template (Product*)

These are a set of three templates for generating metrics from goals. The DCOs of
COBIT that are relevant to an organisation for measuring the information systems
entities can be chosen for the goal. The template is based on the Goal Question
Metrics model proposed by Basili and Rombach (1988) to generate metrics
in the field of software engineering. The first step is defining the goal and these
goals can be taken from COBIT. You may choose any one or more of the 316
DCOs for the purpose.   *(List of 316 goals attached)*

1. Goal definition template

Goals (DCOs) are defined according to five perspectives as detailed in the table below

(Some goals may not have five perspectives)

*Write the goal here. You may take
it from COBIT or modify it or can
create your own goal*

DCO/Goal				
Object to be measured	Purpose of measurement	Measured property (quality focus)	Subject of measurement (viewpoint)	Measurement context (environment)

You may break up the goals
into five perspectives and put
these into the five boxes

Once the goals are defined, the next step is to define the goal into quantifiable questions.
These questions are derived from the five perspectives.

* Product implies that the objective of the IT goals is to evaluate an object (eg: hardware,
plans, software etc).

2. Questions generation template

In this process, quantitative questions are developed as the guidelines given.

(The five perspectives of the goal and the questions guidelines help in this process.

Three major sub-goals	Guidelines to be followed for developing questions	Sample Questions
Definition of the product *(questions related to physical attributes)*	Physical attribute Cost Changes & defects	
Definition of the quality perspectives *(e.g., reliability, user friendliness etc)*	Validity of the model/product *(Appropriateness of the model)* Quality of data collected Model effectiveness *(Quality of results produced using this model)* Model substantiation *(whether the results are reasonable from various perspectives)*	
Feedback for improving the product *(Questions related to improving the product)*	Quantitative characterisation of product quality Quality problems Suggestions for improvement	

Once the questions are generated, these questions are converted into metrics.

3. Metrics generating template

The quantifiable questions provide the basis for generating metrics. Each question may provide one or more metrics that need to be written down. Both subjective as well as objective metrics can be used. There is no limit on the number of que *You may write down the question here if required*

You may write down the questions generated in the previous template in the corresponding column if required or proceed to write only the metrics

Question Q1	
Metrics	
Question Q2	
Metrics	
Question Q3	
Metrics	
Question Q4	
Metrics	
Question Q5	
Metrics	
Question Q6	
Metrics	

Question Q7	
Question Q8	
Metrics	
Question Q9	
Metrics	
Question Q10	
Metrics	
Question Q11	
Metrics	
Question Q12	
Metrics	

If there are more questions, then you may add more metrics

Guidelines for generating questions

Guidelines for Product-Related Questions
For each **product** under study there are three major sub goals that need to be addressed: 1) definition of the product, 2) definition of the quality perspectives of interest, and 3) feedback related to the quality perspectives of interest.

Definition of *the product* includes questions related to *physical attributes* (a quantitative characterization of the product in terms of physical attributes such as size, com-plexity, etc.), *cost* (a quantitative characterization of the resources expended related to this product in terms of effort, computer time, etc.), *changes and defects* (a quantitative characterization of the errors, faults, failures, adaptations, and enhancements related to this product), and *context* (a quantitative characterization of the customer community using this product and their operational profiles).

Quality perspectives of interest includes, for each quality perspective of interest (e.g., reliability, user friendliness), questions related to the *major models) used* (a quantitative specification of the quality perspective of interest), the *validity of the model for the particular environment* (an analysis of the appropriateness of the model for the particular project environment), the *validity of the data collected* (an analysis of the quality of data), the *model effectiveness* (a quantitative characterization of the quality of the results produced according to this model), and a *substantiation of the model* (a discussion of whether the results are reasonable from various perspectives). *Feedback* includes questions related to *improving the product relative to the quality perspective* of *interest* (a quantitative characterization of the product quality, major problems regarding the quality perspective of interest, and suggestions for improvement during the ongoing project as well as during future projects).

