A MOT-BASED COST MANAGEMENT COMPETENCY INDEX: FORMULATION AND TESTING OF ASSOCIATION WITH FINANCIAL PERFORMANCE

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DECLARATION

I, the undersigned, hereby declare that this dissertation is my own work. It is being submitted in partial fulfilment of the Magister Technologiae Business Administration degree at the University of South Africa. It has not been submitted before for any degree or examination at any other university.

(Signature of candidate)

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ABSTRACT

This study examined the nature and extent of relations between Management of Technology [MOT] and cost management. It explores the roles of competencies and competency measurement in these relations and its associations with company performance. The problem statement asks how the MOT community deals with cost management, whether MOT-based cost management competencies can be isolated and measured, whether a tool for measurement can be created, tested and validated and indeed whether it can be used to assess relations between MOT-based cost management competencies and company performance.

To answer these questions, a MOT-based cost management competency index is formulated, consisting of problem statements representing MOT-based cost management insights, knowledge and practices. Designed in the format of a typical research survey, the index is used to source data from sampled companies listed on the Johannesburg Stock Exchange [JSE]. Although too small a sample to generalise about the population, sufficient data is collected and processed with statistical software programs. A second set of variables, about financial performance of the responding companies, consists of Asset Turnover [ATO] and Return on Assets Managed [ROAM]. Data for these variables is sourced from their annual financial statements and processed into ATO and ROAM indicators.

The combined research data set is used to critically describe statistical qualities of variables such as ATO, ROAM, MOT-based cost management competencies of company executives, their education and exposure to the executive management teams in their respective organizations. The research data is subsequently subjected to correlation analysis, as foundation for hypothesis testing. Among the relationships described by correlation analysis and warranting further examination with regression analysis, are associations between MOT-based cost management competencies and ATO and between Education and MOT-based cost management competencies. The former association is found to be not significant, having the research hypothesis rejected. A significant association between Education and MOT-based cost management competencies is indeed found. Utilizing regression equations yielded by the analyses, the predictive capacity of regression analysis is used to demonstrate results of interventions in those associations postulated in the research hypotheses.

The study concludes that it achieved a qualified success in its first objective, which was to formulate a MOT-based cost management competency index, and to demonstrate its application as measurement and management tool on executive managers of JSE-listed companies. The study failed in its second objective, which was to demonstrate a significant association between MOT-based cost management competencies and financial performance of sampled companies. Critical perspectives on the data and the associations tested reveal important shortcomings in the research. These perspectives do though create opportunities for refinement of the MOT-based cost management competency index as measurement and management tool, validation of its status, and indeed demonstration of its business value to the MOT and business community in particular. In closure, the study was meant as a contribution to the discourse on a credo for MOT and the MOT body of knowledge, and it subjects itself to critical analysis by the research community so as to establish whether it succeeded in indeed making such a contribution.

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Technology is an omnipresent production factor in all industries and indeed all spheres of society. Witness the impact of medical and bio-technology on longevity, the role of military and weapons technology in conflict and warfare, the penetrating power of deep sky telescopes, and the automation of daily housing chores, to name a few prominent examples. Few doubt the significance of technology to businesses and organizations today. Though to have succeeded in the market place, all of the above examples required technology-intensive businesses to have either directly or indirectly invested resources in management and innovation of technology, and indeed in the scientific discipline of Management of Technology [MOT]. On the subject of MOT, Van Wyk (2003) asserts that it is a fledging field of academic interest, with an academic agenda reflecting at least three sets of priorities:

a) General management specialties such as marketing, operations, finance and strategy;
b) Knowledge of technology itself and of technology related management procedures; and
c) The contextual setting of the discipline of Management of Technology.

This study responds to a need for further research about the status of MOT, with specific reference to the relationship between MOT and cost management. With this in mind, a MOT-based cost management competency index is constructed and applied as measurement and management tool. At an academic level, this study wants to contribute to the discourse on MOT and its associated body of knowledge. At a practical level, it presents an early version of a MOT-based cost management competency index as a new measurement and management tool to the MOT community.

1.2 BACKGROUND TO THE STUDY

The nature and extent of technology and its associated costs have changed dramatically over the past thirty years, and this has contributed to cost consciousness becoming an omnipresent corporate imperative. As so concisely stated by Chorafas, (2004:11):"Costs matter."

Prompted by hyper-competition and revisions of governance and fiduciary requirements, modern organizations indeed understand that shareholders and other stakeholders expect of them to record and accurately account for the costs, benefits and overall financial performance of investments made in corporate technologies, whether these technologies are part of their production environment or part of their product and service portfolios. Managers in these organizations increasingly have though to generate valid accounting information for more complex decisions in situations where *management of technology* challenges are intensified by the complexity and pace of technology innovation and development, the diversity of technology sources and the potential and real business impact of technology (Phaal, Paterson & Probert, 1998:541). Witness for example the description by Aglietta and Rebérioux (2005:15) of how Information and Communication Technologies [ICT] overturn classic economic laws by having a near-zero marginal supply-side cost of *information products* after implementation of the required capital infrastructure, an example of which would be a telecommunications network. Indeed, traditional management thought in its entirety grew less relevant to new commercial realities, because it could not deal with a fast and ever-changing technology landscape (Van Wyk, 2004:6). Yet cost management remains to be seen as a finance division function. Therefore a case is to be made here that MOT and its academic and practical relations with cost management be revisited and subjected to critical analysis.

1.3 PROBLEM STATEMENT

The foremost question to be asked within the frame of reference of this research is then one of how does the MOT community deal with finance as a general support function, but with particular reference to MOT-based cost management as a technology-related management practice? Should the required professional competencies to deal effectively and efficiently with technology costs be acquired, would that lead to increased performance by public companies? If indeed, how is cause and effect measured, if any, when according to Carlucci, Marr and Schiuma (2004:576), organizations in general appear incapable of assessing the return on investment in knowledge and the impact knowledge has on business performance? Would a MOT-based cost management competency index be recognized as a valid management tool, if none was explicitly shown to exist for MOT-based cost management in a register of technology management tools by Brady, Rush, Hobday, Davies, Probert, and Banerjee (1997:421)?

Given the above, what is the *content* of MOT-based cost management competencies and practices? Can MOT-based cost management competencies be measured and do they indeed impact upon financial performance of companies? How can the validity of a MOT-based cost management competency index as measurement tool be established, and would this contribute to the initiative by IAMOT to define the body of knowledge and basic requirements of MOT education?

1.4 VALUE OF THE STUDY

This research will be contributing to the discourse on MOT and its relationship with management sciences, with specific reference to cost management. It will furthermore be creating and applying as quantitative measurement instrument and as management tool a practical and multi-disciplinary concept, i.e. the MOT-based cost management competency index. From a market perspective, this research isolates, describes and tests the link between MOT-based cost management competencies of corporate executives of listed companies and financial performance of these companies. Clearly, if this research helps to establish a valid methodology to test the research hypothesis, and eventually helps to have the research hypothesis accepted, it will proof that MOT and its relation to cost management hold value to the market. But even if the research hypothesis is to be rejected, this remains a case of bona fide research and as such would want to contribute to scientific discourse in general, and to the discourse on MOT in particular.

1.5 AIMS AND OBJECTIVES OF THE STUDY

The aim of the study is therefore to measure and assess MOT-based cost management competencies of corporate executives and to demonstrate the management value of the measurement tool for general management practice in technology environments.

The objectives of the study are as follow:

- To develop and apply a MOT-based cost management competency index as measurement and management tool.

- To measure and assess the relationship between MOT-based cost management competencies of corporate executives and financial performance as accounted for in financial statements of these companies.

1.6 KEY THEORETICAL CONCEPTS OF THE STUDY

MOT constitutes a multi-disciplinary approach, yet it has an evolving and distinctive core theory (Van Wyk, 2003). This study is also multi-disciplinary in nature, and intends to be the first of a series of building blocks to present academic foundations for a practical technology cost measurement and management tool, the content of which then clearly belongs to MOT and its body of knowledge. To do so, concise definitions of the relevant constructs central to the study, i.e. *MOT*, *cost management* and *competency models*, will be presented here. A novel concept to be specifically developed and applied as measurement and management tool in support of the above is a MOT-based cost management competency index, of which this study is only a first iteration due to the inherent difficulty in scientific justification and validation of a new concept such as this. Development of the index will however be leveraging off earlier efforts to have generated theories and models of technological learning and core competencies; and earlier efforts to have empirically tested correlation between these variables and company performance (Lucia & Lepsinger, 1999; Carayannis & Alexander, 2002; Couillard & Lapierre, 2003; Carlucci et al., 2004). At the same time, it recognizes earlier lessons about technology management tools, as presented by Brady et al. (1997).

Following below is a graphic depiction [Fig.1.1] of the relevant subject fields and associated concepts examined in this study, and their respective roles in the creation of the MOT-based cost management competency index. It should be noted that the following classification is not cast in stone; different dogmas do exist of how knowledge domains are classified into faculties and their respective subject philosophies. Furthermore, it should be expected that a new and multi-disciplinary concept, such as the MOT-based cost management competency index, experience “hereditary” problems in its first iteration. What does appear exact, at least for the purpose of the argument built in this study, is the fact that the three central constructs to be combined here to form the MOT-based cost management competency index, all derive from the corpus of economic and management sciences. A second sub-division becomes more difficult, because Management Accounting and Human Resources Management are both mature bodies of knowledge, but not so MOT. Although a distinctive theory is now being recognized for the MOT body of knowledge, and although the International Association for Management of Technology [IAMOT] does distinguish MOT from the general set of management sciences in its credo for MOT, it does not enjoy a formally accepted definition as yet (Van Wyk, 2003).

At a third level, the classification indeed exposes itself to critique, as the collection at this level firstly consists of distinctive "…technology-related…" management procedures, to quote again from the MOT credo as proposed by Van Wyk (Ibid.); and secondly it consists of cost *management*, described by Berliner and Brimson (1988:41) as not having had a standard definition either, with some having viewed it as cost accounting and others having viewed it as management accounting. Cost management is *now* seen as an enhancement of cost accounting (Martin, 2005) and was defined among others by Brimson as "…the management and control of activities to determine an accurate product cost, improve business processes, eliminate waste, identify cost drivers, plan operations, and set business strategies…", as quoted by Martin (Ibid.). Thirdly, it consists of competency [models] derived from Human Resources Management, with a *competency* described by Lucia and Lepsinger (1999:5) as "…a cluster of related knowledge, skills, and attitudes that affects a major part of one's job…, that correlates with performance on the job, that can be measured against well-accepted standards, and that can be improved via training and development."

Lucia and Lepsinger (Ibid.:5) define competency *models* as "…describing a particular combination of knowledge, skills, and characteristics needed to effectively perform a role in an organization and ….used as a human resource tool for selection, training and development, appraisal, and succession planning." Carlucci et al. (2004:578) define *competencies* as differentiators resulting in performance variation between two companies with the same resources and aims. Core competencies as a distinctive topic increasingly enjoy exposure in MOT literature, with Carayannis and Alexander (2002) asking whether technology learning is a firm core competency, Couillard and Lapierre's (2003) analyzing leadership, learning and resources in their integrated view of technology management and Carlucci et al. (2004) presenting a composition on the knowledge value chain.   Suffice it to conclude that at least in theory, MOT and core competencies are found to have substantial relations; with cost management generally accepted as yet another indicator of competent organizational management.

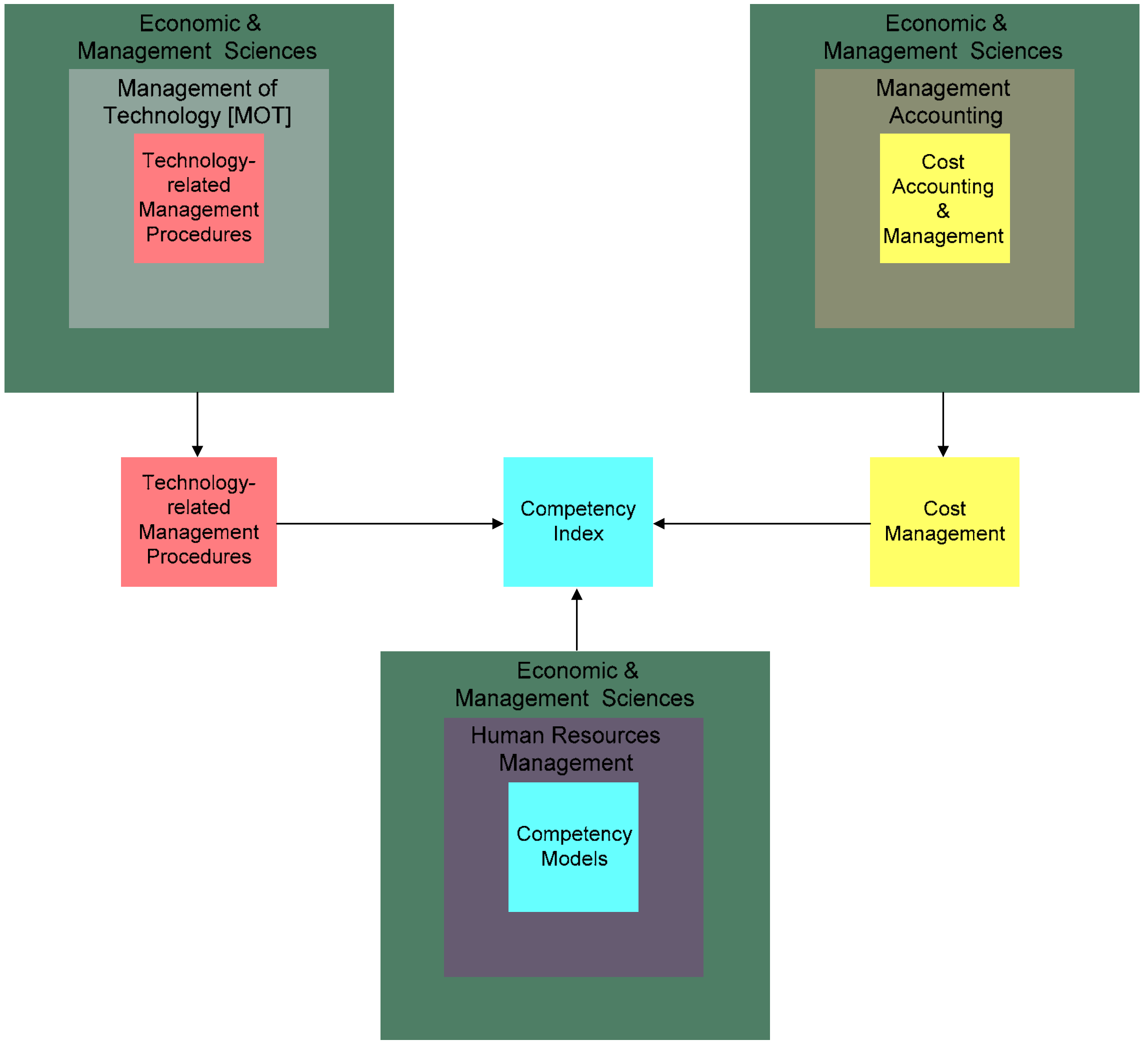


Figure 1.1: A conceptual view of the buildings blocks towards a MOT-based cost management competency index

1.7 LIMITATIONS OF THE STUDY

In responding to the particular requirements of a mini-dissertation, this study has to limit itself to a brief set of objectives, as derived from the problem statement. It will therefore not deal with the wider scope of financial management as this would relate to MOT. Having being identified as a priority for research by Chanaron, Jolly and Soderquist (2002:621) and indeed listed by Van Wyk (2003) as part of the academic agenda for MOT, the broader field of financial management of technology certainly presents many leads for further research. But these leads cannot be pursued in combination with the topic for this research within the limitations of a mini-dissertation. There is indeed also evidence in the literature that cost *accounting* [it is then accepted the same goes for cost *management*] within heavy technology environments requires more examination than will be possible within the extent of this study. Add hereto that this study will not further explore or contribute to the internal debates about a definition for MOT and how cost management relates to cost accounting and management accounting.

One of the objectives of the study is to measure and assess the relationship between MOT-based cost management competencies of corporate executives of publicly listed companies and financial performance of these companies as accounted for in their financial statements. It is however anticipated that the small sample will not afford the study opportunities to extent its conclusions to the population of listed companies. As will be explained later, testing of relationships within the context relevant here will however be introduced and illustrated, so as to put down a foundation for follow-up studies.

It follows logically from the above that as far as reliability is concerned, there will not be an opportunity for the more conservative Test/Retest reliability estimation, meaning the final questionnaire will only be used once on the test population, and there will not be any follow-up tests done as part of this particular study. As far as validity is concerned, this study then is not a true experimental research design and there will not be a control group created for a measured intervention. It stands to reason that both these limitations will be managed within the context of this study, so as not to have them canceling its academic bona fides.

1.8 LAYOUT OF THE CHAPTERS

This study follows the traditional lay-out for mini-dissertations, with the following sequence:

Chapter 1	:	Introduction
Chapter 2	:	Literature Review
Chapter 3	:	Research Methodology
Chapter 4	:	Results and Findings
Chapter 5	:	Conclusions and Recommendations for Future Research

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

The multi-disciplinary nature of this study makes for an abundance of literature references. Whereas on the one hand the researcher must explore these references for clues so as to systematically conceptualize and formulate the problem statement, he must on the other hand guard against irrelevance in abundance and see to it that a logical line of thought is built up in the literature review. At the same time, research conclusions can only be validated by bona fide scientific research processes, and the researcher must therefore also guard against a literature review that a priori validates his conceptions about the stated research problem. Given the above, this chapter describes how traditional cost management methodologies became outdated in technology-intensive environments; and then gives a literature review of how the research community deals with MOT and organizational performance, with the discussion gradually shifting towards the role of MOT-based cost management. Both organizational performance and MOT-based cost management do however critically depend upon core competencies, and the final section of this chapter presents a high level literature review of how core competencies impact upon techno-market insight and company performance, once again with the role of MOT-based cost management competencies put in perspective.

