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The strategic responsibilities and required skills of a chief technology officer

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of

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Abstract

The dawn of Technology Age was marked by the mainframe. The tipping for lock stock societal change has been The Internet.

This Technological progress has changed everything in business since. Information Technology has fed the winds of the Schumpeterian Gale, increasing the rate of creative destruction and upending business models are rate never seen before.

Now more than ever the importance of managing an organisations technological capability is critical for business survival. Organisations require their Chief Technology Officers to go further, creating competitive advantage through astute technological management.

The purpose of this study was to ascertain the strategic responsibilities of a Chief Technology Officer and what skills are required to meet these responsibilities.

The findings of this research are underscored by the works of respected scholars and explored through the development of a Skills and Responsibilities Matrix developed through the research. This research highlights the importance of the CTO role as an executive of the business and the importance of having the correct individual.

Keywords: CTO, CTO skills, Chief Technical Officer

Declaration

I Prudence Spratt, student number 11356279, declare that this research project is my own work. It is submitted in partial fulfilment of the requirements of Master of Business Administration at the Gordon Institute of Business Science, University of Pretoria. It has not been submitted before for any degree or examination at any other university.

Miss. Prudence Spratt

Signature

7 November 2012
Date

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Dedication

I would like to dedicate this research study to my mother, my brother and my sister. All of whom shaped the person I became and raised me with an understanding that my potential was limitless.

"Your time is limited, so don't waste it living someone else's life. Don't be trapped by dogma - which is living with the results of other people's thinking. Don't let the noise of other's opinions drown out your own inner voice. And most important, have the courage to follow your heart and intuition. They somehow already know what you truly want to become.

Everything else is secondary."

- Steve Jobs

Abbreviations

Abbreviation	Description
CTO	Chief Technical Officer
CIO	Chief Information Officer
COO	Chief Operating Officer
IT	Information Technology
CEO	Chief Executive Officer
CAPEX	Capital Expenditure
R&D	Research and Development
ICT	Information Communications and Technology
C-Suite	A board level role i.e. CEO, CFO, COO

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Chapter One - Problem Definition

1.1 Introduction

The emergence of the Chief Technology Officer (CTO) role over the past few years is fundamentally changing the landscape of business management. This change and organisation's adoption of it will likely define the success of most businesses as The Internet does its best to disrupt every business model, while inventing new ones throughout the process.

This research paper aims to clarify the responsibilities of the CTO in technology driven businesses and the skills required to meet those responsibilities. The goal was to develop a framework ("Responsibilities and Skills Matrix") on which to base a CTO skills development. This matrix can then be used to recruit and develop individuals for the role of CTO and the office of the CTO.

Academic views as to the strategic responsibilities of the CTO are varying and thus are the skills necessary to meet those responsibilities. This paper has assessed the available academic literature, and the findings form the basis of Chapter Two. These have informed inputs of the interview questions that were asked of experts in the field, and are presented in Chapter Three; Chapter Four then explores the qualitative research methodology that will be utilised for the study.

The data collected from the interviews was then transcribed and tagged to identify emerging patterns from the data, allowing the listing of responsibilities and skills most frequently mentioned by the experts interviewed in Chapter Five. From this list the Top 10 responsibilities and Top 10 skills to meet the responsibilities of the CTO within technology driven organisations were listed, based on frequency of mention.

The results were then further explored in Chapter Six by way of a skills and responsibilities matrix for the CTO role.

1.2 Research Scope

The scope of this research project is defined by the definitions of the following terms:

CTO

According to Wikipedia ('Chief Technology Officer", n.d.) a CTO is defined as

> A Chief Technical Officer or Chief Technology Officer (abbreviated as CTO) is an executive position whose holder is focused on scientific and technical issues within an organization. Essentially, a CTO is responsible for the transformation of capital – be it monetary, intellectual, or political – into technology in furtherance of the company's objectives. ('Chief Technology Officer", n.d.)

Technology Driven Organisations within South Africa

The definition used within this research paper of a technology driven organisation is any organisation in which the use of technology is critical to day-to-day functioning.

A few examples of such organisations would be: financial institutions, internet service providers, telecommunications companies and any other company that cannot deliver a service or product to a customer without the use of technology.

It is also important to note that only South African based organisations and CTOs will form the scope of this research.

Skill

The Oxford English dictionary defines a skill as "the ability to do something well; expertise". (*Oxford English Dictionary*, 2012)

Responsibilities

And it defines a responsibility as "the state or fact of being accountable or to blame for something". (*Oxford English Dictionary*, 2012)

1.3 Research Motivation

The underlying motivation to my research is both personally and professionally driven. On a personal level, I am so passionate about the technology industry that I feel I need to add to the body of knowledge that is this under-researched field, and on a professional level I one day aspire to be the CTO of a technology driven organisation.

Qualitative research was also chosen with the purpose of enabling a learning opportunity to enhance my listening and verbal interpretation skills rather than defaulting to quantitative research, which is more within my comfort zone.

Adam Long in his blog titled 'The Chief Technology Officer' highlights the importance of the CTO role and how it is largely misunderstood when he says

> The role of the Chief Technology Officer (CTO) is one of the least defined and understood corporate executive roles (such as CEO, COO, CFO, CIO). The role has been gaining prominence in many organizations, as witnessed with the newly created position of Chief Technology Officer of the United States (Long, 2007, para. 2).

Medcof and Atkinson (2009) have their own insights into the role and they believe that

> The role of the CTO is a strategic one which includes responsibilities like ensuring the effective functioning of technology as a whole in the organisation, to align corporate and technology strategy and to serve as an active member of the organisations top management team and to go beyond the responsibilities of which are only technical Medcof and Atkinson (2009, p.26).

Pratt in her article The CTO: It's Chameleon states that "now more than ever CTOs are expected to have the business knowledge that ties that technology vision to a company's mission, performance and financial goals." (Pratt, 2007, para. 5).

Blodgett in her article for the CIO magazine states that the CTO is gaining more responsibility

> One model that is developing especially in larger companies, is to split IT leadership between CIO and CTO although many CIOs have worked with CTOs in the past, today's CTO's are being given more responsibility given the overwhelming demands and complexities leaping into the eBusiness fray (Blodgett, 2007, paragraph:10).

What is becoming abundantly clear is that the CTO has a very important organisational role to play. What remains unclear are the strategic responsibilities are of a CTO, and the required skills the CTO needs to in order to meet those strategic responsibilities within technology driven organisations.

1.4 Research Problem

If anything is clear about the role a CTO plays within the organisation it would be the fact that the role is dynamic and is one that is emerging into a key player on the firm's board. The CTO role is not today what it was five years ago and as such, it will need to be defined in terms of the strategic responsibilities and the necessary skills that are required to excel at the position, especially within technology driven organisations.

"Those who aspire to strategic leadership as Chief Technology Officers must look beyond their roots in technology and develop their careers in light of the realities of how decisions are made in top management teams." (Medcof, 2007, paragraph1)

The evidence from the literature suggests the CTO role now requires an executive player which is well versed in the realms of business and technology, a leader with good interpersonal skills that is someone their stakeholders can relate to as well as someone who can make some of the most important strategic decisions for large organisations. The role requires an innovator with wide organisational experience who is also a visionary and can communicate that vision for the organisation to gain competitive advantage within the marketplace.