Guidelines for Process-Related Questions
For each **process** under study, there are three major sub goals that need to be addressed: 1) definition of the process, 2) definition of the quality perspectives of interest, and 3)   feedback from using this process relative to the quality perspective of interest.

Definition of the process includes questions related to the *quality* of **use** (a quantitative characterization of the process and an assessment of how well it is performed), and the *domain of use* (a quantitative characterization of the object to which the process is applied and an analysis of the process performer's knowledge concerning this object).

Quality perspectives of interest follows a pattern similar to the corresponding product-oriented sub goal including, for each quality perspective of interest (e.g., reduction of defects, cost effectiveness), questions related to the *major model(s) used,* and *validity of the model for the particular environment,* the *validity of the data collected,* the *model effectiveness* and the *substantiation of the model).*

Feedback follows a pattern similar to the corresponding product-oriented sub goal. *(Basili and Rombach, 1988, p. 761 and 762).*

Appendix 4

A Manual to the Automated Model:

Basis of the model

This is a model based on Control objectives for Information Technology Audit, (COBIT which is an open source document) developed by the IT Governance Institute (ITGI) and the Goal, Questions Metrics (GQM) model developed by Victor Basili and his Colleagues in 1988. The purpose of this new model is to measure the performance of information systems in an organisation by breaking the information systems function into numerous activities (as is evident in COBIT) and generating metrics (using the GQM model) to measure each of these activities. Hence while COBIT (COBIT divides the information systems function into 316 generic processes) provides the information systems process/goals/entities, while the GQM model gives guidelines to generate quantifiable questions that are in turn turned into metrics on a 5 point Likert scale where a low score of 1 denotes low performance while a high score of 5 denotes optimum or maximum performance.

The application

The model has been automated with minimal functions. This involves selecting the right process/goals/entities to measure, selecting the appropriate questions and the correct metrics from the given list. The database containing 14 goals comes from COBIT, while the database of over 300 questions and 400 metrics has been fully developed by the developer/researcher. The outcome/output of using this application is a set of performance indicators ranging from 1 to 5 that denotes the state of performance of the chosen information systems process/goals/entities. This is very basic version of the automated model and features can be added only after getting the valuable feedback form the respondents.

Introduction to goals:

The goals in this database are taken from COBIT. It doesn't mean that goals have to be taken from COBIT. Any goal can be used as long as the goal are specific to an IT function, is clear and detailed.

The first box gives the heading of the goal, while the second box describes the goal as given in COBIT. In the third box, the object of the goal that needs to be measured is identified and isolated. The fourth box detailed the purpose of measurement and the fifth box describes the aspects that need to be measured. In the normal course in a well defined goal, all of these are clearly implied and it is not difficult to disintegrate a goals into these three main aspects namely, the object, purpose and the property.

Introduction to questions and metrics:

Questions are derived from the goals. The questions are mostly quantified to such an extent that it becomes easy to formulate the metrics. The purpose of the model is to measure the performance and not compliance or audit. Hence, even though some of the questions reflect an audit or compliance perspective, the focus is always measurement.

For example:

Question: Can the process be improved?
Here a first look will reflect an 'yes' or 'no' answer. But being a performance model, this is translated as
Rating scale (1: needs much improvement – 5: does not need any improvement) that measure the improvement that can be done in the present process.

Another example:
Do the users know their access rights? Here also a 'yes' or 'no' answer is deemed as appropriate, but this question is translated as:
Rating scale (1: users unaware – 5: users knowledgeable) that measures the knowledge of the user regarding the knowledge about their access rights, controls.

Hence it is assumed that there are a lot of instances where rankings can be assigned between and 'yes' and a 'no'.

Screenshots of the Application

Initial form

Selection of goal

Selection of questions

Reports generated

Implementation plan

(AI 7.03Q05) QP - How far is/are the plan/plans functional?

Metric ID	Metric	Value
AI 7.03Q05M1	Rating scale (1: less functional - 5: good functionality) for measuring the level of functionality	2
AI 7.03Q05M2	Rating scale (1: numerous functionality problems - 5: no functionality problems) that measures the magnitude of of functionality problems encountered in the plan/plans	2

(AI 7.03Q06) QP - Does the plan provide stability? If so how far is it stable?