2.2 A PERSPECTIVE ON OUTDATED COST MANAGEMENT METHODOLOGIES

It is now common cause that valid and accurate technology cost information is vital across the business value chain, from product conception, design and production, through pricing policies, supply and delivery to performance reviews. In fact, John Dutton, chairman of the CAM-I Cost Management Systems Target Costing Core Group put on record that cost management will be critical to survival and success in the new millennium (Ansari, Bell & CAM-I Target Cost Core Group, 1997:vii). A classic example of cost misunderstood is that of Motorola’s Iridium project, presented by Sheth and Sisodia (1999) as a “sunk cost thinking trap” and by Schmidt (2002) as an “…escalation of commitment…” and the “…biggest new product flop of the last decade." Benefits will always be subjected to the nature and extent of costs, and will always only manifest after costs were accounted for. Put in another way, the need to understand costs is obvious, as organizations must know their costs to determine their profitability. But managers in technology-intensive production environments increasingly have to deal with uncertainty as to *what* cost management methodology to apply. Witness a selection of papers on the topic by Robinson (1990), Primrose (1992), Demmy and Talbott (1998), Coate and Frey (1999), Cooper and Kaplan (2001), Hughes and Paulson Gjerde (2003) and Cooper and Slagmulder (2004).

McNair, Mosconi and Norris (1988:xv) observed that the relevance of management accounting in technology rich environments is questioned and that …"Advanced technologies … highlight the discrepancies and dysfunction inherent in our management accounting procedures." One of their main observations was that costs became untraceable as a result of the confusion between respectively direct and indirect costs and fixed and variable costs. Macintosh (1994:197) finds "…an almost embarrassingly large body of research …about the darker side of management accounting…" and goes on to describe three conventional categories of critique of management accounting and control systems, i.e. goal congruence, relevance lost and human relations. Peebles and Antolovic (1999) view traditional accounting systems as serving neither operational nor strategic roles at levels below those of major divisions and product lines within an enterprise. These systems can be used to value inventory and distribute the costs of plant, equipment, and management over major products, but they cannot specify the costs required to run a process that produces discrete products and services. Moreover, such accounting systems cannot provide the information through which processes can be re-engineered to reduce cost and increase quality.

According to Cooper and Kaplan (2001:96), direct labour which earlier formed the bulk of cost now represents only a fraction of corporate costs, while expenses associated with production support operations, marketing, distribution, engineering and other overhead functions have increased exponentially. Gupta and Galloway (2003:132) confirm this state of affairs, stating that traditional management accounting has been challenged to find methods helping companies better understanding and identifying business processes and their associated costs.

Throughput accounting, activity-based costing [ABC], life cycle accounting and technology accounting are seen as having contributed all to the emancipation of accounting in technology rich environments (Goldratt, 1992; Glad & Dilton-Hill, 1993:9), with ABC having built up a considerable following. Yet it continues to have it critics (Johnson, 1992, Greenwood & Reeve, 1994; Kee, 1999); with Kaplan and Anderson (2004:131-132) stating that numerous managers have abandoned conventional ABC in favour of time-driven ABC, because of rising costs of implementation, employee frustration, overloading of computing processing capacity, inevitable time delays and indeed inaccurate results associated with the conventional approach. It can therefore be concluded that technology progress made cost management systems irrelevant, to the point where technology management, as represented by MOT, and cost management [systems] clearly have no common outcome-based alignment in terms of concepts, techniques and analysis.

2.3 TOWARDS A SOLUTION OF THE PROBLEM: ORGANIZATIONAL PERFORMANCE, COST MANAGEMENT AND CORE COMPETENCIES

2.3.1 MOT and measurement of organizational performance

Of course "Technology affects all businesses…", to quote Twiss and Goodridge (1989:1), and making technology perform for the organization is indeed a management function, therefore the focus upon *management* of technology. Moenaert, Barbé, Deschoolmeester, and De Meyer (1990:40) early on describe the relationship between technology and organizational performance in their discussion about the product life-cycle, the technological life-cycle and the technological S-curve, and how these tools depict the performance capabilities of respectively a specific *industry* and a specific category of *technology*. Their work no doubt represents a valuable effort to MOT, but does not involve technology cost management *per se*. Baker (1990:821) still expresses doubt as "…to what extent academic preparation…in traditional business fields such as general management, finance, marketing and *accounting* (author's accent) are necessary…" to MOT. Rafferty's applied "techonomics" (1990:552) is a combination of technology and economics which introduces a decision support tool, i.e. the TCME Matrix, for the analysis of **T**echnology, **C**ompetitiveness, **M**arket and **E**conomics. This matrix enables the evaluation and optimization of forecasted production and economic performance, and inter alia encompasses an analysis of typical management accounting concepts such as Net Present Value, Internal Rate of Return, Return on Investment and unit cost, to name a few. A more recent definition of *techonomics* as "…the study of trends in business and society resulting from technological advance and its economic effects…" by Martin (2002) proves that though useful, *techonomics* is a wide-sweeping concept which extends far beyond the academic and practical parameters of the relationship between MOT and cost management, apart from the fact that it would not seem to have achieved popular acceptance as yet. Cleland and Bursic (1992:87) introduces the technology audit, which would make use of tools such as the technological S-curve to determine the "…technological health…" of organizations. In general this is a notion closely related to that of Moenaert et al. (1990), and therefore subjected to the same critique. In response to an observation that there is no agreement among scholars on how to measure technology capabilities in organizations, Ming-ji James Lin (1997:134) successfully used panel discussions and Analytical Hierarchical Process [AHP] technique to have developed a questionnaire for measurement of technology capabilities of individual firms. Note though that firm-level *technology capability* is defined here by experience; budget; equipment; output; information; and management capabilities, with budget as the sole variable representative of *finance* and related disciplines.

Beaumont and Schroder (1997) report on the statistical links between the use of Advanced Manufacturing Technology [AMT], manufacturing performance and business performance amongst Australian manufacturers. Among others they find that technology is perceived as having little effect on internal costs, including the cost of quality, and that there were indeed no strong links to be found between technology and business performance. They do however not present an analysis of *internal costs*. In comparison to Beaumont and Schroder (Ibid.), Brady et al. (1997:417) quote several authors about the positive association found between *technological development* and competitive performance, but according to them organizations must learn to *manage* technology to be competitive. A set of technology assessment techniques by Henriksen (1997:618) includes a comprehensive overview of management accounting and specifically cost management techniques, and how these can be utilized to determine the cost of incremental product improvements, new product profitability, adoption of new processes or supporting technologies, and technology make-or-buy decisions. Within the context of this study, Henriksen (Ibid.) is to be criticised for the fact that these techniques are described as *economic* analysis tools, yet would clearly be fitting into the micro-parameters of management and cost accounting. Furthermore, assuming that core competencies in cost management of technology is to serve as a bridge between MOT and financial performance of companies, Henriksen presents no conceptual tool to help build that bridge. An inevitable conclusion is that her focus on *economic* analysis tools for technology assessment belongs within the discipline of *cost engineering*, a concern confirmed by her extensive review of cost engineering works, which according to Jelen and Humpreys (1991:4) is a subject field combining *engineering* principles with cost management.

Phaal, Paterson, and Probert (1998) describe the structure and application of a comprehensive three-stage technology management assessment procedure. Their procedure provides a means of revealing and assessing the impact upon company performance of a full range of technology management practices in manufacturing firms. An impact assessment of technology on each production area in these firms forms part of the first stage, and involves a collaborative assessment of value, effort and risk. If not stated pertinently and analyzed for its effect upon financial performance of companies, cost and benefit analyses to assess effort and returned value do form part of this type of assessment. However, these are generic to most project assessment and management procedures, and do not add any additional value to the context relevant here. Of significance is their finding that their assessment tool is difficult to implement as many technology management issues are "soft" in nature (Ibid.:550). To their credit, they have covered a wide range of industries, among which were the aerospace, automotive, electrical, electronic, marine and pharmaceutical industries, and created a generic and flexible assessment model which was found to be easily adaptable to any of these industries.

An approach closely related to *financial* accounting and the assessment of the technology value of organizations, is introduced by Hartmann (1999). Hartmann's *technology balance sheet* contains various technology ratios as indicators of technology value, and must be used in tandem with the conventional financial balance sheet. Once again, based on the works reviewed here, this methodology does not seem to have as yet achieved popularity among academics and practitioners, apart from the fact that it obviously is biased towards *financial* accounting with its *historical* perspective of financial performance. Momaya and Ajitabh (2005) see technology as a significant *enabler* of competitiveness, and their study of the relationship between technology management and competitiveness of Indian firms found a strong correlation between technology management and competitiveness. They do state however that *strategic technology management* is only implied and often informal in many Indian firms, rendering assessment of MOT difficult (Ibid.:522). They do not expand on the individual assessment elements of the *technology audit model* they have used, suffice it to conclude that it is a comprehensive assessment model which would include financial assessment, if then not explicit cost management criteria as well.

It can be concluded from the above exposition that the MOT community yet has to agree on a generally accepted model for measurement of how precisely MOT and its business impact relate to organizational performance, with specific reference to financial performance and cost management as a sub-category of financial performance; and how the nature, extent and monetary value of specifically the cost or effort side of the technology cost and benefit equation can be consistently observed, measured, analyzed, manipulated and predicted to improve planning and help create efficiencies.

2.3.2 MOT and cost management

In the past 20 years there have been various scientific inquiries into the relationship between what today constitutes MOT, and cost management. Yet none of the works reviewed here focused holistically on the three elements at the core of this study, i.e. MOT, cost management, and formulation of a MOT-based cost management competency index. Humphreys (1991) and his complete description of cost and optimization engineering certainly remains a foundation for a study of this nature, as does the work of Brady et al. (1997:422), among others classifying value engineering as a typical technology management tool. Value engineering is indeed defined as a "…systematic and organized procedural decision-making process…to secure essential functions at the greatest worth as opposed to costs." (Ve Today, 2005). As such it forms the opposite pole to cost engineering, with *cost* engineering focusing upon cost management, and *value* engineering focusing upon value creation. In both instances, these are well embedded and very popular *engineering* approaches, globally applied and supported. Although both should be strongly associated with MOT-based cost management, it is submitted here that these two approaches cannot be construed as typical management tools which can be applied, pulled out and applied again on the same case, or elsewhere, in typical diagnostic or benchmarking fashion like is intended with the MOT-based cost management competency index. Although mostly positive attributes, these approaches are associated with long lead times, overall commitment from participating organizations, long study courses for practitioners, as well as certification; taking the focus away from management of technology with cost as only one, against the only, dimension of a multi-dimensional decision sphere.

Berliner and Brimson (1988) and Ansari et al. (1997) are representative of the Consortium for Advanced Manufacturing International movement [CAM-I] and its comprehensive efforts to reform cost management, as seen from an industrial and indeed MOT perspective; and both works do have organizational performance as premise as well. Berliner and Brimson (1988:41) express their disappointment with the *ad hoc* nature and slow pace of development of a cost management knowledge base, a problem this study would want to help solve. But how cost management competencies are to interact with MOT, and how the combination is to be measured, analyzed, and dealt with in helping organizations understand technology-related [or then MOT-based] cost efficiencies, to help them perform, are not part of the CAM-I deliberations as reviewed here.

From within management accounting, Macintosh (1994) leads the way towards a multi-disciplinary view on how management accounting and technology interact, specifically describing how management accounting can be used to position a particular technology in its product life cycle; though his work ultimately focuses upon technology as a key concern *in the design and utilization of management accounting systems*. But even if it is positively inclined towards the problem statement, Macintosh is not a treatise on how the MOT community in its endeavour to excel should use cost management to understand technology cost, benefit and performance. In their survey to establish current practices in technology planning, Phaal & Farrukh (2000:9) found that UK manufacturing companies viewed cost, margins and profit as the lowest prioritized *external* driver for technology planning, with only 9 per cent of their respondents mentioning it as a consideration. As an *internal* driver, cost, margins and profit got a response from 25 per cent of the respondents, still the lowest priority though. Nor did their respondents view cost reduction as a significant driver of organizational change (Ibid.:22), which just shows how recently technology management agendas still have gone without MOT-based cost management listed as topic – in spite of a long history of discordance requiring rethink. Pulic (2000:703) agrees that traditional cost accounting methodologies proved inadequate for modern business requirements, but promotes an output or *value created* perspective against an input, or cost, perspective. His Value Added Intellectual Coefficient [VAIC] tool is presented as a methodology to help calculate value creation processes in companies. The focus on value is part of a wider process to be found in the ICT industry in particular as well, also representative of products such as the Total Economic Impact [TEI] assessment and the Business Value from Information Technology [BVIT] assessment of respectively Forrester and Gartner, both ICT advisory firms globally represented (Murphy, 2002; Forrester, 2005). These value-based methodologies have in common a focus upon the quantification and transformation of so-called intangible benefits into facts and figures to be compared against input costs. So what it really improves is the benefit calculations of technology projects, assuming costs are understood and accounted for. To their detriment, these methodologies remain complex, requiring an extra-ordinary amount of skills across all management disciplines and practices and are seldom seen to be constructively applied.

According to Chanaron et al. (2002:621), *finance* was earlier a management discipline hardly connected to technology within the academic community. According to them, this is explained by the fixed parameters of traditional academic research in financial disciplines, and the relative unfamiliarity of technology and innovation as core concepts. Their examination of research agendas of business schools confirms that accounting and its attendant control functions are not judged as a key research area; on which they respond by positioning finance *and* accounting firmly within their systemic view of technological management: "….researchers in finance, accounting and control are paying growing attention to issues and topics that fit well into our vision of technological management…", with the role of technology management defined as to examine the impact of technology upon the set of generic management functions. They do also identify auditing techniques and *cost accounting* in "…technology intensive firms…" (Ibid.:622), as an emerging body of literature and research.

2.3.3 MOT and core competencies as foundation to techno-market insight

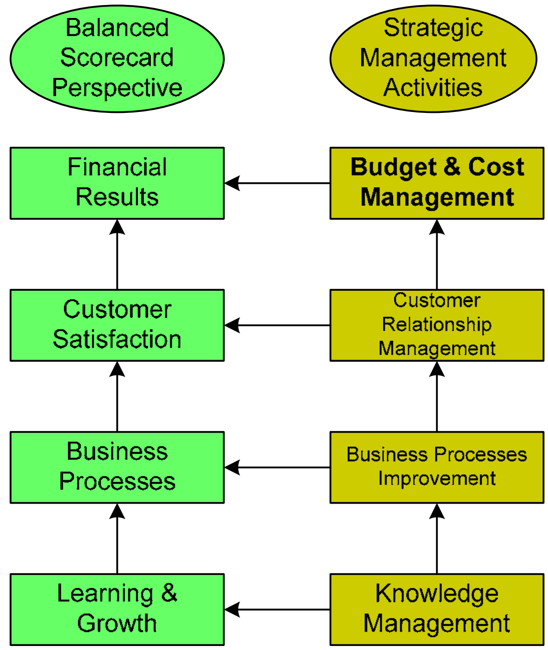
In his analysis of the relationship between companies and technology, and specifically of how research and development [R & D,] and innovation practices are positioned, Giget (1997:613) finds that the management of technological competencies increasingly is integrated with strategic processes in companies. Based on his observations of the Japanese market, and specifically of how Japanese industries *use target costing to identify life-cycle costs of products* during conceptualization and design, he comments that promising innovations achieve their status from the use of technical expertise, human *and* financial resources. His observation of Western practices is that human and financial resources as stakeholders are too often excluded or only belatedly involved in management of R & D (Ibid.:629). Brady et al. (1997:421) refer specifically to intangible forms of technology such as knowledge, skills and competencies and how these underpin company success if managed well. They indeed imply a new need for technology-related measurement and management tools that do consider these intangible forms of technology, and so also help this study to build a justification for a MOT-based cost management competency index.

Phaal & Farrukh (2000:16) find that their respondents see a lack of effective facilitation and training as a significant barrier to successful technology planning, which probably would be positively associated with their survey responses earlier listed. Carayannis and Alexander (2002) examine the relationship between technological learning as a core competence and market performance. From existing literature they use indicators linking development of company-specific technological competencies and performance to construct a multi-dimensional framework of technological learning. This study in effect offers a foundation for an analysis of MOT-based cost management competencies. Though they conclude after a pilot study that quantitative indicators of technological learning only have limited ability to predict company performance (Ibid.:641), their longitudinal research will be serving as frame of reference for this and future efforts to examine MOT-based cost management competencies and to design a tool to measure and manage such competencies. Their finding is in a sense corroborated by Carlucci et al. (2004:577), concluding that it is difficult to use conventional accounting methods to quantify and ascribe value to information and knowledge. However, in spite of substantiation of their findings, Carayannis and Alexander (2002) do not use or refer to MOT-based cost management or indeed to any finance discipline among indicators they have used from existing literature, and so implicitly also present a justification for this study.

Carlucci et al. (Ibid.:577) do also state that many organizations now view effective use of existing knowledge as well as acquisition and utilization of new knowledge as their only source of sustainable competitive advantage. But Coulliard and Lapierre (2003:770) already earlier argued that core competencies are hard to imitate and only bear value if managed as a *strategic asset*. Luggen and Koruna (2004:15-18) too submit that core competencies are central to business competitiveness. To them “techno-market insight” underpins all successful technology innovations and lies at the heart of core competencies. They link the concept also directly to an organization’s absorptive capacity, defined as its members’ capacity to recognize new information, process it and use it for commercial ends – which of course is based on individuals' specific education, knowledge and professional experience. To Luggen and Koruna (Ibid.:19) core competencies basically form the foundation of successful selection and commencement of new technology applications.

In this study the concept of core competencies is measured in a more limited sense, i.e. to encapsulate knowledge and insight with specific reference to MOT-based cost management. Even when limited to a specific cadre of knowledge and insight such as cost management, the concept of core competencies would remain a vital component of techno-market insight. In fact, Coulliard and Lapierre (2003:770) see technology and how it is managed as a fundamental part of core competencies in organizations.