The problem therefore that this research report will aim to address is:-

1. What are the strategic responsibilities of a CTO?
2. What are the skills required to meet the strategic responsibilities of a CTO?

If we use the definitions from section 1.2 above we can further simplify the two research questions to say that this research study will define what a CTO working within a technology driven organisation is accountable for and depending on their skill set, how well they have the ability to perform these tasks.

Chapter Two – Theory and Literature Review

2.1 Introduction

The management of technology has changed dramatically over the last decade as the internet has gained momentum, forcing business to adapt and is continually evolving and maturing with emerging technologies entering the market, and their implementation within the organisation.

Edler, Meyer-Krahmer and Reger believe that

> Firms have more and more developed overall strategies for their management of technology. This is due to the fact that the cumulative nature of technological know-how emphasises the need for strategies that enable firms both to build knowledge in existing core technologies and to access newly emerging technologies to sustain long-term competitiveness of the company (Edler, Meyer-Krahmer and Reger, 2002, p.149).

So if the CTO role is so integral to an organisations overall strategy and therefore performance, the role deserves a clearer definition of its responsibilities and the skills required to meet those responsibilities within academic literature. The literature collected and examined within this Chapter has been grouped into five themes.

In technology driven organisations, the CTO plays a critical role in aligning the technology enablers to the organisation's strategy (Roberts, 2001; Smith, 2003; Medcof and Yousofpourfard, 2006). In order for this to be successful, the CTO needs the scope and breadth of skills to execute. Medcof goes further to say that he believes that "an unempowered CTO will not be successful" (Medcof, 2008, p. 407).

This Chapter evaluates the available academic literature available surrounding the responsibilities of the CTO into five different themes that emerged from the literature:

1. Corporate strategy definition
2. Competitive advantage
3. Innovation
4. Power base

5. Corporate strategy execution

This Chapter then looks at the skills required to meet the strategic responsibilities explored above that emerged from the available academic literature.

2.2 Definition of the Chief Technology Officer Role

The publications reviewed for this research study reveal a few slightly differing definitions of the CTO role:

Medcof (2007) in 2007 defined the CTO role as, “The Chief Technology Officer is the most senior executive responsible for technology in the corporation and ideally plays an important role in formulating firm strategy and ensuring that technological considerations are optimally integrated into that strategy” (Medcof, 2007. p.1 para.1).

Medcof (2008) expanded his definition of a CTO in 2008 further to “The Chief Technology Officer (CTO) is usually the highest ranking technology manager in the firm and in some organisations the position is called Vice President of Technology or some other variant” Medcof (2008, p. 406).

Smith (2007) defines the CTOs relevance within the organisation as, “The CTO is a businessperson who measures innovation, research and experimentation by the contribution they make to a company’s revenues and future competitive advantage” (Smith, 2007, p. 21).

“The modern CTO position calls for a technologist or scientist who can translate technological capabilities into strategic business decisions” (Smith, 2003, p. 2).

Hartley (2011) believes that the role is dynamic “The CTO is a new and evolving role, having been first utilised over the last few decades” (Hartley, 2011, para. 1).

All of the above disparate definitions all talk to the fact that the CTO is a technical expert who assumes the role of the highest ranking technical employee within the organisation, who is responsible for innovation which enables the firm to gain competitive advantage and who plays an integral part in defining corporate strategy and execution thereof.

2.3 Strategy Definition

The CTO plays a key role in the definition of the organisation's corporate strategy, a sentiment which is echoed by numerous academics.

"The CTO is the most senior executive responsible for technology in the corporation and ideally plays an important role in formulating firm strategy and ensuring that technological considerations are optimally integrated into that strategy" (Medcof, 2007, p.23). Roberts (2001) agrees with Medcof and believes that one of the responsibilities of the CTO is in assisting to define and execute the corporate strategy. (Roberts 2001)

Medcof and Atkinson's view is that the CTOs involvement in corporate strategy definition

> Involves selling the technology strategy to the executive team, persuading them to alter the firm's strategy to accommodate the technology strategy, and to agree to adjustments of the technology strategy to fit firm strategy. In short, it is the CTOs role to lead the harmonisation of technology and business strategy within the context of the executive committee (Medcof and Atkinson, 2009, p. 25).

Roberts (2001) found that in technology driven organisations, the degree to how tightly coupled the technology strategy and corporate strategy are correlates to its overall effectiveness. This may be attributed to as Hartley (2011) puts it, "The CTO can help to link strategy with research and development activities, a link that may have been absent previously" (Hartley, 2011, p. 34). Flynn also highlights the importance of the CTO involvement in the corporate strategy definition process when he says that "The CTO understands the company's strategic direction; this in turn requires an understanding of the nature of the corporate strategy and the strategy formulation process" (Flynn, 2006, p. 5).

When Medcof (2008) states that "The effective integration of technology into firm strategy is essential for the success of firms in technology-driven industries", (Medcof, 2008, p.406) he is reaffirming the sentiments of his fellow academic colleagues.

The CTO can also heavily influence the company culture and assist in creating a culture that fosters an acceptance of technology. Smith (2003) concludes that "CTOs can also play an important role in creating the internal culture; specifically the CTO should initiate activities and policies that create a technology friendly culture aligned with the company's business strategy" (Smith, 2003, p.32).

The overall impact of the CTO and the role they play in integrating technology into corporate strategy is well understood, however it is important to highlight that the CTO has a just as important role to play in terms of intercompany processes as Thurlings and Debackere, (1996) state, driving intercompany innovation processes, and determining how best to manage large and complex projects being a key activity of the CTO. (Thurlings and Debackere, 1996).

Smith (2007) believes that the CTO position "calls for an operational executive who can make important strategic decisions that impact the competitive advantage of the company." (Smith, 2007, p. 18) and Ferdows and Adler believe that "assessing technological aspects of major strategic initiatives" (Ferdows and Adler, 1990, p.59) is one of the five major activities that a CTO deems important.

Hartley (2011) sums up the theme of corporate strategy definition nicely when he says "Since integrating technology and corporate strategy is one of the primary functions of a CTO, this study indicates that a CTO can positively impact company performance." (Hartley, 2011, p. 29).

2.4 Competitive Advantage

A key measurement tool of an organisations performance would be to look at whether or not it has a competitive advantage over its competitors within the market place.

The father of corporate strategy, Michael E. Porter feels that

> Technology has a significant role in competitive advantage if it has a significant role in determining relative cost position or differentiation. Since technology is embodied in every value activity and is involved in achieving linkages among activities, it can have a powerful effect on both cost and differentiation. (Porter, 1985, p. 63).

Hartley (2011) believes that competitive advantage had a big role to play in the creation of the CTO role initially when he says "new product development has driven companies to create a Chief Technology Officer position to lead and direct technology development activities". (Hartley, 2011, p. 28).

Medcof and Atkinson (2009) also support this notion, as they believe that it is the responsibility of the organisational CTO to head up the expeditionary leadership role of

> Coordination and leadership across business functions to ensure the progress of technology based innovations, driving commercialization across functions, solving business unit emergency problems that involve technology, scanning for and accessing external sources of technology, scanning for technological competitive intelligence, identifying and evaluating threats and opportunities contained in technological discontinuities, and leading technological alliances and collaborations with other organizations. Medcof and Atkinson (2009, p.26).