Metric ID	Metric	Value
AI 7.03Q06M1	Rating scale (1: Less stable - very stable) that measures the stability of the plans	1
AI 7.03Q06M2	Rating scale (1: less time span - stable for a long peroid) that measures the time span/duration when the plan was stable (without any modifications)	3

(AI 7.03Q07) QP - How far is/are the plan/plans simple-complex?

Metric ID	Metric	Value
AI 7.03Q07M1	Rating scale (1: complex - 5: simple) to measure simplicity and complexity of the plan	3
AI 7.03Q07M2	Rating scale (1: lots of complex areas - 5: les complex areas) that measures the magnitude of complex areas in the plan	3

(AI 7.03Q08) QP - Are the results consistent from various perspectives?

Metric ID	Metric	Value
AI 7.03Q08M1	Rating scale (1: not consistent - very consistent) that measures the consistency of the plans	2
AI 7.03Q08M2	Rating scale (1: lots of areas are not consistent - 5: no consistent areas at all) that measures the areas in the plan that are consistent	5

(AI 7.03Q09) QP - Is clarity of objectives, functionality, stability, complexity, costs, sterngth and weakness the best way to measure the quality of the plan/plans?

Metric ID	Metric	Value
AI 7.03Q09M1	Rating scale (1: less quality in terms of meeting objectives - 5: objectives are clearly met) to measure the quality of the plan based on clarity of objectives	2

(AI 7.03Q10) QP - How far is the plan user friendly?

Metric ID	Metric	Value
AI 7.03Q10M1	Rating scale (1: less usable - 5: highly usable) for measuring usability - navigation of the plan	2

(AI 7.03Q11) QP - Is user friendliness/effectiveness of the implementation plan an appropriate way to measure its quality?

Metric ID	Metric	Value

(AI 7.03Q13) QP - Are the factors of user friendliness/effectiveness able to collect the right information to measure it?

Metric ID	Metric	Value

(AI 7.03Q14) FI - What is the quality level of the present implementation plan?

Metric ID	Metric	Value
AI 7.03Q14M1	Rating scale (1: less quality - 5: good quality) that gives an overall measure of quality of the plan	0

Appendix 5

Difficulties faced during the empirical stage

Getting the cases

It was decided to contact three cases each from New Zealand and Singapore. While it was not difficult to get the cases from New Zealand, the case with Singapore was much different. Organisations in Singapore are so confidential and secretive in nature such that even the simple fact that they have used COBIT or other relevant standards for their IT governance or audit or control program was not revealed. Thus the researcher faced brick walls at each and every stage of the initial contact process even though three types of channels was used to contact the companies (through the Professor – Industry Liaison of Singapore Management University, through the ISACA chapter of Singapore, and through personal contacts of the researcher and his supervisor at the university). Eventually the researcher was lucky to get an organisation that had implemented COBIT on a large scale a few years back. Thus out of a total target of six cases only four were able to be studied for the purpose of research.

Gathering multiple sources of evidence

Even though the participants were happy to provide the researcher with all relevant information through interviews, they were reluctant to part with their notes and reports. In the case of NZ 1, he was happy to provide a written note regarding the evaluation of the model, while in eth case of NZ 2 the scribbles notes on the model was not parted with but only explained in the course of the interview. The same was the case with NZ 3. In the case of SG 1, he had a three page printed report (provided by the team of four people who was present during the demonstration of the model and who had tried the model at their office). While during the interview, the respondent occasionally glanced at the report while answering some questions. Even though the researcher requested the report the respondent was reluctant to give the same. Hence only one source of evidence was used namely the interview. In the case of NZ 1 when the researcher went through the report it was evident that the same was given during the interview. Hence it was decided not to include the lone report (1) because of its exact correlation with the interview and (2) because it was not possible to collect this from the other three respondents.