To Carlucci et al. (2004:581) the first goal of assessment of intellectual capital is to evaluate organizational knowledge, so as to communicate to stakeholders the value of intangible organizational assets. This sentiment is restated by Aglietta and Rebérioux (2005:271), arguing for the expansion of performance indicators for technology-based assets, so that an organization's ability to achieve positive returns on funds so invested are reflected in these indicators. It will be argued here that MOT-based cost management competencies, and how these relate to financial performance of organizations, should be considered for inclusion in a broadened view upon technology-based asset performance and ultimately of organizational performance and competitiveness as well. In concluding this section, Carlucci et al. (2004:584) in their analysis of the Balanced Scorecard [BSC] interprets the financial dimension of the BSC as showing how companies create value for shareholders. But to achieve shareholder value, their interpretation of the BSC has knowledge management as foundational and strategic management activity, and peaks with budget and *cost management* as strategic management activities toward financial results (Fig.2.1); helping them to conclude that effectiveness [read doing the right things] and efficiency [read doing things at lowest cost possible] of organizational processes depend on organizational competencies.



Source: Adapted from Carlucci, D., Marr, B. & Schiuma, G. 2004. The knowledge value chain: how intellectual capital impacts on business performance. *International Journal of Technology Management*, 27(6/7), p.584.

Figure 2.1: The role of budget and cost management activities in organizational performance

2.4 CONCLUSION

Judged from the above, the discussion about MOT, and how it relates to cost management and financial performance of companies, certainly makes for a vigorous debate to be had in management and accounting circles, and business schools in particular. This chapter serves as a frame of literature references associated with the problem statement. But it also builds a case that MOT-based cost management is an essential dimension of MOT, and of competent organizational management, as it enables organizations to show complete accounting traces of increases or decreases in MOT-based resource utilization; it also enables organizations to communicate to investors that Management has the knowledge and insight to achieve positive returns within technology-based environments. The above literature review must however conclude that MOT-based cost management, and the competencies required for this field of endeavour, have not convincingly being identified as a research priority, in spite of an overabundance of business drivers justifying such a focus.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 INTRODUCTION

Swepson (1998) found that literature on good research practices can be confusing when it over emphasises some of the ideals of research without integrating those ideals into a working methodology that can deal with real practical problems. Taking note of these sentiments, this study is non-experimental and hypothesis-testing, but as a scientific exercise it continuously evolves and builds a bridgehead for a longer term assignment, which would have its own design so as to survive the tests of validity, reliability and practicality. To clarify, the rest of this chapter is divided in four sections. The *first* section describes how the non-experimental and hypothesis-testing research design applies to this study. It portrays how open ends are created for more iterations of this research as the problem statement is understood better and is refined, as alternative data collection methods are tested and more data becomes available, and as the temporal dimensions of this study changes over the longer term. It also describes how the Internet impacted upon data collection. The *second* section will deal with traditional design issues, such as population and sampling procedures, hypotheses and data analysis. The *third* section will deal with data validity and reliability, to conclude with ethical issues impacting upon the study. The *final* section gives an overview of data analysis methodologies to be followed. Holistically seen, the design sentiment for this study is based on a philosophy of lifelong learning. It strives toward innovation and continuous refinement in learning method, so that understanding of reality continuously improves and helps to solve real-world problems. To quote Cryer and Miller (1994:3) on the this outlook: “Actual scientific investigations involve a great deal of trial and error, outright guesswork, backtracking, and starting over again.”

3.2 RESEARCH DESIGN

3.2.1 Non-experimental and hypothesis-testing research

To answer the research questions posed by this particular study, and taking into consideration the relevant academic requirements, this research design is non-experimental and hypothesis-testing. It is *non-experimental,* because no intervention occurs in the independent variables so as to have a different effect upon the dependent variables; as well as for the fact that respondents are not randomly assigned to different levels of the independent variables. To picture the above conditions within the frame of reference of this study, accept that one typical *independent* variable is MOT-based cost management competencies of managers of companies listed on the Johannesburg Stock Exchange [JSE]; and one typical *dependent* variable is financial performance of the same selection of companies listed on the Johannesburg Stock Exchange. Since no intervention is planned *for this study* to increase or decrease MOT-based cost management competencies of managers, no further distinction between groups of respondents is required, and therefore no random assignment of respondents to groups is required either. The research design is *hypothesis-testing*, since it will set down at least the first iteration of a methodology to test earlier, though tentative, conclusions about MOT learning and competencies and how these variables impact upon financial performance of companies, if indeed. Of course, should the research hypothesis be accepted or rejected, such an eventuality must be judged in the context of the validity and reliability of the research, and this aspect of the research will be discussed later in the chapter.

The research design is also *correlational*, described by Welman & Kruger (2001:85) as the simplest form of non-experimental research. A correlational design entails a single group of units of analysis, preferably randomly selected, with each individual measured on two or more variables at roughly the same time. The sampling frame in this study is the 420 companies listed on the JSE during June 2005. Those companies on the JSE having responded upon the research survey form the units of analysis, and true to the requirements of correlational research, at least two variables of every responding company within the sample are to be measured, processed and correlated. These variables are MOT-based cost management competencies of the representing managers of these companies and financial performance of these companies, based on selected financial indicators stated in their annual financial statements, and as calculated in terms of Asset Turnover and the Return on Assets Managed [ROAM] model of financial performance of companies (Andrew & Black, 2002).

As stated in the introduction to this chapter, the research design for this study should be seen in the context of a longer term research process, based on a longitudinal design. The next section presents a short overview of longitudinal research and how its links this particular study to a longer term process.

3.2.2. Longitudinal research: iterations and change

Welman and Kruger (2001:87) refer to longitudinal research as a relevant design to study change over time. Singer and Willett (1996:267) recommend longitudinal research for its knowledge gathering attributes, but even more meaningful they recommend at least three waves, or iterations, of data collection so as to register a sufficient number of changes over time in the relevant independent variable observed. In their empirical study to examine the relationship between technological learning as a core competency and company performance, Carayannis and Alexander (2002) also use a longitudinal research design.

This study therefore forms part of a longer term process to improve understanding of MOT-based cost management competencies of corporate executives, also of development and measurement of these competencies and its combined impact upon financial performance of listed companies. As depicted in Figure 3.1, and as explained earlier, in its first phase this study is indeed non-experimental and hypothesis-testing; over the longer term more iterations of the study will follow, and intervention in the set of research variables, i.e. MOT-based cost management competencies, associated education and development, and relations to financial performance, will be considered.

The long term research project will therefore consider a smaller sample frame; more appropriate sampling techniques such as stratified random sampling, specifically to distinguish between technology-intensive and non-intensive businesses; less respondents, training intervention and at least three measurement waves. To a limited extent the longer term research design will also adopt some principles of action research, described by Welman and Kruger (2001:21) as research undertaken to find a solution to a specific practical problem. These conclusions are a priori stated here, so as to present to the reader a wider perspective of how this particular study helps to evolve and codify knowledge through research and practice, and how these again impact upon the immediate problem statement at hand as well as on the longer term view of the research problem.

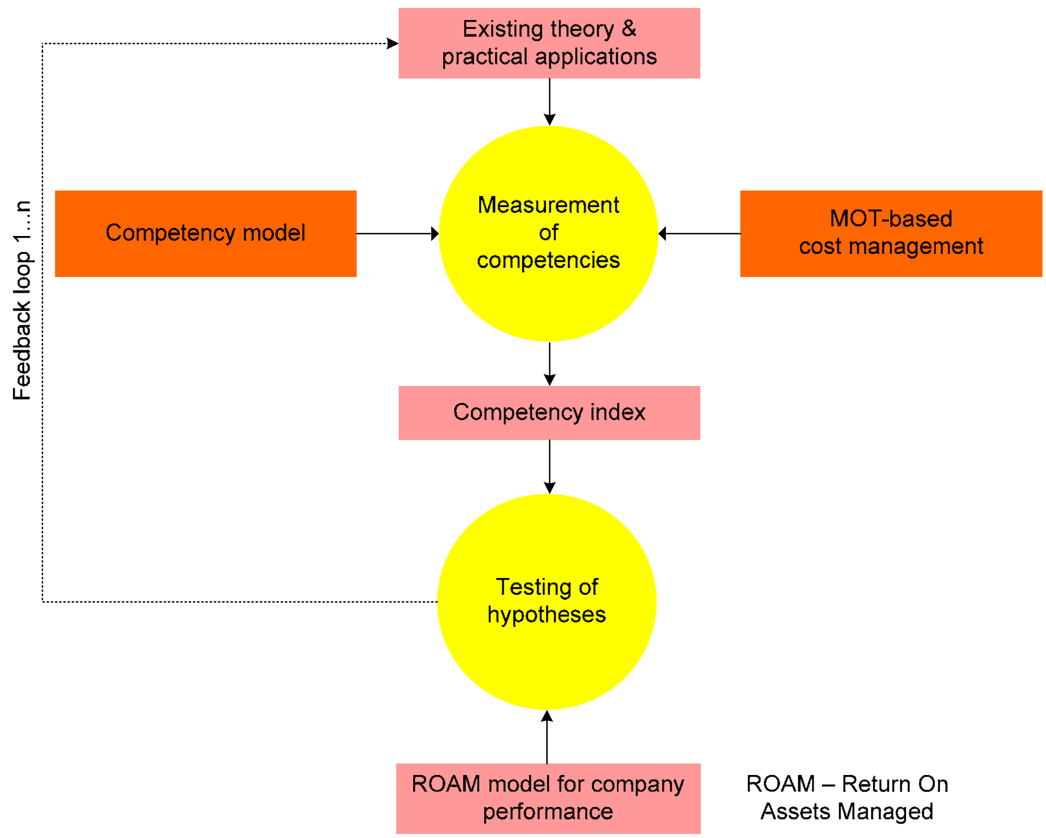


Figure 3.1: MOT-based cost management competencies and feedback loops: iteration 1…n

3.3 TRADITIONAL ELEMENTS OF RESEARCH DESIGN

3.3.1 Population and sampling procedures

A pre-survey interview with a representative of the Cape Chamber of Commerce confirmed that private companies were understandably not going to be positively inclined towards the notion of making their financial statement available for in depth scrutiny of financial performance parameters. L*isted*, as against *private*, companies presented an ideal alternative to examine the formulated hypotheses, as these companies are obliged to publish their annual financial statements. The 420 companies listed on the main board of the JSE therefore formed the sampling frame, defined by Welman and Kruger (2001:47) as a complete list on which each unit of analysis appears only once. As the selected sample frame the JSE was small enough to have sent the research survey to all of its 420 members, and no further sampling was required. Working at a 90 per cent confidence level and providing for a minor percentage of dysfunctional entities listed on the JSE, and assuming a sampling frame consisting of 420 companies, the required sample size to have had a *representative* response was 59 respondents [Annexure A].

3.3.2 The hypothesis under investigation

Introducing the research hypothesis, it is necessary to again refer to the utility value of this research vis-à-vis the longer term process of which it forms part. In this instance, the research hypothesis introduced here should indeed be seen as a formulation of the long term research goal; and as an endeavor to find a valid test for the hypothesis; but especially to have the research hypothesis tested repeatedly after different types of interventions, and with different increasingly more refined versions of the MOT-based cost management competency index. This specific study therefore should be seen as a first iteration in achieving that goal. Welman and Kruger (2001:25) define a research hypothesis as a *positive* statement about the links between operational variables, with these links at least provisionally confirmed if the research findings support the hypothesis.

In the light of the above, this study examines the following research hypothesis:

a) The research hypothesis holds that an increase in MOT-based cost management competencies of corporate executives of listed companies is associated with an increase in financial performance of these companies.
b) The alternative hypothesis is one of no association between MOT-based cost management competencies of corporate executives of listed companies and financial performance of these companies.

3.3.3 Data selection and collection

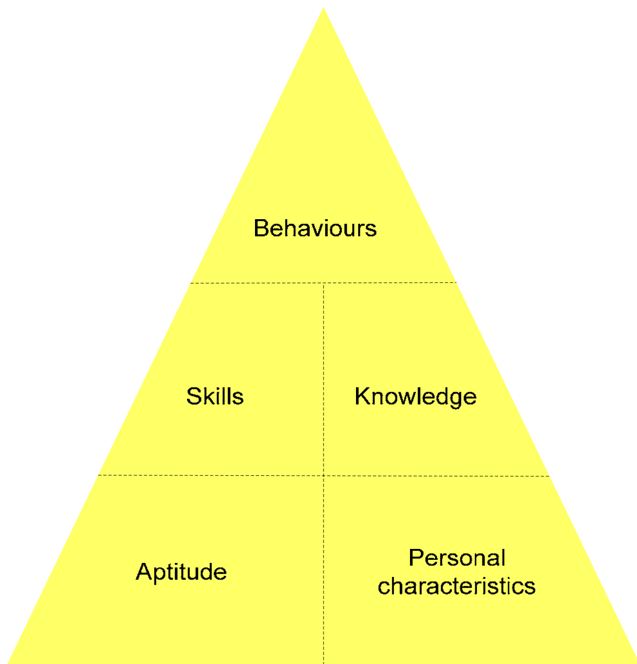
3.3.3.1 Data selection and survey preparation

Data selection and collection are premised upon the problem statement and the research hypothesis. For the purpose of this study, a tool to measure MOT-based cost management competencies had to be formulated and constructed in the form of a research survey. Selecting the content that should be reflected in such a specialized and multi-disciplinary measurement tool is based on two primary research questions, i.e. what are MOT-based cost management competencies and practices, and how do these translate into survey content? To properly answer these questions, the literature research for this study was expanded over a two year period, and apart from the formal subject field of MOT, an extensive analysis was done of technology-based cost management, and the typical academic and practical challenges experienced by this field of endeavor; as well as of competency modeling, and how this practice has evolved to have achieved the popular profile it enjoys in management science and practice. In addition, prescriptions by Brady et al. (1997:424) about academic contributions to technology management tools, such as critical assessments of existing tools, identification of gaps in the field and generation of new technology data to deepen understanding, were all closely adhered to in the design of the MOT-based cost management competency index. As an evolving measurement instrument the competency index had undergone several iterations during pre-survey testing, analysis and academic consultation. In its present form it is an automated survey consisting of seventeen statements about MOT-based cost management; with these statements justifying their selection based on what has been observed as the most challenging academic and practical problem statements in MOT-based cost management [Table 3.1].

Table 3.1: Problem statements for MOT-based cost management competency index

Problem statement as formulated in survey
Organizations generally have adequate competencies in technology management.
The extent of investment in technology is the ideal indicator of technology competency in an organization.
Innovation depends on Technology Intelligence.
It is impossible to functionally classify technology in a formal taxonomy, given its diversity and complexity.
Innovators normally beat technology imitators to the market.
The Technology Adoption Life Cycle is to marketing what the Technology S-curve is to strategic technology planning.
Technology audits and value chain analysis are mutually exclusive concepts.
Accounting standards generally keep up with the pace of technological change.
The effort required to allocate costs accurately to technology processes may be disproportionate to the benefits derived.
Cost management in advanced technology environments is better done with multiple costing systems.
Overheads in advanced technological environments are generally in proportion to the number of units produced.
Research & Development costs must be charged to the benefiting products and services.
A technical innovation normally succeeds in a price sensitive market.
Most of a product's life cycle costs are locked in during design.
Value engineering can reduce the quality of a product.
Advanced technology environments have more fixed costs and less variable cost.
Abandonment analysis happens at the end of the product life cycle.

Using these statements to test corporate executives' knowledge and insight of MOT-based cost management, this study builds a competency *index* which closely emulates the middle layer of a competency pyramid (Fig.3.2) introduced by Lucia and Lepsinger (1999:7). The *index* is meant to serve as indicator of competencies which would only encapsulate MOT-based cost management knowledge, insight and skills. The index is not intended to become a competency model in the sense meant by Lucia and Lepsinger (Ibid.:5,7). It stands to reason that completing the bottom and top layers of a complete competency pyramid so as to formulate a competency model would require a different research design altogether.



Source: Adapted from Lucia, D.A. & Lepsinger, R. 1999. *The Art and Science of Competency Models: pinpointing Critical Success Factors in Organizations.* San Francisco: Jossey-Bass Pfeiffer, p.7.

Figure 3.2: The role of skills and knowledge in the competency pyramid

In retrospect, at least two problems with the survey in its final format should be pointed out. In the first instance the guideline for attitude scales of this nature is that the number of positively and negatively formulated statements be approximately equal, so as to counteract an acquiescent response style, according to Welman and Kruger (2001:151), and this scale had only seven of the former and ten of the latter. In the second instance, a survey with the same measurement instrument ran simultaneously in the City of Cape Town, and yielded at least four responses of high level managers viewing problem statements as problematic, difficult to answer and filled with jargon. This probably contributed to the low level of response to the survey, as will be seen later in the discussion. The very obvious conclusion that the more complex a technology management tool becomes, the less it is likely to be used, is pointed out by Brady et al. (1997:422), but simplicity in design is not easy to achieve.

As to the choice of a survey design, the primary requirement was to use a tool that would provide a rating scale, to allow respondents to express both the direction and strength of their opinion about the problem statements presented in the competency test. It must also be stated that attitudes, or then opinions as they are measured by this survey, serve as proxy for knowledge, insight and skills, but especially for the former two traits.

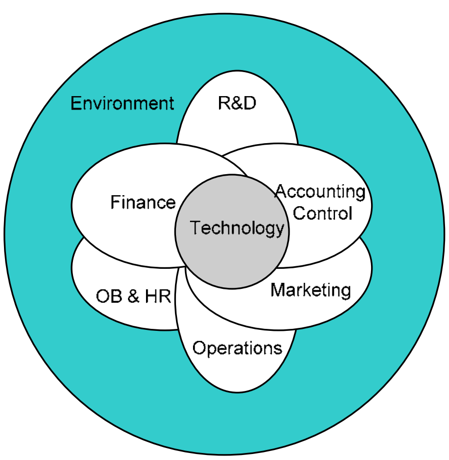
Whereas Welman and Kruger (2001:150-151) distinguish between the Likert Scale and the Semantic Differential as two different types of attitude scales, Sclove (2001) views the Semantic Differential merely as a particular application of the Likert Scale, and this study conforms to the latter view. With the five-point Likert Scale the most commonly used (Ibid.), a Semantic Differential was designed with Strongly Agree; Agree; Neutral; Disagree; and Strongly Disagree as response options. With reference to the popularity of the five-point Likert Scale, Ray (1980:53) has convincingly shown that the higher the number of response options, the higher the validity of the response. On the use of a midpoint on the Likert Scale, Sclove (2001) concludes that there is evidence that the presence or absence of a mid-point on an attitude scale produces distortions in the results obtained. While the problem, according to Sclove (Ibid.) remains unsolved, this study in accordance with Ray (1980:54) resolved to respond positively on the question of whether the researcher should present the respondent with a neutral position – after all, using such an option improves the scale function of the measurement instrument and positively inclines respondents towards the survey.