While there are many contributing factors that can determine whether or not an organisation has a competitive advantage within the marketplace a CTO is a very important factor in that process as, as Ferdows and Adler (1990) put it a, “CTO can contribute to agility by facilitating the process of tapping opportunities emerging among technology suppliers, developing products and processes that capitalise on new technological opportunities, and marshalling the complementary skills and resources needed to effectively exploit these innovations” (Ferdows and Adler, 1990, p.61).

Medcof and Atkinson (2009) also talk to the fact that the CTO is not only a short term role as they believe that “senior technology leadership is involved in decisions that tend to extend for a time horizon of 10 to 20 years or even longer” (Medcof and Atkinson, 2009, p. 6) which further affirms the fact that the CTO is a key player in creating and helping sustain competitive advantage.

This is discussed further by when he says Flynn (2006) “To be effective, CTO’s must appreciate how emerging technologies can give a company a competitive advantage and be able to take a global view of technology management” (Flynn, 2006, p. 4).

2.5 Innovation

In line with this "global" view, one of the most important roles a CTO fills is that of innovation leader, as this is the key enabler of gaining competitive advantage.

Burgelman, Christensen, and Wheelwright, (2004) believe that "Established high-tech companies typically spend at least 5 percent of sales on technology and innovation-related activities" (Burgelman, Christensen, and Wheelwright, 2004, p.1) this is a sizable investment that organisations make in innovation, it can therefore be assumed that innovation is an important strategic initiative.

Smith (2003) said

> a CTO who embodies current knowledge, is networked with company engineers, has years of experience and has access to executive decision makers is a valuable resource in recognising important new technologies and bringing them into the company's strategic decision making process (Smith, 2003, p. 3).

and Uttal et al. (1992) believe that one of the main responsibilities of the CTO role was in "leading new technology and innovation developments" (Uttal et al., 1992, p. 22).

Medcof and Atkinson (2009) concur with Smith and Uttal by having stated that a CTOs role is in "leading strategic innovation, leading the introduction of knowledge management, building a company culture of innovation, building networks for gathering competitive intelligence on important organizational issues" (Medcof and Atkinson, 2009, p.27).

So it is therefore important for the CTO to be the organisational custodian of innovation, innovation enables new product development from the emergence of new technologies and creates advantages for the organisation in terms of their go-to-market product offering that creates an overall competitive advantage for the organisation within the industry it operates in. Ferdows and Adler (1990) believe that the supervision of new technology developments is one of the five major activities that a CTO must perform.

Porter (1985) believes that strategic innovation is a significant part of how companies can find ways for growing and building advantages, rather than just eliminating disadvantages. Deevi (2011) suggests that many organisations have augmented their R&D operations with open innovation which is evidence of organisations internalising innovation and therefore building these advantages that Porter talks about. Cannon (2005) impresses that it is the

CTOs responsibility to ensure that the organisation values the intangible assets it acquires through innovation.

Keep abreast with External Technology Changes / New Product Development/ Maintaining Competitive Advantage

Innovation is assisted by the CTOs involvement with external committees and by having their finger on the pulse of new and emerging technologies, so that they can drive early adoption of such technologies. This external involvement in society plays a big role in the CTOs ability to inspire and foster innovation within organisations Smith (2003) highlights one of the main responsibilities of the CTO as "monitoring next technologies and assessing their potential to become new products or services", he also goes on to include that a CTO's role is also required to be available to government and academia as expert consultants on technology, "prominent technologists are often called upon to provide services to government, academic and professional organisations." (Smith, 2003, p.31).

Hartley's (2011) study provides empirical evidence that "the CTO position has a positive impact on innovation and financial performance of an organisation." (Hartley, 2011, p.34). If the CTOs role can impact the overall financial performance of an organisation, then that gives them significant power at board level. This theme will be explored in the next section.

2.6 A CTO's Power Base

Uttal et al. (1992) introduces the next theme of a CTO's power base nicely when they say, "when a CTO lacks credibility, it is hardly surprising that he feels disenfranchised, excluded and lacking in influence. Without credibility, the CTOs efforts are doomed to fail, a leadership gap is sure to persist" (Uttal et al., 1992, p. 15).

Ferdows and Adler (1990) include, "representing technology within senior leadership team of the organisation" as one of the five major activities of the CTO. (Ferdows and Adler, 1990, p. 58). Therefore the CTO role needs to acquire enough organisational power to be able to significantly influence the key decision makers.

External Parties/Communities

The CTO must develop other bases or influence which are largely informal, such as strong personal relationships with the CEO and other influential people, a strong

> informal network both inside and outside the organisation, a significant ownership position in the firm, expertise in matters other than technology including an intuitive grasp of business issues and good knowledge of the corporation and its environment. (Medcof, 2008, p. 419).

Smith (2003) also believes that representing the organisation through marketing and the media is one of the six main strategic responsibilities of the CTO that he defined in his research. Ferdows and Adler (1990) believe that, "managing the external technology environment" is one of the five major activities they defined in their research that a CTO fulfils, so this particular theme is coming through strongly in numerous pieces of literature. (Ferdows and Adler, 1990, p. 59).

In Smith's later work (2007) he believed that the CTO position emerged due to the acceleration of technologies, "it appears as if the CTO position proliferated as a result of the rapid acceleration of technologies available to become products or services." (Smith, 2007, p.22) and Ferdows and Adler (1990) agrees with Smith's sentiments by having said that "the CTO plays this integrating role made increasingly necessary by the peculiar dynamics of technological evolution". (Ferdows and Adler, 1990, p. 61).

The fact that the CTO role itself was formed out of a desperate need for technology leadership within the technology driven organisations and give the role more power over roles that are your more run of the mill C-Suite positions because of the dependency on technology consultation for most strategic decisions.

CAPEX and P&L Responsibilities

CTO's main source of power comes from their technological expertise. Ferdows and Adler's findings suggest that there are very few CTOs who have not sunk deep roots in the technical community at some point in their career. Gwyenne (1996) believes that a CTO's power base can be further widened by having P&L responsibilities, "taking responsibility for profits and losses gains credibility for the CTO where it counts -- at the highest levels of management." (Gwyenne, 1996, p. 17).

Board Responsibilities

Medcof (2007) echoes Uttal's sentiments by stating that

> position and technical experience alone are not sufficient bases of power and influence in the upper echelons, but there are other power bases that CTOs can use. CTOs will

not have credibility with their CEOs and other executives, unless they are seen to be both business and technically savvy. (Medcof, 2007, p.27).

2.7 Strategy Execution

Corporate strategy is only as good as its execution and here the CTO has yet another big role to play in terms of consulting to the organisational business units about technology, putting in place effective process which enable innovation as we as making almost daily important technology decisions.

> "The broad mandate of the CTO is three-fold. First, is to ensure the effective operation of the technology function and it's relationships with other functions. Second, is to ensure the harmonization of firm and technology strategy. Third, is to make an appropriate contribution as a member of the top management team to the overall success of the organization through contributions that go beyond the immediate mandate of the technology function." (Medcof and Atkinson, 2009, p. 6).

Consult to inter-organisational Business units about technology

The CTO is also responsible for consulting to other areas of the organisation about technology and to assist with technology strategy. "The CTO is a technically minded person who is available to help other senior management to understand technology issues and communicate effectively with regard to technology and strategy." (Hartley, 2011, p. 34). Ferdows and Adler (1990) echo Hartley's statement when they include "coordinating among business units' technological efforts to leverage synergies and create economies of scale' (Ferdows and Adler, 1990, p. 58) in their summary of the five major activities performed by a CTO.