3.3.3.2 Data collection

3.3.3.2.a) Survey data for a MOT-based cost management competency index

On-line surveys are a relatively new development in the research arena, and are generally conducted via e-mail, though some companies and research institutions are using surveys on corporate intranets. The main limitation of this approach, not relevant here, is the requirement of potential respondents to have e-mail in the first place, and for the researcher to have their e-mail addresses. A more immediate and relevant danger was for an email survey request to be seen as spam, and apart from having a sensible appeal to the mail recipient, no other cure would help mitigate this problem. According to Pearson Education (2004) there is indeed some evidence that e-mail surveys enjoy higher response rates than mail surveys; but the main drivers for selection of the Internet as a conduit for this study were the cost and speed benefits of electronic communication, as well as the *portability* of an automated survey; by which is meant that the survey with minor refinements in the introduction was indeed ran parallel for yet another study, and helped to considerably ease the burden of reminders for this study.

Although they could not assist with the original request to directly distribute the survey on behalf of the author, and so lend formal authority to the survey, the JSE did agree to source the email addresses of the company secretaries of all its listed members. The e-mail message introducing the research survey consisted of a clearly formulated request to these company secretaries to distribute the survey for completion to their respective corporate management teams or alternatively to the delegated authorities of these corporate management teams. The notion to have the survey completed by *corporate management teams* was premised upon the fact that technology, and for that matter MOT as well, can be seen as central to every organization, with all traditional management support functions having interactions with technology, irrespective of whether these support functions are centralized or decentralized, and therefore having to have the necessary competencies in management thereof. This particular notion of technology management as "…systemic…at the core of all…management science and practice…" (Chanaron et al.:619), is illustrated below (Fig.3.3):



Source: Adapted from Chanaron, J., Jolly, D. & Soderquist, K. 2002. Technological management: a tentative research agenda. *International Journal of Technology Management*, 23(6), p.620.

Figure 3.3: The central role of technology in the organization

The first email request [Annexure B] to participate in the survey [Annexure C] went out to company secretaries on 15 March 2005. Though some email addresses were inaccurate, and some listed companies were in the meantime suspended or de-listed, the email request for participation was received by at least 400 members of the JSE, with only 13 companies responding on the original request. A reminder notice [Annexure D] was sent out on 30 May 2005, on which no response was received at all. A second and *reformulated* reminder [Annexure E] went out on 10 September 2005, with another 17 companies responding, bringing the total response to only 30 completed surveys, against the minimum requirement of 59 responses.

Having had an extra-ordinary low response rate confirmed for the first time that the data collection process in email format was at least a qualified failure. Worse even was the fact that not in a single instance was the survey completed by more than one member of the management teams actually targeted in the sampled companies. A low response figure was always anticipated, but in this instance the real lack of response was to have a debilitating effect on the research conception and design, as well as on its external validity. However, to put the above in context, it should be noted that Carayannis and Alexander (2002) in their longitudinal study of technological learning as a firm core competency worked with only 24 companies, while Momaya and Ajitabh (2005) in their exploratory study of the relationship between technology management and competitiveness of Indian firms worked with a sample of only 9 companies. What persisted therefore was a holistic perspective as set out earlier in terms of which this study forms part of a longer term project to test the research hypothesis and to refine it in accordance with the nature of feedback received during the respective research iterations.

The completed surveys were subsequently processed, with the responses coded in terms of guidelines stated by Burgess (2001), Welman and Kruger (2001), and the University of Reading (2005). The coded responses were fed into a Microsoft Excel spreadsheet and the respective competency scores were calculated and listed, as they appear in Table 3.2. In the form it appears here, this composite index of MOT-based cost management competencies is meant to serve as a key construct in this research, but its internal validity as measurement instrument cannot be analyzed within the limited parameters of this study. Its scientific bona fides are therefore based on a short analysis of the scores achieved on every problem statement by the respondents, specifically the mean score, the best total score and the lowest total score. These scores are compared to the score that can theoretically be achieved if all answers are on par with the model answer set. Based on mean scores, the highest scoring respondent achieved 22, and the lowest scoring respondent achieved -7, with the average on 9. The column "Total score per problem statement", shows that statements 5, 14 and 15, in that sequence, were the most difficult, having totaled means of sub-zero. On the opposite side, statement 12 was the easiest to comply with, having a mean of 37.

Table 3.2: The MOT-based cost management competency index: problem statements sorted from most difficult to least difficult

Number of problem statement	Problem statement as formulated in survey	Total score per problem statement	Sequence of scores	Highest scoring respondent	Lowest scoring respondent	Typical average score
5	Innovators normally beat technology imitators to the market.	-12	1	2	-2	-2
14	Most of a product's life cycle costs are locked in during design.	-6	2	2	0	0
15	Value engineering can reduce the quality of a product.	-2	3	0	0	2
13	A technical innovation normally succeeds in a price sensitive market.	2	4	-1	-1	-1
16	Advanced technology environments have more fixed costs and less variable cost.	4	5	2	-1	3
1	Organizations generally have adequate competencies in technology management.	9	6	2	-2	0
4	It is impossible to functionally classify technology in a formal taxonomy, given its diversity and complexity.	10	7	3	-1	-1
17	Abandonment analysis happens at the end of the product life cycle.	17	8	2	-1	0
6	The Technology Adoption Life Cycle is to marketing what the Technology S-curve is to strategic technology planning.	18	9	0	0	0
10	Cost management in advanced technology environments is better done with multiple costing systems.	20	10	-1	0	0
9	The effort required to allocate costs accurately to technology processes may be disproportionate to the benefits derived.	21	11	2	-1	2
3	Innovation depends on Technology Intelligence.	25	12	2	3	2
11	Overheads in advanced technological environments are generally in proportion to the number of units produced.	26	13	2	-1	2
2	The extent of investment in technology is the ideal indicator of technology competency in an organization.	29	14	2	-1	-2
8	Accounting standards generally keep up with the pace of technological change.	31	15	2	-1	2
7	Technology audits and value chain analysis are mutually exclusive concepts.	32	16	2	0	0
12	Research & Development costs must be charged to the benefiting products and services.	37	17	-1	2	2
	Total score			22	-7	9

The highest scoring respondent responded with 2's [3 is the limit] on both the two most difficult statements, while the respondent having achieved the typical average score had them both wrong. This respondent scored a 2 on the third most difficult question, in comparison to the 0 [neutral] of the highest scoring respondent.

Having combined data about the respondent's main role [e.g. Chief Financial Officer] and functional area [e.g. Finance] to create an indicator of executive exposure (Table 3.3), it was accordingly listed in the final data set.

Table 3.3: Executive exposure

Respondent	Main role	Functional area	Executive exposure
1	8	5	6.5
2	8	8	8
3	15	50	32.5

This component of the data set was now ready for statistical manipulation and analysis.

Given that the survey was in electronic format, and that it encapsulated MOT-based cost management problem statements that were *globally relevant*, an alternative plan to generate valid data was to have contacted the London, Australian and Nieu-Zeeland stock exchanges and to seek closer cooperation from these institutions, so as to have had the survey distributed among their respective sets of members on behalf of the author. These institutions were specifically selected on the basis of their size, geographic proximity and dominant English culture. Yet, neither the London nor the Nieu-Zeeland stock exchanges responded at all on the request for cooperation. The Australian Stock Exchange did in fact respond by giving an indication to the author of how to source the email addresses of its listed members. A random sample of the approximately 1765 companies listed on the Australian Stock Exchange was done, and in this instance their web pages were individually researched so as to have sourced the relevant email addresses. Having sent and resent them the request to participate were however to no avail, with only three companies responding positively out of 316 targeted.

3.3.3.2.b) Data for analysis of financial performance

A second component of the required data set was to have researched and processed selected financial indices of company performance for those companies having responded on the survey, as published in their annual financial statements. A critical learning objective in this instance was to find financial indices, or a combination thereof, which would best express

MOT-based value now, and as this research evolves over time. MOT encapsulates *management* of all technology-based assets in organizations, and according to Andrews and Black (2002:6) shareholder value is principally derived from sustainable productivity of companies' *asset bases*. They took Asset Turnover [ATO] as the basis for their Return on Assets Managed [ROAM] model, and used their model to illustrate management competencies of fictitious public companies, based on [unidentified] real-world firms which could be described as technology-intensive. Carayannis and Alexander (2002:637) also deem ATO a more constant measure of performance than profit margin, and a standard practice in strategic management research; so they too use it as financial performance indicator to examine the relationship between technological learning and company performance. Based on the above, the ROAM model (Fig.3.4) was subsequently selected for this study as main proxy for financial performance of companies.

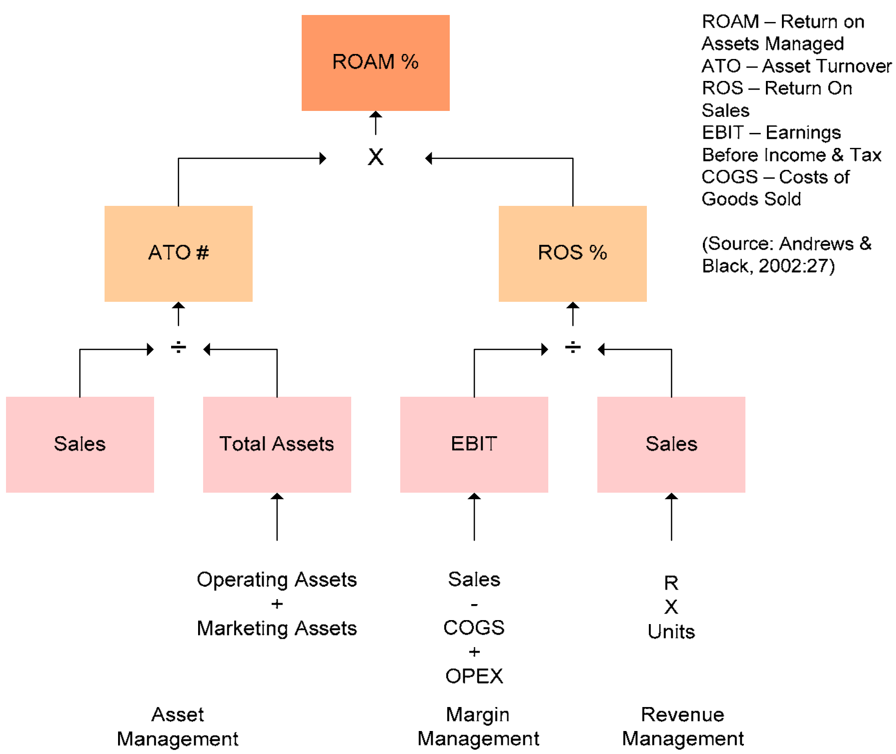


Figure 3.4: The ROAM model

Using ROAM also presented ATO as financial indicator, and though the former is seen as a more complete and holistically derived indicator of enterprise maturity in financial performance, ATO will certainly be used as key variable in the examination of the hypothesized relationship as well.

Having selected ROAM and its constituent parts meant to have sourced and analyzed the financial statements of the responding companies; and without exception these statements were found on the web sites of these companies. In all instances the financial data so collected was compared to the JSE's listed company data sources, and in some instances differences were found. Where it was possible, sources of errors were traced and corrected, but in all instances the published annual financial statements remained the default as data source. The relevant indices were subsequently calculated and combined into a set of ROAM indicators of which a selection is listed in Table 3.4:

Table 3.4: ROAM indicators of financial performance

Respondent	Total Assets	Annual Sales	Asset Turnover (ATO)#	Earnings before Interest & Tax (EBIT)	Return on Sales (ROS)%	ROAM
1	390,000,000	578,745,000	1.48	57,017,000	9.85%	14.62%
3	91,729,000,000	4,625,000,000	0.05	679,000,000	14.68%	0.74%
5	129,832,000	248,832,000	1.92	11,864,000	4.77%	9.14%
6	71,882,100,000	5,682,700,000	0.08	1,071,100,000	18.85%	1.49%

3.4 METHODS TAKEN TO ENSURE VALIDITY AND RELIABILITY

3.4.1 Validity, random sampling, randomization

Validity reflects the strength of research conclusions, inferences or propositions. External validity refers to the degree to which the research findings for a sample may be applied to the total population to which the research hypothesis applies. Internal validity refers to the degree to which research conclusions correctly assign changes in the dependent variable to the independent variable and not to any irrelevant variables. According to Yu (2004), the purpose of random sampling is to enhance the *generalizability* of research results, while the purpose of randomization is to establish the *cause-effect interpretations* of the results. In other words, random sampling counteracts the threat to *external validity* whereas randomization addresses the threat of *internal validity*. Cryer and Miller (1994:14) describe randomization as an action of which the outcome can be simulated by the mathematics of probability, or then as an action of which the outcome exhibits predictable behaviour.

3.4.1.1 External validity

As the sample framework for this study contained a relatively small population of 420 members, all of them were targeted for the survey, meaning that no sampling was required. In targeting the Australian Stock Exchange, random numbers were indeed generated with an Internet-based random number generator and the listed companies were accordingly selected and emailed. Receiving back only 30 responses out of a possible 420, made it clear that like in the case of Momaya and Ajitabh (2005), the results of this study could not be generalized either. Although the study therefore does not enjoy external validity, it remains a worthwhile academic exercise and maintains the potential to achieve the stated research aims and objectives. Beyond these, the study is also to be used as a test bed generating pointers for further research as well as to contribute to a fledging debate about the topic under discussion.

3.4.1.2 Internal validity

By its very nature the non-experimental hypothesis-testing research design carries less internal validity (Welman & Kruger:103), as it does not have the tools to test and re-test relationships. On the other hand, the traditional threats to internal validity do then not apply to this research design either, given its non-experimental nature. Welman and Kruger (Ibid.:104) do however concede that properly designed non-experimental studies may help to formulate conclusions about multi-variable relationships; that is if these variables are indeed relevant to the selected research area and if the correct statistical methodologies are selected for analysis of relationships.

As there is no completely objective method to decide upon significance levels for significance tests of relationships between study variables (Cryer & Miller:475), this study will work with a confidence coefficient of 90 per cent and an associated significance level of 10 per cent, which in effect sets a 10 per cent probability of falsely accepting the research hypothesis and so setting a risk upon internal validity. This decision is nevertheless brought about by the low level of survey responses. The required number of responses for a valid sample at 95 per cent confidence coefficient is 201, and at a 90 per cent level it is 59, while only 30 responses were returned in time

To conclude, this particular study loses its external validity due to a lack of the requisite respondent numbers, and though every possible measure is taken to ensure internal validity, it inherently carries less internal validity than would be the case with true experimental research.

3.4.2 Reliability

Reliability involves the consistency of the research measurement, with specific reference here to the research survey and related data collection methodologies. This is a pilot study about the development of a valid measurement instrument, i.e. the MOT-based cost management competency index, and all the required steps were taken to ensure survey reliability. That means that pilot surveys were tested and subjected to scrutiny by subject experts in the field of MOT, cost management as well as research methodology, and refined versions were combined into an early version of a measurement and management tool. Still, having a first set of industry-based responses, and analyzing these with the relevant statistical tools, should now yield new vistas upon the reliability of the research survey, and upon the MOT-based cost management competency index in particular. According to Welman and Kruger (2001:141) Cronbach's coefficient alpha is a good statistical test for internal consistency of a measurement instrument; and though the original research proposal includes Cronbach, it was not possible to source a statistical program or at least an appropriate addition to Microsoft Excel to execute such an analysis. It does certainly form part of the long term plan for the development of the measurement tool.

3.4.3 Special ethical considerations

There are no particular ethical considerations within the present scope of the study, apart from the obvious imperative to comply to ethical research practices and to strive to maintain scientific integrity under all and every circumstance.

3.5 DATA ANALYSIS

Although the Likert scale as used in this study is often associated with ordinal data, characterized by ranks and ratings, the data set for this research is in fact seen as satisfactory approximations of interval data. Interval data as used in this study is characterized by equal distances between adjacent units, and can be used to quantify and compare the sizes of differences between units (StatSoft, 2003). In practice this means that an index measurement for MOT-based cost measurement competencies of 7 is precisely one more than a measurement of 6, which is 0,8 more than a measurement of 5,2. These are indeed not ranks of scores for competencies, they are seen and used as continuous units, can therefore assume any value on a continuum, and can accordingly be counted, ordered and measured, as is the case with all the other variables in the study.

Given their respective sets of outputs, and the value of these outputs to this study, the collected data was fed into two different computer software packages for statistical analysis. The first package is Moonstats, an educational product forming part of the Welman and Kruger handbook about research methodologies (2001); and the second package is Microsoft Excel, for the purposes of this study enhanced by a 30-day trail version of a commercially available statistical addition titled *Analyze-it*. None however allowed complicated statistical methods, and plans for this study to execute multiple regression and Cronbach's alpha were discarded.

Descriptive statistics such as the median, range, mean, standard deviation, kurtosis and skewness were calculated and illustrated for all variables in the data set. These were used to assess, interpret and characterize the data set. Subsequent to this, these statistics were employed to identify potential weaknesses in the research survey and to identify relevant statistical methods for multi-variate data analysis.

The descriptive statistic most widely used to describe relationships between continuous variables is the correlation coefficient, a measure of the degree to which the measured relationship follows a straight line (Cryer & Muller, 1994), and it is therefore used as a key research technique in this research as well. Correlation is furthermore seen to be enhanced by regression analysis under the correct scientific conditions, specifically for data collected in non-experimental designs such as would apply to this research.

3.6 CONCLUSION

Given the academic considerations discussed in earlier chapters, the purpose of this chapter was to introduce the reader to the relevant scientific processes that would operationalize the research, so that *deductive* linkages be created between existing theories, associated problem statements and testing of hypotheses in the specific isolated circumstances of this study. To the extent that the researcher would expect contributing in an i*nductive* manner to the international knowledge base about the identified research problem, this chapter does however find that the external validity of the research is limited, which would limit the nature and extent of contributions to ongoing academic discourses about the subject.

CHAPTER 4

RESULTS AND FINDINGS

4.1 INTRODUCTION

This chapter systematically presents, describes and analyzes the research data. The first section presents descriptions of all the relevant categories of data, upon which is based a series of correlation analyses which are presented in the second section. The third section presents a series of regression analyses of those relationships having warranted further examination. The penultimate section presents an overview of the findings, and subjects the research hypothesis to the required tests. The final section concludes the chapter.

4.2 DATA DESCRIPTION

Table 4.1 presents an overview of the industries represented in the sample, as well as the industry averages for every variable to be dealt with in the rest of this chapter.

Table 4.1: Industry representation and averages: sorted from lowest to highest MOT-based cost management competencies

Industry & number of respondents	Competency Index	ROAM	ATO	Education	Executive exposure
ICT (1)	0.0	7.88%	1.23	8	40
Healthcare/medical (1)	1.0	-24.18%	0.00	5	35
Leisure/entertainment (2)	6.6	17.15%	0.64	6	20
Finance (5)	7.8	3.59%	0.15	5	21
Property / real estate (3)	7.8	8.02%	0.46	6	18
Distribution/wholesale (1)	8.0	8.69%	1.94	4	50
Telecoms (2)	8.9	18.85%	1.40	6	33
Services (1)	9.0	14.62%	1.48	7	7
Retail (5)	10.4	8.85%	2.63	6	20
Mining (4)	10.9	-2.34%	0.74	6	31
Manufacturing (4)	12.2	9.39%	1.21	6	26
Building/construction (1)	15.0	6.80%	1.39	7	35

Note: ROAM = Return On Assets Managed

ATO = Asset Turnover

Altogether 30 entries for every selected variable were recorded, coded and calculated. Discounting those industries represented by a single respondent, it can be concluded from

Table 4.1 that the Manufacturing, Mining and Retail industries, in that sequence, had the highest average scores for the competency index, and with one exception, i.e. that of the Financial Industry, were represented by the most respondents as well. On the face of it, the lowest score by the leisure/entertainment industry [still discounting single response industries], can be understood, but the position of the financial industry on the index raises concern.

The rest of this section is used to statistically describe in table form the descriptive attributes of every variable, and then to discuss the scientific bona fides of every variable, to be illustrated with bar charts, frequency histograms and normal probability plots for every variable. Statistical attributes to be described are the mean, standard deviation, minimum, maximum, range, median, mode, skewness, kurtosis and 90 per cent confidence interval [90 per cent CI]. Descriptive statistics are a way of summarising the variables in a dataset, and all the indicators that will be used in this study are explained below:

Table 4.2: Explanation of data indicators

Indicator	Explanation
Mean	The average value obtained for a variable.
Standard Deviation	An indication of how closely values are clustered around the mean.
Minimum	The smallest value obtained for a variable.
Maximum	The largest value obtained for a variable.
Range	The difference between the highest and lowest values.
Median	The middle value when the values are arranged from smallest to largest.
Mode	The most common value found in the data category.
Skewness	An indication if the distribution of values are symmetrical or not. A distribution, or data category, is symmetric if it looks the same to the left and right of the centre point. The skewness for a normal distribution is zero, and any symmetric data should have a skewness near zero.
Kurtosis	An indication of how thick the tails of the distribution of values are. Data categories with high kurtosis tend to have a distinct peak near the mean, decline rather rapidly, and have heavy tails. Data sets with low kurtosis tend to have a flat top near the mean rather than a sharp peak. A uniform distribution would be the extreme case.
90% Confidence Interval	Working with a sample, there is a 90% probability that the actual mean of the larger population from which the sample was drawn lies within the range indicated by this value.

The different variables were all subjected to statistical analysis at the 90 per cent confidence interval. The results are listed and compared in Table 4.3, and will be systematically discussed. All the variables are graphically displayed with bar charts [green on grey]. Frequency histograms and superimposed normal density functions are used to effectively show degrees of skewness and kurtosis of the data variables. If the observations are normally distributed the heights of the columns should be roughly shaped like the normal distribution curve, which is the superimposed blue line to be shown on the frequency histograms.

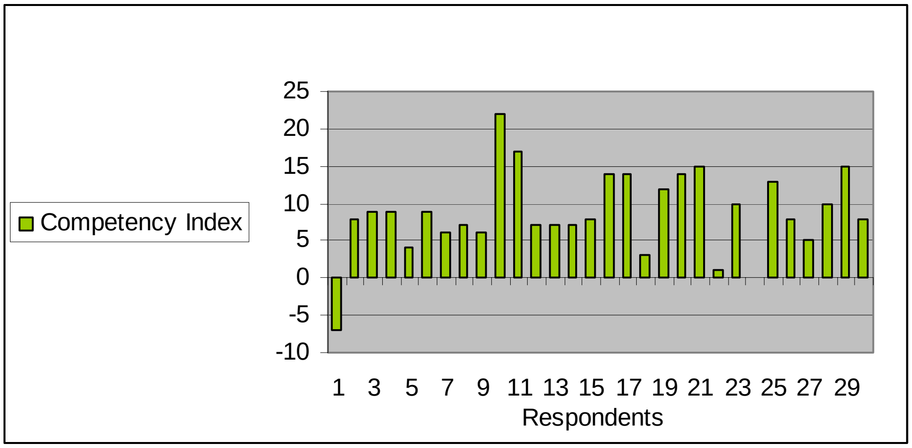
Given the small sample size, normal probability plots are also used to assess whether or not the different variables are approximately normally distributed or not (Cryer & Miller, 1994:267). In the normal probability plot, data is plotted against a theoretical normal distribution in such a way that the points should form an approximate straight line. Departures from this straight line indicate departures from normality. Done correctly, the results of the three sets of graphical techniques applied on the same variable should corroborate each other, and should assist the observer to determine normality or departures from normality.

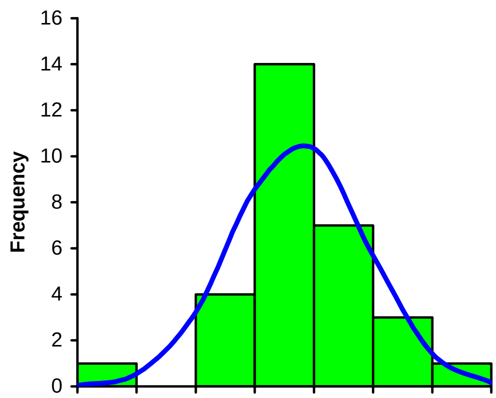
Where variables in the data set are manipulated in the search for relationships, all entries are treated consistently. For example, if the lowest 9 entries for the variable *Executive Exposure* are removed, values for all other variables across these 9 entries are removed as well.

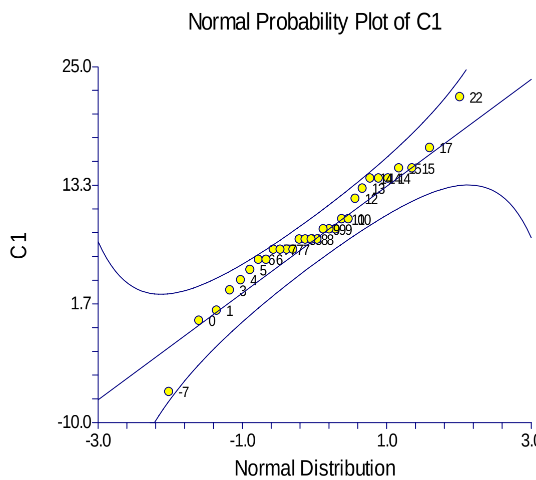
Table 4.3: Comparison of descriptive statistics for the selected data variables

Variable	Mean	Std Dev	Minimum	Maximum	Range	Median	Mode	Skewness	Kurtosis	90% CI
MOT-based cost management competency index	8.7	5.63	-7	22	30	8	7	-0.27	1.46	7-10
ROAM	7%	14%	-33%	41%	75.%	8%	0	-0.5%	1.96	1.5%-9.2%
ATO	1.1	1.19	0	5.31	5.31	0.97	0	1.76	4.31	0.25-1.4
Education	6	1.71	4	9	5	5.5	5	0.29	-1.40	5-7
Executive exposure	26.3	14.45	5	50	45	29	40	-0.03	-1.18	22-32

4.2.1 MOT-based cost management competencies







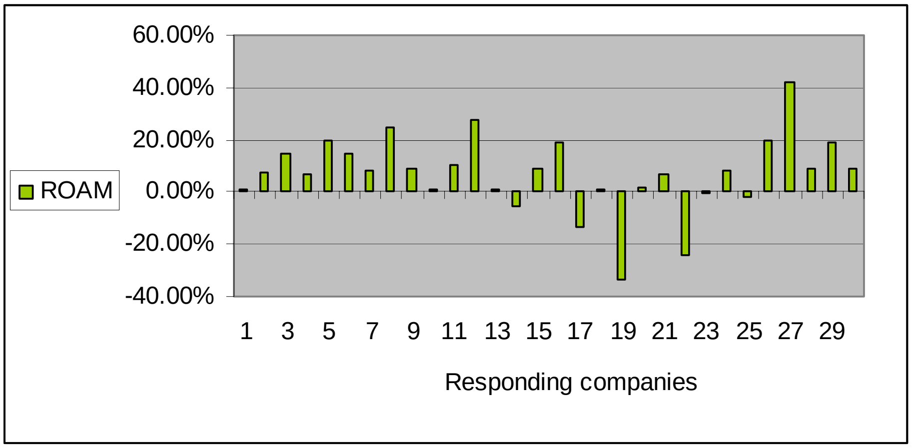
With the support of Table 4.3 and the various graphical displays it is now possible to conclude that data about the MOT-based cost management competency index is *relatively* normal and can be used with confidence for further analysis. With a degree of skewness of -0.27, whereas zero is the ideal, data distribution is not symmetrical; and with a degree of kurtosis of 1.46 the tails of the data distribution are very thin. The outliers of -7 and 22 certainly are the primary reason for the departures from normality in this variable. These data points are however confirmed and are not the result of error. Of course, a minimum of -7, a maximum of 22, and a range of 30 suggest that there are wide differences in MOT-based cost management competencies among the sample population. A mean of 8.7 is also very low, and certainly confirms the pertinent nature of the observed problem as formulated earlier. The median of 8 is lower than the mean of 8.7, and is an indication that most values for this variable are lower than the mean. Should the two outliers of -7 and 22 be replaced with the value of the mean of 8.7, the degree of skewness decreases to a marginal 0.0378, and the range to 17. Finally, the 90 per cent confidence interval shows that 90 per cent of the sample *means* from the larger population would be in the range 7 to 10. It should be noted that small samples and lower confidence levels tend to widen these intervals. These insights are though for the moment only of academic value, as the sample size has limited the validity of the study, but the CI does nevertheless demonstrate the powerful potential of the competency measurement and management tool. Interestingly, dividing this variable between technology-intensive and technology non-intensive companies, based on what is known about these companies and the industries they form part of, the average competency index score for technology-intensive companies is 9.6, with 90 per cent confidence intervals of 7 to 12, while those for technology non-intensive companies are respectively 7.7 and 5 to 10. The division do also result in precisely 15 companies in each category.

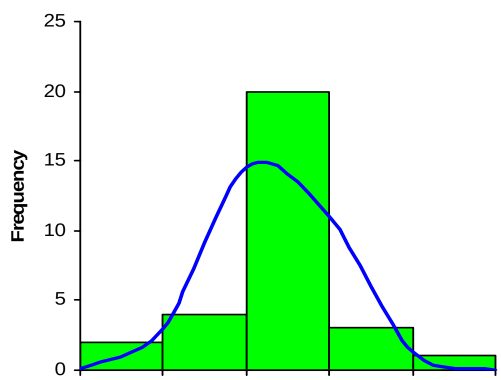
4.2.2 Return On Assets Managed (ROAM)

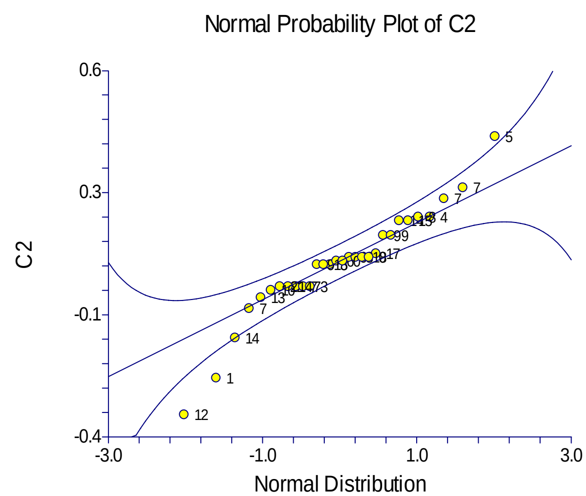
This variable presents a degree of skewness of -0.5 per cent and a degree of kurtosis of 1.96, with a distinct peak near the mean of the data distribution, and very thin tails. In both instances, these indicators represent the second highest entries in the data set. In this instance, like in others to follow, it should be noted that departures from normality in the data set are not necessarily manifestations of abnormal data, but mere cases of extreme entries. Given the small sample, all the data entries, and in particular the outliers, were carefully checked for recording or calculation errors and corrected where required. In this case, outliers have manifested in a minimum of -33 per cent and a maximum of 41 per cent, with 75.5 per cent the highest range in the data set, taken into consideration the different data configurations. One of the potential reasons for this possibly lies in the fact that widely different industries, subjected to equally widely different market forces, are represented in the research sample, as can be seen in Table 4.1. Divided in technology-intensive and technology non-intensive companies, the former category achieves an average ROAM of only 5.1 per cent, while the latter achieves a ROAM of 8.97 per cent.

Table 4.4: Descriptive statistics for ROAM

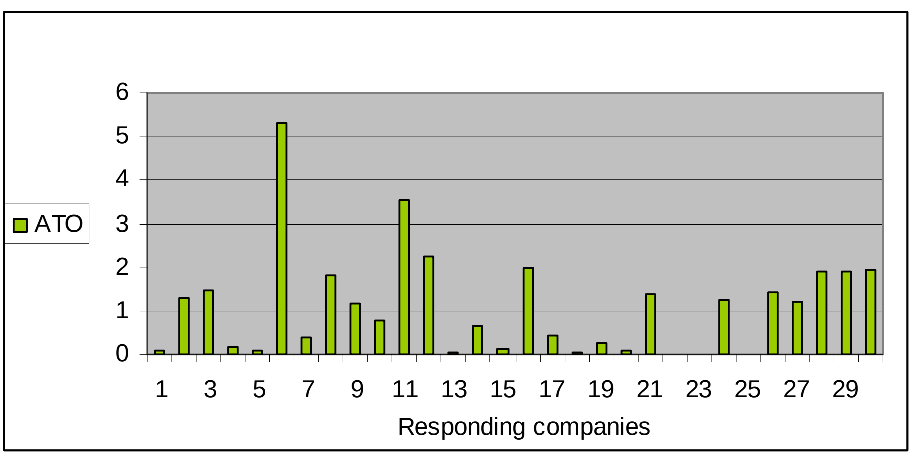
Variable	Mean	Std Dev	Minimum	Maximum	Range	Median	Mode	Skewness	Kurtosis	90% CI
ROAM	7%	14%	-33%	41%	75.%	8%	0	-0.5%	1.96	1.5%-9.2%

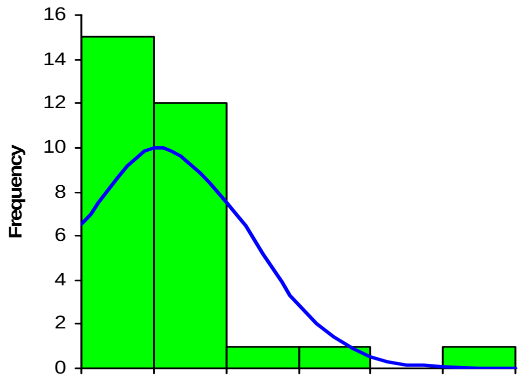






4.2.3 Asset Turnover (ATO)





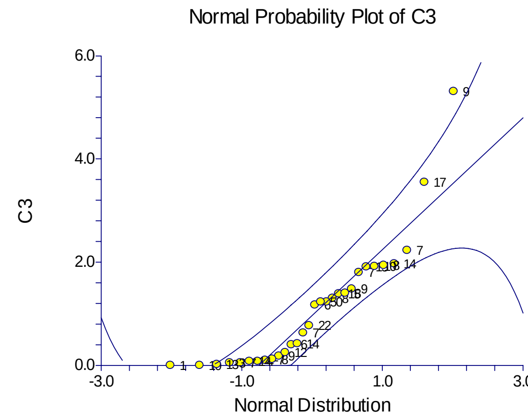


Table 4.5: Descriptive statistics for ATO

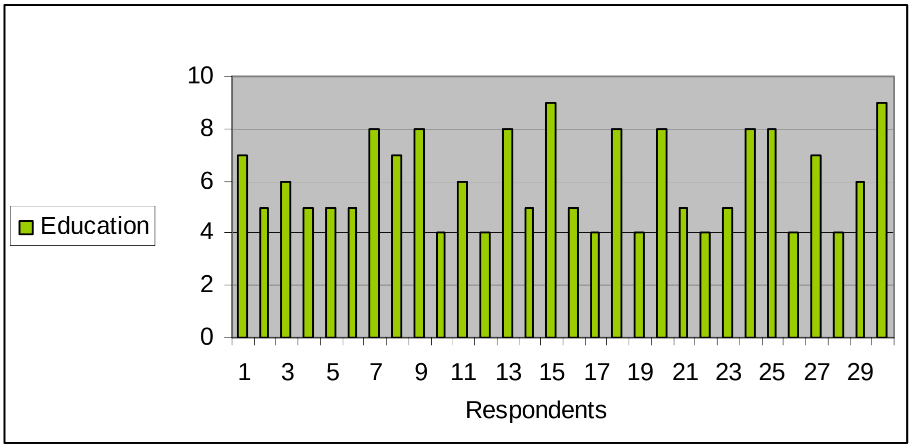
Variable	Mean	Std Dev	Minimum	Maximum	Range	Median	Mode	Skewness	Kurtosis	90% CI
ATO	1.1	1.19	0	5.31	5.31	0.97	0	1.76	4.31	0.25-1.4

The descriptive statistics and frequency histogram for ATO show that this variable indeed does not have a normal distribution at all. As confirmed by the subsequent normal probability plot, this distribution shows considerable curvature and does not support normality. Distributions like this do have the potential to mislead analysts and must accordingly be treated with the required reservations. Asset turnover depicts how many times every unit invested are returned to the investor, or then in this instance, how many times every Rand invested is returned; and if the various entries are displayed without contextual "noise" (Table 4.6), the observer would pick up widely different values, but all presenting typical ATO entries. The variable does therefore present a challenge beyond the obvious, and would probably benefit by statistical transformation, so that the degree of skewness can be reduced. Data transformation as tool for refinement of variables with departures from normal distributions is a tried and tested methodology, and although log transformations were provisionally tested with ATO, this specific topic, though stimulating, requires a separate discourse. Division of the respondents into technology-intensive and technology non-intensive firms did not alter the trend as displayed, so an explanation for the departure from normality is not to be found in the sub-categories of the variable.