The role of the CTO is not like any other on the board – it is a complex role which requires a diverse skill set and must not be treated in the same manner. Smith (2011) believes "technology is both more diverse and more specialised than finance and human resources, and it may be more difficult to manage with the same top-down hierarchy used in those domains." (Smith, 2011 p.60). The complex skill set required by a CTO to meet the strategic responsibilities outlined above will be explored in the next theme.

2.8 Skill Set

Deevi (2011) opens the discussion about the next theme by stating that, “the role of the CTO is a broad and complex one requiring a breadth of skills” (Deevi, 2011, p. 9)

This breadth of skills is explored within this theme demonstrates the need for consideration of the fact that the CTO can no longer just have a depth in technical expertise to function effectively at their job but also need a breadth of other skills that are required by other C-Suite positions. Flynn (2006) states that, “whatever the precise nature of the technologies they manage; most CTO’s now need a broad understanding of technology and its application to the business.” (Flynn, 2006, p.4)

Smith (2003) demonstrates the need for consideration of the fact that the CTO needs visionary skills to be effective. “One of the key roles of the CTO is to provide the technical vision to compliment the business vision, setting the tone and direction for the company’s technologies. Leadership, in this context, comes from being able to define what the company’s products and technologies might look like in two, three, or more years.” (Smith, 2003, p.4).

One of skills that came up in the literature for a CTO to have other than technical skills was financial skills. A CTO needs to have a good financial acumen in order to be to be efficient at their job because strategic decisions must be evaluated in terms of the return on investment.

Communication skills came out as another important skill and specifically the skill to be able to translate technology jargon into useful business information. Tietze, Herstatt, & Lorenzen (2007) explain it well when they say, “the need for a management function emerges with good communication skills and the capability to understand and “speak both languages”, the technical and economical” (Tietze, Herstatt, & Lorenzen, 2007, para. 6).

Line management skills featured in the literature that was reviewed, however it more spoke to the fact that having had line management experience gave the CTO more credibility within the top management team. Gwynne (1996) explains this well when he says,

> overall, CTOs who have line responsibility come out strongly in favour of the experience - for their companies and themselves. In certain types of corporation, which include technology-based companies of all sizes, and particularly small start-ups and business units that rely heavily on technology, they see the mixture of roles as almost indispensable (Gwynne, 1996, p.20).

In reviewing the existing academic literature available, many different CTO skills were mentioned throughout the text as advantageous for a CTO to possess. Below is a summary of the most frequently discussed skills that will form the basis for validation after the research has been collected and analysed.

Skill	Description/Explanation
Networking	Building strategic technology alliances inside and outside the organisation
Vision and confidence	Creating something new in order to exploit a unique opportunity and having the personal gravitas to sell the vision to gain organisational wide buy-in
Technical expertise	Deep roots within the technical field and keeping abreast of technology changes within their industry
Field experience	Understanding of the issues experienced in the day-to-day operations
Interpersonal skills	People skills, motivational and mentoring ability
Leadership	Setting a strategic vision, aligning people, motivating and inspiring people
Conversing at business executive level	CTOs must understand the issues confronting the business as a whole, not just the technical issues
Business (not just technical) savvy	Must appreciate non-technical facets, especially the financials of strategic decision making to gain credibility with CEO and other executives
Selling	The ability to sell the technology strategy to the rest of the board as well as being able to translate technical details into real customer advantages that are superior to those of competing products
General management skills	Ability to manage HR, intellectual property, knowledge management, R&D expenditure and projects. Ability to understand how the organisation works in order to plan and manage execution of strategy and projects

Table 1: CTO Skills

Medcof and Atkinson (2990) provide a great brief summary of the skills required for CTOs to have to meet their strategic responsibilities as, “technical skills are specific to the technical field in which the individual has training or work experience. Interpersonal skills are those that enable one to manage people effectively. Administrative/Conceptual skills have to do with the ability to understand how the organisational system works, what it is capable of doing, planning and managing execution. These are most critical for senior leadership who carry out these functions at the highest level.” (Medcof and Atkinson, 2009, p. 6-7).

2.9 Conclusion

Many strategic responsibilities and skills required to meet those responsibilities have been explored within this Chapter. In order to aid in a better understanding, a graphical representation of the different themes explored is presented below.

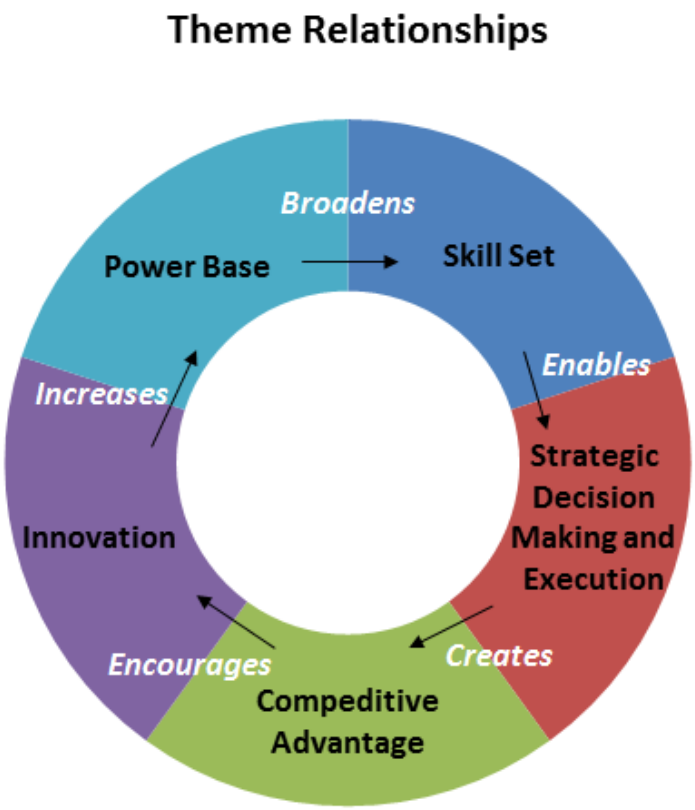

Figure 1: Theme Relationships

A CTO requires a certain skill set (discussed in Chapter Six) to make strategic decisions on behalf of the organisation and execute them. By making the right strategic decisions and executing them effectively, it creates a competitive advantage for the organisation. In order to maintain competitive advantage, the organisation must continue to innovate and through innovation of new technical products and services, it increases the organisation power the CTO has as now the board can quantify the CTO's value add on the bottom line. This organisational power then allows a CTO to broaden their skill set by taking on more board responsibilities.

To re-iterate, the purpose of this research paper is to define the strategic responsibilities of a CTO and the skills necessary to meet those responsibilities within technology driven organisations. In order to conduct the necessary research to answer these two questions, the themes that emerged from the academic literature formed the foundation of the interview questions that the participants were be asked in the exploratory interviews I conducted.

The reason the themes had to form the basis of the interview questions was to ensure that all of the different facets of the CTO role were explored and discussed, to ensure a complete dataset in which to analyse.

The relationship between the research questions outlined in the next Chapter and the themes explored in this Chapter are depicted in research consistency matrix in Table 2 below.

Theme	Propositions (Research Question)	Literature Review	Data Collection Tool	Analysis
Defining Corporate Strategy	What role do you play in helping to define the corporate strategy of your organisation? OR What deliverable are you required to submit which are used as inputs in defining the organisations corporate strategy?	Edler et.al; 2002; Smith, 2007; Medcof, 2008; Uttal et. Al, 1992	Interview Question No:1	Defining the CTO involvement in Corporate Strategy Definition.
Skill Set	Other than technology specific ones, what skills do you believe are necessary for a CTO working within a technology driven organisation to have?	Edler et.al; 2002; Smith, 2007; Medcof, 2008; Uttal et. Al, 1992	Interview Question No:2	A comprehensive list of skills required by CTOs to perform their function other than those which are technical.
Innovation	What role do you play in the innovation of new technologies, or new technology enabled business process optimisation projects? What skills do you believe make you better at leading innovation for your organisation?	Edler et.al; 2002; Smith, 2007; Medcof, 2008; Uttal et. Al, 1992	Interview Question No:3	Looking specifically at Innovation compiling a comprehensive list of skills required for 'innovators' and defining the CTOs role in innovation within the organisation.
Competitive Advantage	How does your organisation utilise technology to gain a competitive advantage within the marketplace? What are some of the specific roles you have played with implementing these technology enablers?	Edler et.al; 2002; Smith, 2007; Medcof, 2008; Uttal et. Al, 1992	Interview Question No:4	To understand to what degree the organisation is technology dependant and how they effectively utilise technology to gain/increase competitive advantage within the marketplace.
Executing Corporate Strategy	How dependant is the corporate strategy on the technology strategy? If possible please provide some examples of technology enablers of corporate strategy.	Edler et.al; 2002; Smith, 2007; Medcof, 2008; Uttal et. Al, 1992	Interview Question No:5	Defining the degree to which corporate and technology strategy is linked (the degree to which the CTO has an impact on overall corporate strategy) and therefore the CTOs responsibilities thereto.

Table 2: Consistency Matrix

Chapter Three - Research Questions

This research report aims to answer two main questions, being:

1. What are the strategic responsibilities of a CTO?
2. What are the skills required to meet the strategic responsibilities of a CTO?

The following questions will be used in ascertaining the required information to answer the above questions from the face-to-face expert interviews:

Interview Questions:

1. What role do you play in helping to define the corporate strategy of your organisation? OR What deliverables are you required to submit which are used as inputs in defining the organisations corporate strategy?

2. Other than technology specific ones, what skills do you believe are necessary for a CTO working within a technology driven organisation to have?

3. What role do you play in the innovation of new technologies or new technology enabled business process optimisation projects? What skills do you believe make you better at leading innovation for your organisation?

4. How does your organisation utilise technology to gain a competitive advantage within the marketplace? What are some of the specific roles you have played with implementing these technology enablers?

5. How dependant is the corporate strategy on the technology strategy? If possible, please provide some examples of technology enablers of corporate strategy.

Chapter Four - Research Methodology

4.1 Research Method

This study aims to define the strategic responsibilities of a Chief Technology Officer and the skills required to meet those responsibilities within technology driven organisations. These responsibilities have changed over recent years with the emergence of new technologies and their implementation into the workings of large organisations.

A descriptive, qualitative research approach was taken facilitated by ten semi-structured, expert interviews with CTOs within technology driven organisations to describe the strategic responsibilities of a CTO and the skills required to meet those responsibilities from interpreting the interviewee's words. Open ended questions were asked of the interviewee to supplement their answers with qualitative information as per the overall research study approach.

An expert is described by Belting (2008) as a, "person who has a high degree of skill and knowledge in a certain domain, field or industry due to long-time experience and has status, power-to-act and decision-making opportunities based on these skills and knowledge." (Belting, 2008, p. 1)

The research method was chosen based on research best practise for eliciting knowledge from experts Belting (2008) as the study intends to reconstruct the knowledge of experts. Roller (2011) confirms the chosen research method by advising that "successful research with the corporate executive still lies in the warm, personal connections we make in the face-to-face mode". (Roller, 2011, p. 18)

Expert interviews fall under the semi-structured interview method of data collection (Belting, 2008). This type of data collection method focuses on collecting qualitative information. Information obtained is largely a description and interpretation of the interviewees' words. The main aim of the interviewer is to understand the topic in question from the point of view of the interviewee. In the case of expert interviews, the latter will be considered knowledgeable in the field of study or topic (Belting, 2008; Tjitra, 2011, Valenzuela and Shivastava, 2008).

McNamara (1996) concurs by stating that “interviews are particularly useful for getting the story behind a participant’s experiences. The interviewer can pursue in-depth information around the topic.” (McNamara, 1996, p. 1).

To ensure a structured approach to applying the chosen research methodology, the seven steps of ‘Interview Investigation’ defined by Tjitra (2011) will be adopted those being:

1. Thematising – formulate the purpose of the investigation and describe the concept of the topic to be investigated before the interview starts.
2. Designing – consider all seven stages to obtain the intended knowledge/outcome and taking into account the moral implication.
3. Interviewing – base on the interview guide, reflective approach to the knowledge sought and the interpersonal relation of the interview situation.
4. Transcribing – prepare the interview material for analysis, including a transcription of oral speech into text and notes on other factors eg: body language.
5. Analysing – decide method/unit of analysis to transform the results into a readable product.
6. Verifying – ascertain reliability and validity of data obtained (answers).
7. Reporting – transforming the verified results into a readable product.

(Tjitra, 2011, p. 10)

4.2 Population and Unit of Analysis

The proposed population of the study is only CTO’s that work in technology driven organisations, the size of the population is unknown.

Due to the nature of the research study and chosen research design, a non-probability convenient sample of the population was chosen as the research project’s study frame.

A non-probability sample was chosen over a probability sample due to the fact that the interviewees will be chosen based on ease of access the interviewer has to the interviewee

and the firm type the interviewee works for. Therefore the respondents within the sampling population do not have a known non-zero probability of selection.

4.3 Size and Nature of sample

The size of the population sample that was used to carry out this research was ten respondents which have the corporate title of Chief Technology Officer within technology driven organisations.

Technology driven organisations as defined in Chapter One are organisations in which the use of technology is critical to day-to-day functioning of the organisation, a few examples of such organisations would be: financial institutions, internet service providers, telecommunications companies and any other company that cannot deliver a service or product to a customer without the use of technology.

Of the ten respondents within the sample group, a significant effort was applied to try and achieve a diversified sample of large, medium and small organisations at a ratio of 4:3:3.

Should the diversification of the sample be deemed too difficult to obtain access to, then the sample set will be compiled based on ease of access to interviewee.

4.4 Data Collection, Data Analysis and Data Management

Data Collection

The data collection method applied is one of recording of the interview with the subject matter experts and then utilising a technological tool called Dragon Naturally Speaking which is speech recognition software to transcribe the interview into text while manually validating the accuracy of the transcription using spot check audits of the transcription.

One hour per interview was allocated and the place where the interview took place was at the convenience of the interviewee.

After the interview is transcribed into text, the interviewer then combined the notes taken on the other visual factors from the interview with the transcribed text.