Table 4.6: Typical nature of ATO indicators

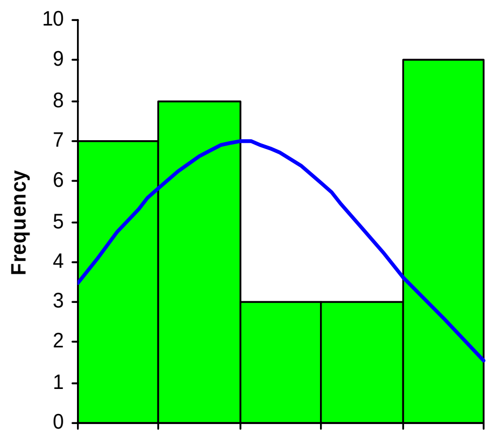
1.48	0.12	3.55	0.10	0.05	0.25	1.94	0.00	1.17	0.18
0.08	1.39	0.00	2.23	0.63	1.92	1.80	0.40	1.40	1.23
0.05	1.91	0.42	0.02	1.30	0.08	5.31	1.23	1.97	0.77

4.2.3 Education



Key to Education (Y-axis):

4 = Diploma
5 = Degree
6 = Honours degree
7 = Masters degree
8 = MBA / MBL / M tech BA / CA or combination
9 = Doctorate



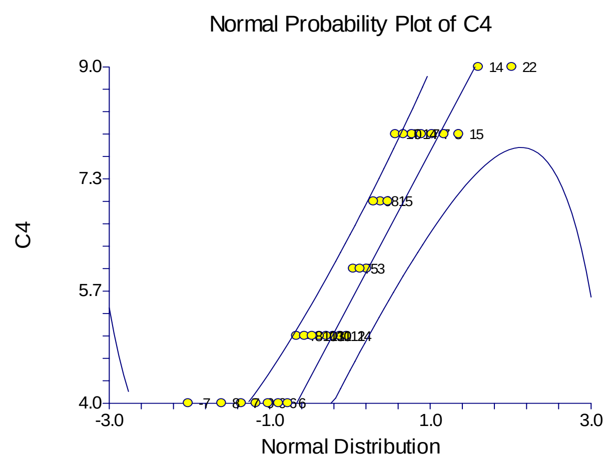


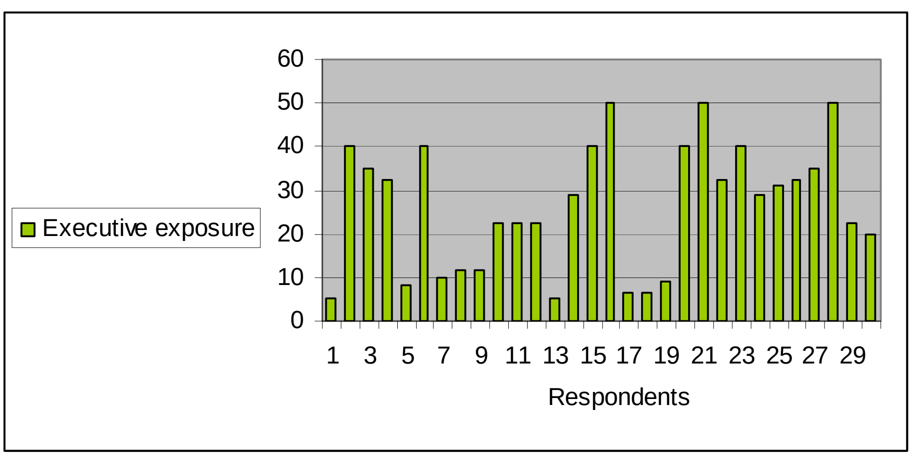
Table 4.7: Descriptive statistics for Education

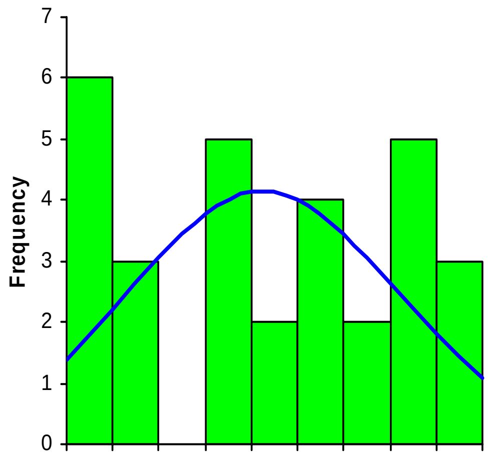
Variable	Mean	Std Dev	Minimum	Maximum	Range	Median	Mode	Skewness	Kurtosis	90% CI
Education	6	1.71	4	9	5	5.5	5	0.29	-1.40	5-7

At -1.40 the degree of kurtosis for this variable would suggest fairly thick tails in the coded data, and this again suggests therefore departures from normality. A mean of 6 suggests an average of an honours degree for the sample population, but the mode of 5 suggests that degree-level qualifications are most often registered. Post-degree management qualifications such as MBL, MBA or M Tech BA, with at least one respondent combining a MBA with a Chartered Accountant qualification, were certainly popular among the respondents, with a frequency of 7 entries. The lowest values processed were that for a tertiary diploma, while the highest were for two doctorate degrees, one of which had the highest score for the MOT-based cost management competency index. Of yet more interest, though again only of academic value, is the fact that the larger population would have an educational level of at least a degree to a masters degree, as reflected by the 90 per cent CI range of 5-7.

4.2.5 Executive exposure

The degree of skewness for this variable is closest to zero among all the variables, meaning that the data distribution for Executive Exposure is closest to symmetry. The degree of kurtosis indeed is closest to zero as well, meaning that the tails of this distribution are closest to that of a normal distribution. The mean of 26 is much lower than the mode of 40, and this does contribute to the relatively high range of 45. Altogether it means that positions such as Chief Executive Officer and Chief Finance Officer have higher executive exposure than positions such as Chief Information Officer and Chief Technology Officer, and these again has more exposure than positions such as product manager, process manager, engineer, consultant, etc. Having considered alternatives to the low survey response, and in particular the lack of any response whatsoever from corporate management teams, this variable was formed by combining respondent responses for organizational roles and functional areas, as demonstrated earlier in Table 3.3.





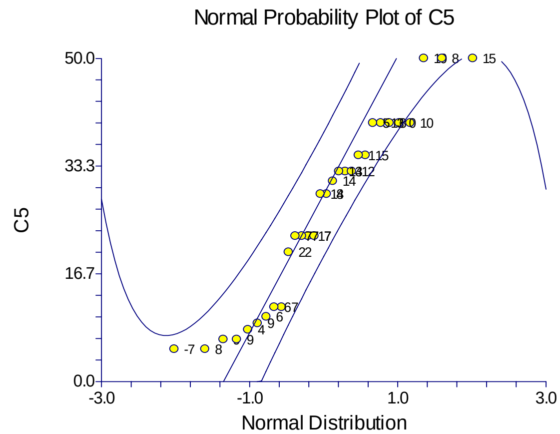


Table 4.8: Descriptive statistics for Executive Exposure

Variable	Mean	Std Dev	Minimum	Maximum	Range	Median	Mode	Skewness	Kurtosis	90% CI
Executive exposure	26.3	14.45	5	50	45	29	40	-0.03	-1.18	22-32

Although this variable has the best statistical symmetry, its utility value as proxy for corporate management teams means that at least one more perspective on its attributes is required. Table 4.9 displays a new set of attributes with the lowest nine entries for Executive Exposure removed. The mean increases from 26 to 34, variation within the variable decreases from 14.45 to 9.3, the range decreases from 46 to 31 and the 90 per cent CI increases drastically. The manipulation of this variable, and how it impacts upon relations with key variables, will therefore be further examined during data analysis.

Table 4.9: Descriptive statistics for Executive Exposure with lowest entries removed

Variable	Mean	Std Dev	Minimum	Maximum	Range	Median	Mode	Skewness	Kurtosis	90% CI
Full set	26.3	14.45	5	50	46	29	40	-0.03	-1.18	20-25
Lowest entries (removed)	34	9.3	20	50	31	32.5	40	0.23	0.84	30-37

4.2.6 Conclusions about data set

A major setback for this study is indeed the limited sample, having had conclusions about the variables confined to the sample population only. This shortcoming requires refinement in data collection strategies for future iterations of this experiment. Although formal tests for normality have little value for small sample sizes, non-normality in data distributions has potentially the highest impact on research design under these circumstances, and therefore the imperative to test for normality. The above section has indeed shown that all the variables in the data set have departures from normalities. Although the causes for these departures are explained, contributing to the validation of the sampled data set, the different variables will be used conservatively in the analysis of data to follow.

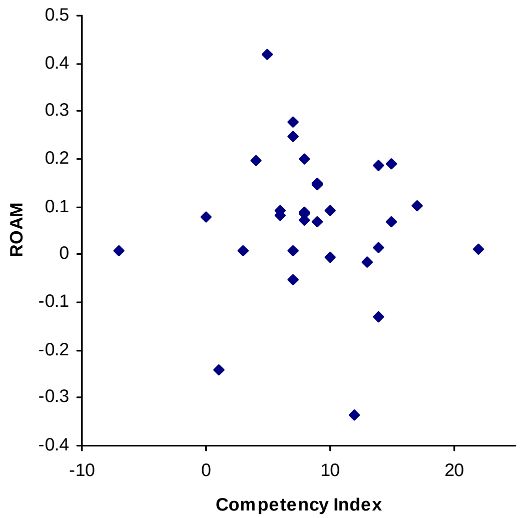
4.3 DATA ANALYSIS

Only experimental data can conclusively demonstrate *causal* relations between variables (StatSoft, 2003), and given the non-experimental nature of this study, relations are sought and tested in terms of their strength and reliability only to serve as pointers for follow-up experimental research. In this instance, only a single sample applies, and in accordance with the research proposal, the stated intend with data analysis is to quantify the relationships between different sets of two variables each. Primary among these are the variables formulated in the research hypothesis, i.e. MOT-based cost management competencies and financial performance of listed companies. Since the tools are available, and to scientifically explore more possibilities towards the longer term research objectives, these variables will also be paired with the rest of the variables described, and different relationships will be tested. With numerous techniques available for data analysis, relevant and valid methods for data analysis and hypothesis testing must be carefully selected to achieve the stated research objectives. Normally these considerations form part of the research proposal, refined during data collection and description. Since this study involves a small sample, with departures from normality, non-parametric tests would normally be required. *Non-parametric* simply means that no assumptions will be made about the distribution and the parameters of the larger population from which the study sample was drawn, nor are these parameters then required. However, while a relatively simple non-parametric procedure for correlation analysis is available in the form of Spearman's rank order correlation, non-parametric regression is more complicated and in fact not accommodated by the two statistical packages used in the study. With the result that simple linear regression, normally reserved for parametric data, but once again a straight-forward procedure, will be executed on those data variables warranting further investigation. One obvious outcome is that the results of these analyses must always be treated within the context stated here.

4.3.1 Correlation analysis

Correlation is a measure of association between two variables, and according to Cryer and Miller (1994:146), the statistical technique most widely used to summarize relationships between continues data. The variables are not designated as dependent or independent, and the outcome of the analysis is a scatterplot of the relationship, accompanied by the correlation coefficient, denoted by the symbol *r*. A *r* of -1 is a perfect negative correlation, a *r* of 1 is a perfect positive correlation, and a *r* of 0 means there is no correlation. While the correlation coefficient is a measure of strength between the two variables tested, it needs not be the result of a *causal* link between them. As stated earlier, causal links can only be established with true experimental research. The rest of this section will display and discuss the results of a set of correlation analyses, systematically executed on the described variables.

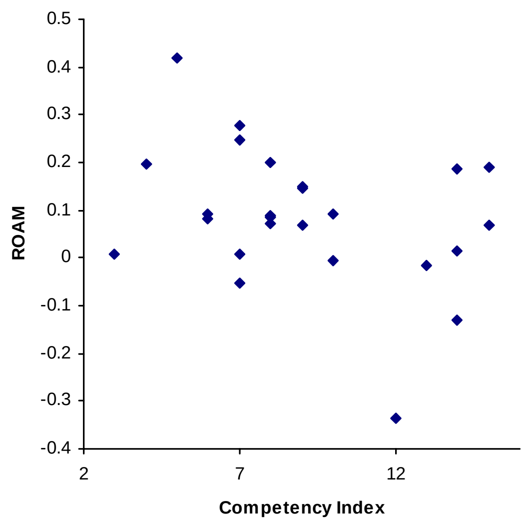
4.3.1.1 Correlation between MOT-based cost management competencies and ROAM



r = -0.12

In what is the most significant *provisional* result for the research hypothesis, the correlation between MOT-based cost management competencies and ROAM proves that in their *present format* there is in fact no relation between *specifically* these two variables. While the finding only applies for the sampled data, it can safely be concluded that regression between these two variables in their *present format* would not yield any new insights. But what would be the result if the data set was manipulated? In the following correlation, altogether five outliers, respectively the three lowest and two highest *MOT-based cost management competency* entries, were removed from the data set [N = 30 in full data set, but N = 25 in manipulated data set].

With r = -0.30, evidence of a moderate association is manifested. The negative trend means that a decrease in one variable is associated with an increase in another, which certainly runs counter-intuitive to the assumptions made for this study. The strength of the relationships decreases to r = -0.21 when the lowest 40 per cent of *MOT-based cost management competency* entries were subsequently removed from this variable.

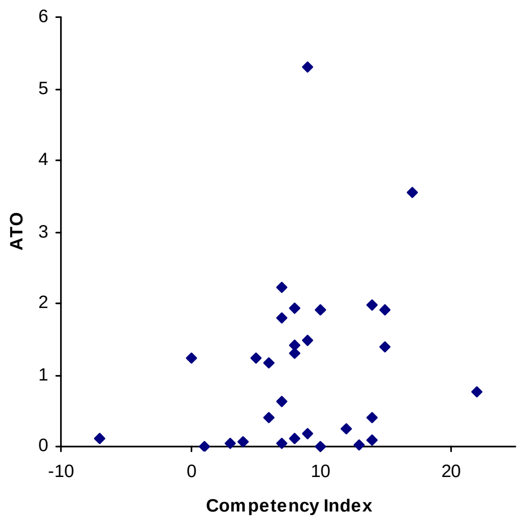


r = -0.30

Having manipulated *ROAM* in precisely the same manner yielded no association with the first manipulation [five outliers removed] and r = -0.15 with the second manipulation [40 per cent entries removed]. Furthermore, r = 0.04 if the lowest scores for Executive Exposure are removed. One final test remains, i.e. that of testing for relationships between the variables as divided in technology-intensive and non-intensive sub-categories, with no entries removed, and in both instances no association is found. In summary, the two key variables are clearly not related as treated within the context of this study, though the negative relationship with the manipulated data set does justify further examination with regression analysis.

4.3.1.2 Correlation between MOT-based cost management competencies and ATO

With r = 0.25 evidence of at least a moderate correlation is presented between these two variables as presented in the full data set. Searching further for associations in the relevant sub-categories yielded a moderately strong association of r = 0.47 between these two variables in technology non-intensive companies, and r = 0.06 in technology-intensive companies, which means in fact that the association of r = 0.25 in the full data set is explained mainly by technology non-intensive companies. With the lowest Executive Exposure entries removed, r = 28, which again is a moderate association.

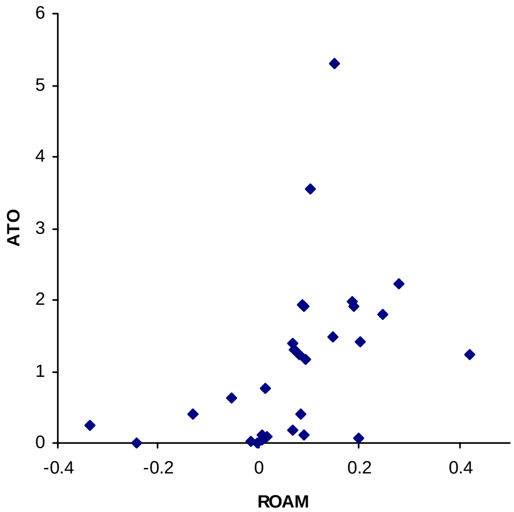


$r = 0.25$

Care should be taken in formulating conclusions about relationships where ATO is involved due to its significant departures from normality, in spite of the fact that this is a non-parametric test. Once again, statistical transformation of ATO might have yielded more positive results in the search for association. The net results for testing of the research hypothesis is however that further analysis of these two variables is required, as ATO remains an indicator of financial performance, albeit then one less complete than ROAM.

4.3.1.3 Correlation between ROAM and ATO

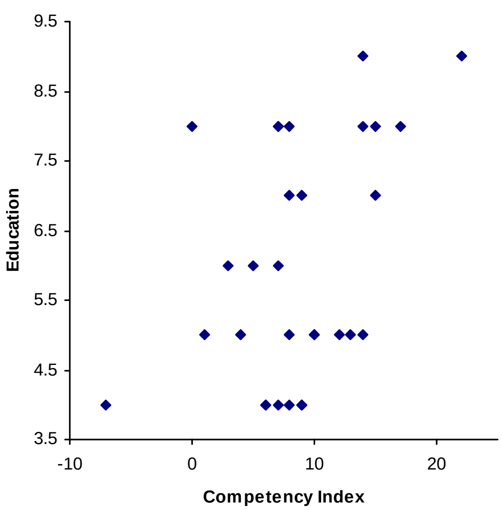
For the benefit of the reader, and to proof the underlying association between ATO and ROAM, whereas ATO was used as input value into the ROAM calculations, the association between these two variables yielded the value of $r = 0.69$, which can be considered a strong correlation, possibly to be improved by transformation of ATO. The relevant scatterplot is displayed below, and a regression analysis will be executed to help describe the relationship.



r = 0.69

4.3.1.4 Correlation between MOT-based cost management competencies and Education

The inherent nature of competencies, and its links to education and training, make testing of this relationship within the framework of this study an imperative, but in particular so within the framework of the longer term experimental research with its planned interventions and manipulations of variables.

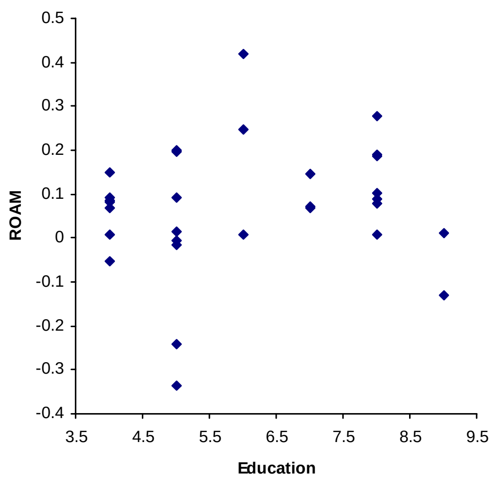


r = 0.30

In this case the value of r = 0.30 can be considered a moderate correlation. This trend remains at the same level if the lowest entries in Executive Exposure are removed. In both instances the scatterplot displays a positive trend, which means that an increase in education is associated with an increase in MOT-based cost management competencies. Of course this represents validation of a key assumption at the foundation of this study, i.e. that competencies are based on education, knowledge and insight, and that an increase in one should be accompanied by an increase in the other. It also presents new academic vistas to be explored now and over the longer term, i.e. what are the relationship between Education as independent variable and MOT-based cost management competencies as dependent variable? Since this would require regression, it is a topic to be explored again in the next section. For now, further explanation of the relationship is explored for in the subcategories of technology-intensive and technology non-intensive companies. With $r = 0.51$ in technology-intensive companies, and $r = 0.24$ in technology non-intensive companies, a trend opposite to that in the relationship between MOT-based cost management competencies and ATO, is found in the dynamics of these sub-categories .

4.3.1.5 Correlation between Education and ROAM/ATO

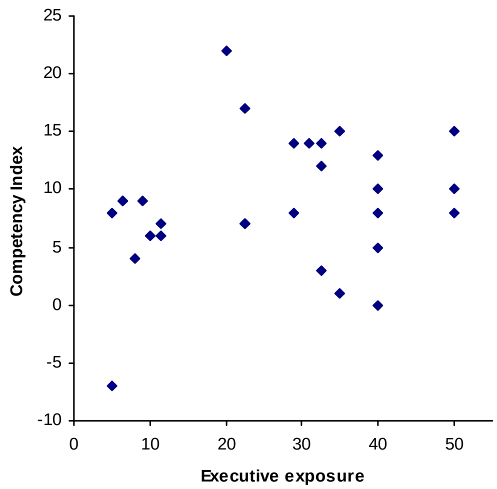
If the association between MOT-based cost management competencies and *ATO* is explained by *technology non-intensive* companies, and if the association between MOT-based cost management competencies and *Education* is explained by *technology-intensive* companies, what then is the association between Education and ROAM and Education and ATO? The following analyses explore these questions further:



$r = 0.13$

With $r = 0.13$ manifesting as a relatively weak correlation between Education and ROAM, the correlation between Education and ATO, not surprisingly, is measured only at $r = 0.19$. This relationship does therefore not warrant any further inquiry.

4.3.1.6 Correlation between MOT-based cost management competencies and Executive Exposure



$r = 0.21$

$r = 0.21$ can be considered a moderate correlation, justifying further inquiry with regression analysis, though once again the roles will be inversed, with Executive Exposure to serve as independent variable and MOT-based cost management competencies as dependent variable.

4.3.1.7 Conclusions about correlation analysis

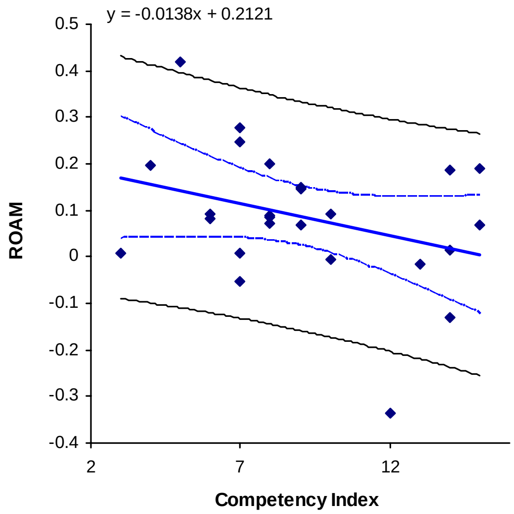
This section has proved that more scientific examination is required before the stated research hypothesis can be accepted or rejected. Whereas no relationship was found between MOT-based cost management competencies and ROAM in the full data set, evidence of moderate and indeed moderately strong associations were found between MOT-based cost management competencies and ATO, respectively in the full data set and in the sub-category of technology non-intensive companies. Another major finding was evidence of moderate and strong associations between MOT-based cost management competencies and Education, once again respectively in the full data set as well as in the sub-categories of technology-intensive companies and with the data set having the lowest entries in Executive Exposure removed.

4.3.2 Regression analysis

Whereas correlation analysis measures the strength of relationships, regression analysis helps to describe the significance of these relationships. Significance is expressed in P, and the smaller the P value, the more significant the relationship. By convention a P value greater than 5 per cent ($P>0.05$) is seen as not significant, and should have the research hypothesis rejected (Altman & Bland, 1995:485), and this study will suffice with this simple test of significance. The variables are now designated as dependent and independent variables, respectively serving as the predicted and the predictor. Of note is the fact that regression analysis can be utilized to predict the outcome of the dependent variable [predicted], based on a given level of the independent variable [predictor], which within the context of this study, means that a given level of education would predict a specific MOT-based cost management competency level. The predictive capacity of regression analysis would for example also be used to suggest a certain level of MOT-based cost management competencies to achieve an associated level of company performance, measured in ATO as suggested by the results of the correlation analyses executed earlier.

4.3.2.1 Regression: MOT-based cost management competencies on ROAM

Correlation between the MOT-based cost management competencies and ROAM proved that there was no association if the full data set was used. Removing the outliers in MOT-based cost management competencies [N = 25] resulted in $r = -0.30$. The tendency for ROAM to decrease with an increase in MOT-based cost management competencies is displayed in the scatterplot of the regression between these two variables. Although counter-intuitive, the negative relationship found here compares well with the negative correlation found between *technological learning* and company market performance by Carayannis and Alexander (2002: 640). Closer inspection of their results found a curve shape in the relationship, and they have speculated that organizations have an optimal “learning absorption bandwidth” (Ibid.:640), where learning should not exceed the absorptive capacity of a company, but must also be sufficient to sustain performance.



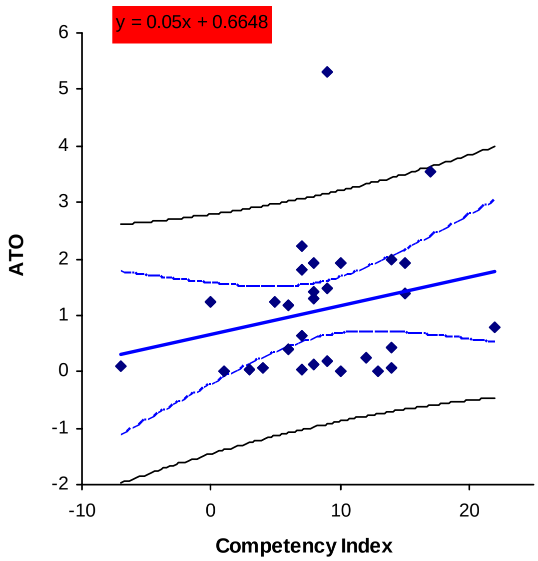
Having the regression equation, it must be established how well ROAM [predicted variable on vertical Y-axis] is predicted by MOT-based cost management competencies [predictor variable on horizontal X-axis]. Specifically, how much *variability* in ROAM can be accounted for by the linear regression where MOT-based cost management competencies are a predictor? The answer to this question lies in the Sum of Squares [SSq], which is best described as the mathematical result of the regression function, and of which a smaller value indicates a good fit of the observed values around the straight-line model, using MOT-based cost management competencies as predictor and ROAM as the response variable.

Source of variation	SSq	P
Due to regression	0.055	0.1091
About regression	0.456	
Total	0.511	

In this instance, a proportion of only 0.055 can be explained by variation, while a proportion of 0.456 remains unexplained, or is due to unknown variance. It is therefore clear that MOT-based cost management competencies as predictor variable is really responsible for only a small proportion of variation in ROAM. The P-value of 0.1091 signifies that the relationship between the MOT-based cost management competencies and ROAM is not statistically significant either.

4.3.2.2 Regression: MOT-based cost management competencies on ATO

The following regression analysis continues to pursue the search for relationships between MOT-based cost management competencies and financial performance of companies. In the first instance, the full data set [n = 30] applies, and in the second instance, only the sub-category of technology non-intensive companies is analyzed.



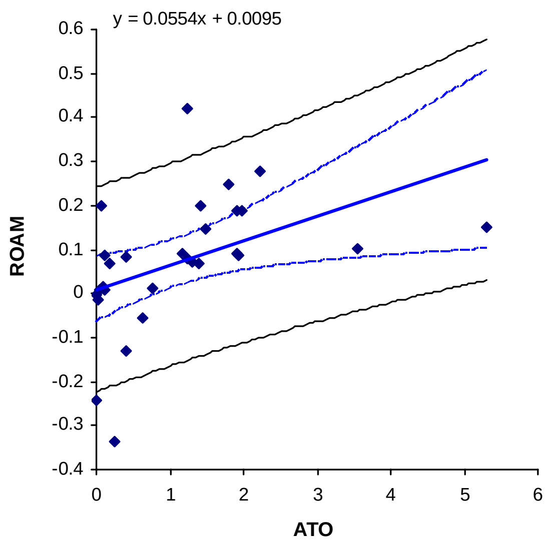
Source of variation	SSq	P
Due to regression	2.300	0.2096
About regression	39.054	
Total	41.354	

As can be seen from the above, the P value of 0.2096 means that the relationship between MOT-based cost management competencies and ATO is not significant. With the lowest entries for Executive Exposure removed, the P value of 0.2803 still means no significance. *Using the predictive capacity of regression analysis, it can however be postulated that a higher level of competencies could have another outcome on this particular relationship.* More specifically, what would be the outcome in the observed response [ATO] if the competency index variable was increased to 22, which represents the top score for the MOT-based cost management competency index? Using the formula for the regression line as provided by regression [marked in red in the display] to predict ATO if the competency index was 22 is as follows: $y = b(x) + a$, or then $1.77 = 0.05(22) + 0.6648$. An ATO of 1.77 means every Rand invested is returned 1.77 times, which is significantly higher than the average ATO of 1.1 achieved by the responding companies. It is also higher than the range of 0.25 – 1.4 for the population, predicted by the 90 per cent confidence interval. Yet it remains significantly lower than the highest ATO measured, i.e. 5.31.

It has been shown that the above relationship has a moderately strong correlation of $r = 0.47$ if the sub-category of technology non-intensive companies are analyzed. Though the associated P value of 0.17 indicates that it is not a significant relationship, increasing the competency index to 22 again yields an ATO of 2.6, which once again is much more positive than the general trend among the observed companies. All of the above results should however be read with caution, due to the fact that the study cannot make generalizations about the population, as well as for the fact that ATO data shows departures from normalities. It should though be noted that the closer the relationship between the two variables as shown by correlation, the higher *r* and the better its predictive capacity in regression.

4.3.2.3 Regression: ATO on ROAM

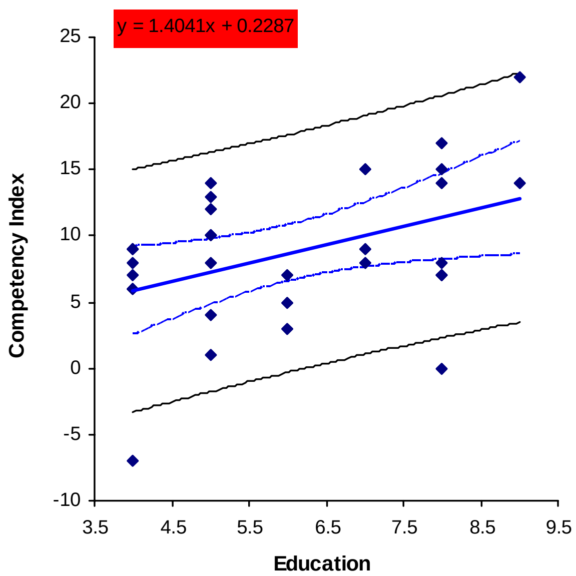
There is a strong correlation between ROAM and ATO, confirmed by $r = 0.69$. Since ATO is a building block for ROAM, a regression of ATO on ROAM yields a P value of 0.012, which is indeed a significant relationship, confirming the inherent integrity of ROAM as composed for this study. It should be noted that ATO becomes the independent variable in this analysis. The effect of departures from a normal distribution in ATO remains clearly visible, and it is submitted that corrective measures in ATO will improve the explanation of variation in the relationship and so continue to improve the underlying integrity of ROAM.



Source of variation	SSq	p
Due to regression	12.713%	0.0122
About regression	49.549%	
Total	62.262%	

4.3.2.4 Regression: Education on MOT-based cost management competencies

Education is also a building block for competencies, and testing its effect upon the MOT-based cost management competency index is therefore a natural outflow of the moderately strong association found between these variables. Once again, the competency index is the dependent, or predicted, variable.

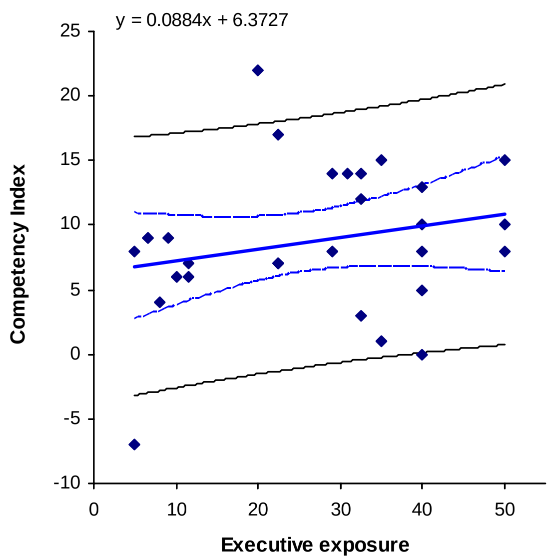


Source of variation	SSq	P
Due to regression	167.507	0.0187
About regression	752.793	
Total	920.300	

The P value of 0.0187 is smaller than 0.05 and signifies a significant relationship. The mean for Education is 6; *what would be the effect upon MOT-based cost management competencies if Education is increased to 8?* Within the context of this study 8 represents post-degree management qualifications, of which a MBA is a typical example. Recalculated, the regression equation [marked in red in the display] is 11.46 = 1.4041(8) + 0.2287. The competency index is therefore predicted to increase from a mean of 8.7 to 11.46, which is significantly higher and indeed also outside the population parameters of 7-10. The predicted outcome of a competency level of 11.46 upon ATO is 1.23, which is marginally higher than its present mean. This particular discussion, however, belongs in the domain of multiple regression, with which the impact of Education and MOT-based cost management competencies on ATO and ROAM could be modelled independently.

4.3.2.5 Regression: Executive Exposure on MOT-based cost management competencies

A final regression analysis of Executive Exposure on MOT-based cost management competencies returns a P value of 0.22, which suggests that this is an insignificant relationship. Find the display of the regression below:



4.4 TESTING OF THE RESEARCH HYPOTHESIS

This study examines the following research hypothesis:

a) The research hypothesis holds that an increase in MOT-based cost management competencies of corporate executives of listed companies is associated with an increase in financial performance of these companies.
b) The alternative hypothesis is one of no association between MOT-based cost management competencies of corporate executives of listed companies and financial performance of these companies.

Correlation analysis showed that there was no association between MOT-based cost management competencies and ROAM, serving as the primary indicator of financial performance. Using ATO as a secondary indicator of financial performance showed a moderately positive association, yet proved to be of no significance during regression. *Based* *on the evidence presented, the research hypothesis must therefore be rejected. However, the alternative hypothesis cannot be accepted either, as it was not proved by the rejection of the research hypothesis. In other words, absence of evidence is not evidence of absence, as will be shown below*.

Information was generated during correlation analysis that showed a moderate association between MOT-based cost management competencies and ATO, and a moderately strong association was in fact proven between these two variables as measured in the sub-category of technology non-intensive companies, as well as when the lowest entries for Executive exposure were removed. Furthermore, it was proven that ATO as a proxy indicator for financial performance has significant departures from normalities and could have benefited by statistical transformation, which would have had the potential of a positive impact upon the relationship between MOT-based cost management competencies and financial performance.

Another uncertainty which remains to be scientifically proved is that of the validity of the measurement tool for MOT-based cost management competencies. Although the tool's validity is been corroborated by its own results and by the significance of the relationship between education and MOT-based cost management competencies, no direct scientific evidence has been produced that it in fact measures what is intended. There is therefore a possibility that a third party could find or design a competency index with an improved set of MOT-related problem statements, or with yet a totally different approach, which when applied could prove a very strong relationship with financial performance of public companies. About its contextual application, would the MOT-based cost management competency index meet the attributes set out by Brady et al. (1997:420)? In other words, would the tool be appropriate to the problem; would it *distinguish* itself among many other tools, as appropriate for measurement and management of what is to be diagnosed and or benchmarked; and would its manner of application and its limitations be known to the person using it?