Roller (2006) includes six hints and tips on executive interviewing in her *Meeting Executives Face-to Face* article, those being:

1. Positive preliminary contact and scheduling
2. Clearly-defined and achievable goals
3. Flexibility - personalizing the interview
4. Distinguishing between useful and not useful input
5. Listening skills – exploring what is said and not said
6. Limited researcher involvement

(Roller, 2006, p. 1-6)

Data Analysis

"The messiness of the interconnections, inconsistencies, and seemingly illogical input we reap in qualitative research demands that we embrace the tangles of our conversations by conducting analyses close to the source" (Roller, 2011, p. 15).

Again, a technological qualitative data analysis tool will be used to organise and analyse the data. This tool Atlas.ti, will be utilised to organise the data (transcriptions) into logical categories and index the different pieces of data for easy retrieval. Atlas.ti is a scientific software tool for the qualitative analysis of large pieces of data and is widely recognised as a tool which enables researchers to uncover phenomena in textual data.

Atlas.ti will also be used to code transcriptions into key themes, concepts, questions or ideas using an inductive approach to defining the categories of the codes.

The coding will then be utilised to build up conceptual frameworks based on common understanding/themes from the different respondent's expert knowledge.

Data Management

The management of the data is of the utmost importance as it provides the content and evidence for the entire research project. Therefore numerous backups of the data will be made, one will be stored online virtually, one will be stored on the local computer of the researcher and another will be stored on an external hard drive.

The redundancy of numerous storage facilities ensures that the data from which the entire research project is based is not lost or the integrity compromised at any point.

4.5 Data Validity and Reliability

The nature of qualitative face-to face research is that the question-answer validation can take place right away, so no misinterpretation is experienced when transcribing the interview into text.

Roller, (2011) states that “by probing and clarifying questions on the spot to unearth any possible misinterpretations or meanings, this question-answer validation enables the researcher to maximise the quality of individual responses” (Roller, 2011, p. 5).

Tjitra, (2011) concurs with Roller by stating that “our best guarantee of the validity of our material is careful, concrete level, interviewing within the context of a good interviewing relationship” (Tijitra, 2011, p. 21). So to a large extent, it is up to the interviewer to ensure that the interviewee fully understands the question and context and builds up a good rapport with the interviewee to be able to extract the most honest and through answers throughout the interview process as possible.

Interviewer bias

Errors that occur within qualitative research are often introduced by the researcher and are not easy to detect. In order to minimise the potential for interviewer bias, interviews were transcribed on a word for word basis and a professional opinion was elicited to objectively review the codes and coding used to analyse the transcribed interviews to check for interviewer bias in the data analysis.

“Being highly aware of error introduced by convenience samples, as well as non-sampling errors (such as interviewer and selection bias in recruiting, moderator and response bias in the discussions themselves), qualitative researchers build in measures to control error in their selection and interviewing procedures” (Roller, 2011).

4.6 Potential Research Limitations

Due to the nature of this study, including time constraints, various limitations have been identified. These include:

- A limited sample frame of eight CTOs will be interviewed
- Using non-probability convenient sampling could introduce subjective bias

McNamara (1999), identifies the following limitations to this method of research:

- They are not appropriate if quantitative data are needed
- They may be biased if informants are not carefully selected
- They are susceptible to interviewer biases
- It may be difficult to prove validity of findings

(McNamara, 1999, p. 2).

Meuser and Nagel (1991) identify additional potential limitations of this research method to be prepared for and aware of, when conducting the interview:

- The expert blocks the interview in it's course, because he or she proves not to be an expert for this topic as previously assumed
- The expert tries to involve the interviewer in on-going conflicts in the field and talks about internal matters and intrigues of his or her work field instead of talking about the topic of the interview
- He or she often changes between the role of an expert and a private person, so that more information results about him or her as a person than about his or her expert knowledge
- As an intermediate form between success and failure the 'rhetoric interview' is mentioned. This is when the expert gives a lecture on his or her knowledge instead of joining the question – answer game of the interview. If the lecture hits the topic, this form of interaction makes it difficult to return to the actual relevant topic.

(Meuser and Nagel, 1991, p. 449-450)

Chapter Five - Results

5.1 Description of Sample

The research sample was drawn from technology driven organisations within South Africa as previously outlined within the research methodology section. All interviewees are currently in Chief Technology Officer positions within their respective organisations and the sample comprised of a mixture of small, medium and large organisations.

It was originally intended to interview a total of ten CTOs, however only a total of eight interviews were conducted. Seven of the interviews were conducted face to face and one interview was conducted telephonically due to the geographically location of the interviewee. The semi-structured exploratory interviews lasted on average 60 minutes.

The interview was conducted in sequence of the interview questions using the interview guide in Appendix 9.2 – interview probes were also used where appropriate outlined in the interview guide.

Due to the organisational role that the CTO fulfils, their time is precious and securing an hour in their calendar was a challenge. It was also a challenge finding CTOs as it is not the most common C-Suite role within South African organisations, and gaining access to these individuals was also challenging.

5.2 Difficulty in Securing Interviews with CTOs

The ease of access to CTOs to interview for this research project was slightly overestimated and proved to be more difficult than planned. The CTO is just as well guarded as any other board member of the organisation and numerous administrative requirements were needed to be met in order to gain access to them and secure an interview slot.

5.3 Confidentially of company details

For confidentially purposes, the anonymity of the interviewees and organisations they work for must be maintained in line with the research methodology outlined in Chapter Four.

To ensure the confidentially of respondents was upheld, each was required to sign a consent form (Appendix 9.1). Fulfilling this requirement helped to illicit more open and complete information from the CTOs interviewed.

Interviewees will be identified throughout this report by a random identifier therefore allowing the data to remain clean while also ensuring organisational anonymity.

Participant / **Attribute**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Size of Organisation	Large	Medium	Small	Large	Large	Large	Large	Medium
Technology Dependant Organisation	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Sector	ICT	Digital	Network	Finance	ICT	Services	ICT Services	ICT Services
Marketing CTO		X		X		X		X
Operational CTO	X		X		X		X	
Title	CTO	CTO	CTO	CTO	CTO	CTO	CTO	CTO

Table 3 : Interview Sample

5.4 Patterns observed in the research sample

While interpreting the results of the data, patterns started to emerge that were significant enough to constitute further analysis. The first pattern was that the respondents fell into two distinct groups; CTOs interviewed were classified as either a Marketing CTO or an Operational CTO.

Three interviewees actually alluded to this distinction in the interview and upon further exploration, the two distinct types started to emerge with the following attributes:

The portfolio of the Operational CTO is evident in companies 1, 3, 5, 7 and 8:

- They are highly dependent on technology and are the primary consumers of the technology for operational purposes
- The CTO is predominantly client facing

The profile of the Marketing CTO is evident in companies 2, 4 and 6:

- They are either secondary users of technology, or resell another organisations primary technology
- The CTO is primarily non-client facing

As you can see from the above distribution, there is a larger representation of operational CTOs within the research sample.

The whole research sample, both operational and marketing CTOs, stated that the skill set required by a CTO is the same as that for any other C-Suite level employee, however it also demands an in-depth knowledge and technical expertise. This pattern will be explored in more detail later on in this Chapter.

For simplicity and ease of reviewing the data, relating to the ‘marketing type’ CTOs responses are highlighted in grey.

5.5 Research Results

In Table 3 on page 27 represents the distribution of CTOs interviewed from the initial sample population that satisfied the key attributes emerged through themes within the literature review in Chapter Two of this report as well as the pre-defined research questions in Chapter Three.