Yet another major weakness in the study is that of using the variable *Executive Exposure* as a proxy for what transpires in corporate management teams as far as MOT-based cost management is concerned. The critical observer might indeed conclude that this premise is very weak, and that the results of the study therefore simply suggest the lack of association between MOT-based cost management competencies and financial performance *only for the* *fraction of corporate activities represented by those functional roles fulfilled by the respondents, irrespective of their generally accepted corporate profiles*.

A final reservation is that of the small sample size, which meant a very low statistical power, with very wide confidence intervals, which again is simply associated with more uncertainty. Small sample size could in fact be the primary reason for a correlation with strong association, proved to be of no significance by regression; since the smaller the relation between two variables, the larger the sample size required to prove significance. To conclude therefore, more evidence is required to accept the alternative hypothesis.

4.5 CONCLUSION

This chapter presented an in-depth description and analysis of the variables in the research data set. It showed that the small sample size had a major impact upon the data set, primarily insofar it concerns departures from normality, but also because of its potential impact upon the measurement of significance. The lack of corporate team response as much impacted upon the data and the external validity of the results, if it is to be accepted that Executive Exposure is not a meaningful proxy. Correlation and regression analyses with the data set in its unaltered form did however show that *significant* associations do exist, in particular between ATO and ROAM and between Education and MOT-based cost management competencies. In both instances the predictor variables formed foundations for the predicted variables, which yet again were both key constructs in the study. Though MOT-based cost management competencies and ATO showed association during correlation analysis, these associations proved not to be significant during regression, but these are confirmed signs of relationships and are to be examined further under different research circumstances.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE RESEARCH

5.1 INTRODUCTION

Based on the literature review, this study formulated an assessment that the MOT community needs to revisit cost management, and MOT-based cost management practices. The assessment was indeed bolstered by scientific evidence that showed a need for an entire relook at management competencies and practices in technology-based environments, and how these competencies and practices are associated with techno-market insight and organizational performance. These issues can all be seen as part of the discourse about a credo for MOT. To contribute to this discourse, the aim of this study was therefore to measure and assess MOT-based cost management competencies of corporate executives and to demonstrate the value of the measurement exercise for general management practice in technology environments.

The first section of the final chapter of this mini-dissertation will present a unified set of conclusions about the study, and whether it achieved the stated aim and objectives. A second section will present an overview of key research questions generated by this study, and a final section will conclude the study. Having used scientific methods, this research also laid foundations for peers to repeat the study concept elsewhere, and to test and compare results. Given the inherent weaknesses in this study, it is indeed possible for peers to achieve different results and to reach different conclusions. This is the nature of scientific discourse, and should help to establish the theoretical and practical bona fides of the approach and management tools introduced here.

5.2 SUMMARY OF RESEARCH CONCLUSIONS

5.2.1 The MOT-based cost management competency index

The study's first objective was to develop and apply a first iteration of a MOT-based cost management competency index as measurement and management tool. In spite of a number of critical questions posed about its bona fides, it should be concluded that the study indeed succeeded in having designed and tested a prototype of a tool for measurement, analysis and management of MOT-based cost management competencies. In fact, the study showed how a MOT-based cost management competency index is to be constructed and be used for comparative purposes at the level of the individual executive as well as at industry level. Of particular significance were the results of the correlation and regression analysis that showed a clear and positive relationship between education and MOT-based cost management competencies. Simply put, the higher the educational level, the higher the competency level. Had the opposite been shown, it would have stopped the evolution of the MOT-based cost management competency index in its first generation. But given the positive results, it was possible to show that increasing education to the level of a post-degree management qualification would increase MOT-based cost management competencies beyond the range postulated for the rest of the market. Of course, this does not suggest that curricula and syllabi of existing management qualifications satisfy the need for MOT-based cost accounting, because the mean predicted by the increase of education to MBA-level is only 11.46 whereas it could be argued that the benchmark to be achieved is at least 22, albeit that this score was achieved by a respondent with a doctorate.

5.2.2 MOT-based cost management competencies and financial performance

A second objective of the study was to measure and assess the relationship between MOT-based cost management competencies of corporate executives and financial performance as accounted for in financial statements of the companies employing these corporate executives. Having created the MOT-based cost management competency index as the one side of the required equation, the other side was to consist of an appropriate indicator of financial performance, which was to be ROAM.

5.2.2.1 ROAM as an indicator of financial performance

Though this study used Return on Assets Managed as indicator of corporate financial performance, it did so since ROAM seems to have been the most complete of a plethora of available financial indicators; but also one that was most appropriate to a MOT analysis. But this does not mean that ROAM was the *best* indicator to have used in this analysis; the concept of ROAM indeed has not enjoyed a very high profile. Financial indicators are however a part of the foundation for what is postulated for the longer term research process started by this study, and it had therefore to be shown that ROAM and ATO is significantly associated, which indeed was the case. If the fundamental premise of using asset-based financial indicators for MOT type of analyses is accepted, then establishing the association between ATO and RAOM helps to build trust in ROAM; but it may also be proved that ROAM is not required and that ATO suffices for the type of analysis required here.

5.2.2.2 Conclusions about the relationship

No significant relationship was found between MOT-based cost management competencies and financial performance of the responding companies, and the research hypothesis was rejected. Although the study therefore failed in achieving its second objective, this failure must be evaluated within the specific parameters of the study. It is to be concluded that substantial departures from normality in its distribution made ATO, and therefore its effect on ROAM, a difficult variable to set into an equation fundamental to the study. Given the limited extent of the study, transformation could not be executed on variables requiring it, and yet another conclusion is therefore that this study continued to be too an ambitious endeavour as a mini-dissertation. Evidence of a positive association was however found between MOT-based cost management competencies and financial performance of companies, as represented by ATO; and the search should continue to more closely describe the relationship between these variables, in spite of an earlier examination working with much better data having failed to establish causal links between *technological learning* and company performance.

5.3 QUESTIONS FOR FUTURE RESEARCH

This section will systematically describe the research questions raised. These questions were raised during the study but reserved for this section.

5.3.1 The MOT-based cost management competency index

The description and analysis in this document of the MOT-based cost management competency index is limited, and the main question to examine now is the internal validity of this tool. Specifically, does the MOT-based cost management competency index measure what it intends to measure? Although various signals supported the validity of the tool, of which the most important is the relationship between education and MOT-based cost management competencies, its internal validity has not been proven in this study and would require a follow-up study if the tool is to continue to be used and refined. With reference to the usage of the tool, the question arises of what would be a benchmark score for the competency index? This study, marked negatively, yielded a highest score of 22, whereas theoretically 51 could be scored. How can these scores be used to refine the problem statements and the coding of the statements, as it could reasonably be argued that not all responses need be in the Likert scale format of "strongly agree" or "strongly disagree"? Should another scale be used, or should a scale at all be used? If organizations have a limited absorption capacity for technology learning, as was reported earlier, do they have a limited absorptive capacity for MOT-based cost management competencies as well?

Although the index scores per industry provided fascinating insights, should every industry and every technology vertical not have its own type of MOT-based cost management competency index? Given the different scores for technology-intensive and technology non-intensive industries, should different indexes be designed for these sub-categories? Answers to these questions should be judged in the light of the fact that this is a first iteration of the competency index, and it necessarily depends on the form and function of the typical research survey. Under different circumstances, and with compliance of cooperating organizations, the survey might indeed assume a different form, yet always maintaining the underlying scientific *notion* and *function* of a MOT-based cost management competency index.

5.3.2 ROAM as an indicator of financial performance

All of the findings presented so far pointed towards moderate to weak, or even a lack of any relationship, between technology-related competencies and company performance. Yet literature-based evidence was provided of a positive correlation between MOT in general and company competitiveness, so the concept of *company performance* within a MOT-based context should be revisited. A fundamental question that does arise for example, is whether the intangible nature of innovation management is encapsulated by ATO and by ROAM? Are ATO and ROAM therefore appropriate dependent variables to set up against MOT-based cost management competencies in the type of analysis that was done here? Are there not financial indicators that would represent a closer linkage between excellence in MOT, the intangible nature of many MOT practices, and the cost dimension of financial performance? Having established an early template for a MOT-based cost management competency index, this issue certainly present a significant lead for future research.

5.4 CONCLUSION

The discourse about a credo for MOT states that traditional management subjects remain an important priority for training in MOT. It also points out the need for a body of knowledge about the discipline. In reply, this study set out to contribute in two ways to the discourse about MOT. Firstly, with the focus on traditional management subjects, the study analyzed the relationship between MOT and cost management and concludes that it is a relationship in need of new foundations for a reality with technology omnipresence. With that in mind, a second focus area was to contribute to the MOT body of knowledge with the introduction of a new measurement and management tool for MOT-based cost management competencies. In an effort to demonstrate the MOT-based cost management competency index's value to market and performance analysis, the study demonstrated a series of experiments to test the relationship between MOT-based cost management competencies and company performance. Working with limited data, the tests were only a qualified success and failed to provide significant new insights. Many more questions than answers were generated in this endeavour, but new scientific perspectives were indeed formulated to justify refinement of the MOT-based cost management competency index, and its continued test application in the market place.

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ANNEXURE A: SAMPLE SIZE CALCULATOR

Determine Sample Size	
Confidence Level:	90%
Confidence Interval:	10 (%)
Population:	420
Sample Size:	59
Find Confidence Interval	
Confidence Level:	90%
Sample Size:	59
Population:	420
Percentage:	50 (%)
Confidence Interval:	10 (%)

ANNEXURE B: FIRST EMAIL REQUEST TO PARTICIPATE IN SURVEY

Dear Madam/Sir

I am conducting research on the relationship between Management of Technology [MOT] and corporate performance as the topic of my M Tech Business Administration mini-dissertation. I would highly value your company's input in this regard by having the survey as attached forwarded to your management team for completion and return. Should you agree to assist in this endeavour, kindly copy my email address ferdie.lochner@capetown.gov.za on your distribution list.

The automated survey should take approximately 20 minutes to complete on screen and respondent confidentially is guaranteed. Full details and complete instructions are to be found on the survey itself. My email address is listed as return address at the end of the survey. In conclusion, should you wish so, I will share with you the executive summary of my findings by completion of the research.

I thank you in anticipation.

Ferdie Lochner

ANNEXURE C: RESEARCH SURVEY

9 Kameeldoring Street
Kuils River
Cape Town
South Africa
7580

10 September 2005

Dear Respondent

Relationship between Management of Technology and Corporate Performance

I am conducting research on the relationship between Management of Technology [MOT] and corporate performance as the topic of my M Tech Business Administration mini-dissertation, and would highly value your input in this regard.

The aim of my study is to assess the capacity of corporate managers to *manage* technology, with a specific focus upon financial management and accounting of technology, together with its impact upon company performance. My intention is also to expand the body of academic knowledge on the above topic to the benefit of the academic and business community. Therefore I kindly request about 20 minutes of your time to complete the attached survey.

The objectives of my study are as follow:

- To develop and apply a MOT competency index as quantitative measurement instrument.
- To measure and assess the relationship between MOT competencies in technology-related management and cost accounting and company performance, as accounted for by selected financial indices.

This research is conducted in my personal capacity as a M. Tech Business Administration student at the University of South Africa (www.UNISA.ac.za). All information received will be applied responsibly and treated in the strictest confidence and no individual respondent will be mentioned or identifiable in any manner in the research report or associated papers.

INSTRUCTIONS

- Find instructions on how to complete the survey at the top of every section to be completed.
- For the final research to be completed in a sensible time frame, the completed survey must be returned to the email address, stated at the end of the survey, before 19 September 2005.
- Should you wish to receive an executive report of the research findings, please provide your contact details on the final page of this survey.

Thank you for your valuable input.

Yours sincerely,
Ferdie Lochner

A Management and Cost Accounting of Technology index

Please indicate whether you agree or disagree with each of the following statements: (Please tick only one response for each statement).		**Strongly agree**	**Agree**	**Neutral**	**Disagree**	**Strongly disagree**
A1	Organizations generally have adequate competencies in technology management.	☐ S/A	☐ A	☐ N	☐ D	☐ S/D
A2	The extent of investment in technology is the ideal indicator of technology competence in an organization.	☐ S/A	☐ A	☐ N	☐ D	☐ S/D
A3	Innovation depends on Technology Intelligence.	☐ S/A	☐ A	☐ N	☐ D	☐ S/D
A4	It is impossible to functionally classify technology in a formal taxonomy, given its diversity and complexity.	☐ S/A	☐ A	☐ N	☐ D	☐ S/D
A5	Innovators normally beat technology imitators to the market.	☐ S/A	☐ A	☐ N	☐ D	☐ S/D
A6	The Technology Adoption Life Cycle is to marketing what the Technology S-curve is to strategic technology planning.	☐ S/A	☐ A	☐ N	☐ D	☐ S/D
A7	Technology audits and value chain analysis are mutually exclusive concepts.	☐ S/A	☐ A	☐ N	☐ D	☐ S/D
A8	Accounting standards generally keep up with the pace of technological change.	☐ S/A	☐ A	☐ N	☐ D	☐ S/D
A9	The effort required to allocate costs accurately to technology processes may be disproportionate to the benefits derived.	☐ S/A	☐ A	☐ N	☐ D	☐ S/D
A10	Cost management in advanced technology environments is better done with multiple costing systems.	☐ S/A	☐ A	☐ N	☐ D	☐ S/D
A11	Overheads in advanced technological environments are generally in proportion to the number of units produced.	☐ S/A	☐ A	☐ N	☐ D	☐ S/D
A12	Research & Development costs must be charged to the benefiting products and services.	☐ S/A	☐ A	☐ N	☐ D	☐ S/D
A13	A technical innovation normally succeeds in a price sensitive market.	☐ S/A	☐ A	☐ N	☐ D	☐ S/D
A14	Most of a product's life cycle costs are locked in during design.	☐ S/A	☐ A	☐ N	☐ D	☐ S/D
A15	Value engineering can reduce the quality of a product.	☐ S/A	☐ A	☐ N	☐ D	☐ S/D
A16	Advanced technology environments have more fixed costs and less variable cost.	☐ S/A	☐ A	☐ N	☐ D	☐ S/D
A17	Abandonment analysis happens at the end of the product life cycle.	☐ S/A	☐ A	☐ N	☐ D	☐ S/D

Information in Sections B & C is required in order to statistically analyze every response:

B Respondent attributes

B1 Your highest qualification

Grade 10 ☐
Grade 12 ☐
Certificate ☐
Diploma ☐
Degree ☐
Honors degree ☐
Masters degree ☐
MBA / MBL / MTech ☐
Doctorate ☐
Other ______________________________

B2 Your main role in the organization *(please tick only one)*

President ☐
Chairman ☐
Director ☐
Chief Executive Officer ☐
Chief Operating Officer ☐
Chief Financial Officer ☐
Chief Technology Officer ☐
Innovation Manager ☐
Chief Information Officer ☐

Technology Manager ☐
Process Manager ☐
Project Manager ☐
Product Manager ☐
Technology Consultant ☐
Business Consultant ☐
Engineer ☐
Cost Engineer ☐
Other ____________________

B3 Your functional area in the organization *(please tick only one)*

Executive Management ☐
Internal Consulting ☐
Finance ☐
Human Resources ☐
Information Technology ☐
Research & Innovation ☐
Design & Development ☐
Production & Operations ☐
Supply Chain & Logistics ☐
Marketing ☐
Sales ☐
Public Relations ☐
Other ______________________________

C Organizational attributes

C1	Company name	____________________
B2	Address 1	____________________
C3	Address 2	____________________
C4	Address 3	____________________
C5	Postal / Zip Code	____________________
C6	Country of primary incorporation	____________________

C7 Industry sector *(please tick only one)*

Advertising / marketing	☐	Legal	☐
Automotive	☐	Leisure / Entertainment	☐
Banking	☐	Manufacturing	☐
Brokerage	☐	Media	☐
Building / Construction	☐	Mining	☐
Chemical	☐	NGO / Non-Profit organization	☐
Distribution / Wholesale	☐	Property / Real estate	☐
Education	☐	Recruitment	☐
Financial Services / Insurance	☐	Retail	☐
Government	☐	Short Term Insurance	☐
Healthcare / Medical	☐	Telecommunications	☐
Internet / e-Business solutions	☐	Transport	☐
IT Services	☐	University / College	☐
IT Software	☐	Utilities	☐
IT Solutions Provider	☐	Other ____________________	

Please tick and complete if you wish to receive an executive report on the findings of this study ☐

Name	____________________
Surname	____________________
Phone number	____________________
e-mail address	____________________

After completing the survey, please save this document to your local hard drive (e.g. c:\temp) and attach to e-mail addressed to *Ferdie.lochner@capetown.gov.za*

ANNEXURE D: FOLLOW-UP EMAIL REQUEST TO PARTICIPATE IN SURVEY

Dear Sir, Madam

Kindly peruse the short survey attached and consider my sincere request to pass it on to your operational management team for completion. **Technology is omnipresent and continually creates new management imperatives, and this survey will again make you aware of the typical questions you should ask yourself before making decisions about technology.** All companies completing the survey will receive the combined results of how able their management teams are in the field of technology management. All instructions are on the survey. Please have completed survey submitted to the stated email address.

With sincere thanks and appreciation.

Ferdie Lochner

ANNEXURE E: SECOND FOLLOW-UP EMAIL REQUEST TO PARTICIPATE IN SURVEY

Dear Sir/Madam

My earlier request to you to have your management teams completing a short research survey about technology cost management did not have a good response. I do need more data to scientifically test my assumptions about technology cost management and its impact, if any, upon company performance. This is a friendly reminder for you to consider my request again, and if indeed you have already agreed to assist in this research endeavour, that you be so kind as to remind members of your management team to complete and send back to me the survey at my stated email address on the electronic survey. I do again attach the survey for your consideration.

With sincere thanks and appreciation.

Ferdie Lochner