The responses received from the sample group interviewed, enabled the research questions to be answered and thus satisfied the research objectives.

There were five research questions that were asked in each interview, these were outlined in Chapter Three. The interview guide (Appendix 9.2) provided for a solid base to probe each interviewee and the probing questions were modified in the interview as and when the situation called for it.

Probing questions were often used in the interviews to obtain a complete answer to the research question; the results of each question will now be discussed in detail below. Each research question will be analysed using the reoccurring themes that came up during the interviews, to represent the patterns in the data in order to enable rich analysis and interpretation.

The research results below are grouped by the respondents answer and the relevant theme that emerged is also tabulated to assess how frequently the them was referenced by the respondent in their reply. This allows the researcher to identify emerging trends within the responses.

5.6 The CTOs Role is Defining Corporate Strategy

The first interview question that was asked of each participant was ‘what role do you play in helping to define the corporate strategy of your organisation?’, or ‘What deliverable are you required to submit, which are used as inputs in defining the organisations corporate strategy?’

Results for question one are represented in tables X below:

Participant	Comment
1	We have global group strategy and then we take that (shows book) and use it as the high level input into our strategy and see what we are going to do locally to align to it
2	I have a say in pretty much all aspects of senior level decision making and I have an input on pretty much everything we do
3	Our corporate strategy is pretty much the technical roadmap and we align business goals with the technical stuff we do which I define.
4	As a CTO you need to understand the technology stacks and then you can leverage those core strategies within the organisation to get to where you want to be with the overall corporate strategy yet have a solid platform or underlying infrastructure to exploit all of these new features and functionalities.
5	From overall strategy point of view my portfolio is looking out to the investment plans so capital investments and looking out for example or the infrastructure that we put in
6	So my role in corporate strategy - so technology forms the foundation of the corporate strategy but it's not a technology strategy per se the strategy is built on the technology so technology is fundamental to our business we only make money from the technology.
7	I play a big role in helping to define corporate strategy I think that its very important to have a tool which allows you to have insight into technology trending and foresight so that the business strategy is moulded around the technology strategy so that you have the ability to scale your organisation as technology changes.
8	I am very involved in defining the corporate strategy in that I define the product strategy and that determines what products we are going to deliver and the

	strategy around that is that drives a lot of what we do.

Table 4 : Interview responses on the role played in defining corporate strategy

Pertinent Quotes from Research Question One:

'Technology succeeds because they are ecosystems and politics that drive economics' beneath the politics of technology.'

Participant 6

'There is a lot of differentiation in terms of what CTO role is played by the individual depending on their personality'.

Participant 6

Of the CTOs interviewed, all had a significant input into the corporate strategy. To varying degrees, helping to define corporate strategy is a key responsibility for the respondents.

The fact that only technology dependant organisations were included in the research sample meant that the researcher was looking to find the result of the respondents contributing heavily to the organisational strategy, however the interesting pattern that emerged from research question one is that the marketing CTOs appear to have a larger say in the overall organisational strategy whereas the operational CTOs mainly contributed in terms of supporting the underlying technology, as an enabler of the overall organisational strategy. Both roles are as equally important, just in a different way.

5.7 Skills necessary for a CTO to Have

Interview question two that was: 'other than technology specific ones, what skills do you believe are necessary for a CTO working within a technology driven organisation to have?'

Results for question two are represented in tables X below.

Participant	Comment
1	General management skills and effective people management/soft skills are also very important because you need people to execute what you lay out and the better the people you have working for you and the better they are managed the more successful it will be.
2	The best way to describe the skills that are needed to do my job would be everything
3	You need to adjust with individuals different personalities in your team so people skills are very important as well as pre-sales
4	You can't be a one-dimensional individual being business savvy is very important.
5	I think you've got understand the financials a lot more now than you used to have two as a big part of my portfolio is managing the Capex and operating costs and so on
6	Being a CTO is also a political game but most importantly in you need to be more of an I-shaped person rather than a T-shaped person, so it's important to have depth and breadth of functional skills to be a good CTO.
7	Pretty much I think it's a case of having started in the various back office type functions and having intimate product knowledge.
8	People skills are a big thing because it's one thing understanding technology but understanding the way or the manner in which people interact with the

	technology or the way customers expect the technology to work or look or feel or act is critical.

Table 5: Comments skills believed to be necessary for CTOs

Pertinent Quotes from Research Question Two:

'You can't be a one-dimensional individual. Being business savvy is very important.' Participant 4

'Aware of the external market – it is important to be first to market with new products because of the consumer perception that you are the best'

Participant 1

'I think general finance skills and general business skills and to grow the business because I find if you just focus on the technology and operational side you will never identify opportunities where you could exploit products and increase revenue and places where you can add value'

Participant 5

'The other skill that I think is quite key you need to understand the financial impact which a lot of CTO's battle with, as much as the financial aspect of the hardware is important the financial impact of the hardware interacting with the whole network is also vital so finance skill is also very important. '

Participant 8

Question two was the most interesting of the study to analyse.

The range of skills tabulated was sizable, however all participants emphasises the importance of the fact that the role of the CTO does not just require depth in technical understanding but they also require a breadth in other skills which are required by other C-Suite positions.

There is enough evidence to support the fact that the skill set required by a CTO is larger than that of another C-Suite position and is justly a key player at the board level.

5.8 A CTOs Role in Innovation

Interview question three was: 'what role do you play in the innovation of new technologies, or new technology enabled business process optimisation projects? What skills do you believe make you better at leading innovation for your organisation?'

Results for question three are represented in tables X below.

Participant	**Comment**
1	Unfortunately we don't do as much innovation as I would like because of having a lot on our plate in recent years with ramping up our data network. But we do have an innovation lab and a team that trials new products in the lab.
2	I am continuously looking at the market and trying to predict what the markets can do because sometimes new technologies take a while to plan before you can start executing on them so we were generally start to execute on a plan within 6 to 12 months
3	So we give our team Carte Blanche to come up with new ideas and they are given budget to try and prove the concept, it does not happen as often as we would like it is not happen as much as we would like because people are busy with their day jobs but we do encourage it a lot
4	You are always innovating as a CTO you should never not be innovating.
5	So if we look at a new technology we have a very big role to play and I am one of the main sponsors of our innovation hub so you trying to start up a lot more innovation is an organisation and trying to support the guys to say let's find ways how to bring in ideas and incubate them and not just focus on our core business any more

6	I spent my life researching and reading to stay abreast with what's happening in the external market that's what I do and I can see about standards and bodies are participate in
7	I don't spend as much time as I would like to with the end customer I spend more time on what their challenges are rather so I have big enough overall view of the trends and challenges because you find the same thing will pop up a couple of times with over a six-month period. We will then innovate to finds solutions to these challenges to provide these solutions as services.
8	I think the key for me is that we innovate a lot so we have brainstorming sessions with product management and I am heavily involved in new product development at the portion of the business I love.

Table 6 : Comments on the role played in innovation

Pertinent Quotes from Research Question Three:

'*Get into something that you're extremely passionate about, don't get into it for the money because if you feel that you can make a difference and if you feel you can change the world even in just a little way then you will love what you do and be successful.'*

Participant 3

'Innovation is used very loosely innovation can happen anywhere at any time'

Participant 6

'You also need to be creative because creativity enables innovation and problem solving.'

Participant 4

The results of the data confirm that just as the CTOs of five years ago were responsible for Research and Development, the CTO of today is the executive owner of innovation within organisations.

Again, the theme of the operational and marketing CTO is made clear in question two in that the operational CTOs innovation is a lot more internal to the organisation and the marketing CTOs innovation is a lot more externally focused and looking at the industry and market in

which they operate to differentiate their organisations. Regardless whether the CTO is internally or externally focused innovation in an organisation need a champion and the CTO fulfils this role of the champion of innovation. Innovation is one of the key drivers for sustained competitive advantage.

5.9 Technology and Competitive Advantage

Interview question four was: 'how does your organisation utilise technology to gain a competitive advantage within the marketplace? What are some of the specific roles you have played with implementing these technology enablers?'

Results for question four are represented in tables X below:

Participant	**Comment**
1	So we are just uses a normal radio network like any other service provider but I believe the way we use the network infrastructure and the services we run on top of the network give us a competitive advantage.
2	Each year I do a review what technology we are using and what techniques, - because often it is more important - we hope and then I take stock of that and I tell the board what I believe the future will be and how we intend to take advantage of it
3	But I believe that our technical expertise is definitely a core competency because where there needs to be done if we really put our mind to it we can do it
4	We are also looking at potentially moving into a new part of the industry which will in time give us a competitive advantage over others
5	I think where's good as we can be here, because there's been more of a focus on running the business and looking at changes and looking at the technology

	innovations outside the company that we should bring in
6	Because we sell typically generic products having a competitive advantage comes in with our customer interaction. I would typically spend 90% of my time talking to people and being in front of the customer and I think we have a competitive advantage because our customers have access to such skills.
7	So we are early adopters of new technology we go through extensive testing before we release anything and we have the ability to understand to the nth degree the input cost to make the basis of our technology. The other difference is with us is that we have very strong high performing culture and you people don't fit into that culture quickly get ousted and encouraged to leave.
8	Rebranding of our own core products and associating them with images is our key differentiator because we sell the same products as all of our competitors in the market so from a product perspective there's not much at all they can differentiate any of us.

Table 7 : Comments on how utilising technology to gain competitive advantage

Pertinent Quotes from Research Question Four:

'Surround yourself with the right people - not everyone is going to be passionate about everything so you need to find the right people for the job.'

Participant 4

'So strategy and vision talks to not necessarily building something that people asking for but being able to have the foresight of building something that you know a customer in the near future'

Participant 6

In the analysis of question four there was no key differentiator between the marketing and operational CTOs.

There was however, a general pattern of having a competitive advantage in the marketplace because these organisations can attract and retain top talent. Employees, their skills and the organisational culture came through in question four as the key to gaining competitive advantage in the marketplace if you are a technology driven company. The researcher was not expecting to gain these findings as the people management is typically deemed an HR function in the business, this was an interesting finding and it is indicative of the fact that technology is easier to replicate across organisations where as a strong culture and skilled people are much harder.

5.10 Corporate Strategy Vs. Technology Strategy

Interview question five that was asked of each participant was, 'how dependant is the corporate strategy on the technology strategy? If possible, please provide some examples of technology enablers of corporate strategy.'

Results for question five are represented in tables X below:

Participant	**Comment**
1	They are almost the same thing.
2	So my organisation they are one and the same thing we are 90% focused on technology other 10% would be up human resources in terms of being successful. So when we define corporate strategy we are defining at the same time our technology strategy.
3	The corporate strategy and the technology strategy almost synonymous
4	They are similar but we are more restricted in terms of regulation so technology strategy doesn't drive corporate strategy but it definitely enables it, regulation can drive corporate strategy because of the environment that we work in.
5	You need to be able to see across all the different areas and not just look at technology in isolation and ask how can we make this technology work by choosing the right time to bring this in and have a look at the investment model and what would work best so think that corporate strategy is about tying in all of these different elements with a technology strategy so the technology strategy is almost the main input into this corporate strategy.
6	So corporate strategy is a very broad term and my particular role in the company spans corporate strategy across the different subsidiary companies, So two things that have shaped the way we have entered the market in the global market space is the global trend of cloud computing and how this is enabling the enterprise to become more mobile which founded our enterprise

	mobility portfolio style model.
7	So I think there is two parts to this: 1. You need the ability for a certain type of technology to be widespread and 2. To understand the market dynamic and then allow that to drive your corporate strategy so in a way technology strategy does drive the corporate strategy.
8	Ultimately they are tightly coupled but I don't think the technology drives the corporate strategy and business still drives corporate strategy and the technology is just the means to get it delivered.

Table 8 : Comments on how dependant corporate strategy is on technology strategy

Pertinent Quotes from Research Question Five:

'The technology strategy is almost the main input into this corporate strategy '

Participant 5

'*So to summarise the CTO role it is about understanding what is out there, what is relevant your market and how you move to what is available and relevant to that market.'*

Participant 7

Within most of the research sample it appears the corporate and technology strategy are so tightly coupled they are almost one and the same thing.

What was not made clear was whether the technology is driving corporate strategy or vice versa. Regardless, the fact that the technology and corporate strategies are so tightly interlinked means that the CTO is a major player in determining and executing the corporate strategy.

5.11 Overall Summative Model

Table X was compiled based on the coded data based on the frequency they were raised by respondents during the CTO interviews.

The following data were not provided to the interviewee's prior to the interview nor were the interviewees probed in the direction of these attributes – they emerged organically from the answers provided.

Listed in order of frequency, below is a list of skills a CTO is required to have:

Skills from Data	P1	P2	P3	P4	P5	P6	P7	P8	Total
Technical Expertise	1	4	2	2	1	3	3	3	**19**
Adaptability	1	3	4	3	2	0	2	0	**15**
Financial Skills	2	6	0	3	1	0	0	2	**14**
Business Management Skills	1	1	0	2	1	5	1	0	**11**
Networking Skills	0	1	1	4	0	5	0	0	**11**
Leadership Skills	1	0	3	2	0	0	2	0	**8**
Field Experience	0	4	0	0	0	1	2	1	**8**
People Skills	2	1	2	0	1	0	1	1	**8**
Selling Skills	1	1	1	1	1	1	1	1	**8**
Visionary Skills	2	1	2	0	1	0	1	1	**8**
Confidence	0	1	1	3	0	1	1	0	**7**
Engineer by trade	0	3	1	0	0	2	0	1	**7**
Day to Day Operations	1	0	1	2	1	0	1	0	**6**

Table 9 : CTO Skills

Important points to consider from the above findings are the fact that financial skills and a general breadth of skills rank very highly, more so than day-to-day operational skills.

Listed in order of frequency, the below list of the responsibilities a CTO is required to have are:

Responsibility From Data	P1	P2	P3	P4	P5	P6	P7	P8	Total
Keep abreast with external technology changes	1	9	3	4	2	3	4	1	**27**
Innovate (R&D)	3	3	2	3	1	2	3	1	**18**
Corporate Strategy Definition	3	7	2	0	1	1	2	2	**18**
Board Responsibilities	1	1	3	2	1	4	3	2	**17**
Corporate Strategy Execution	4	5	2	1	2	1	1	0	**16**
New Product Development	3	2	0	2	2	1	1	1	**12**
Consult to inter-organisational business units about technology	0	0	3	4	1	0	2	2	**12**
External Parties/Communities	1	2	2	1	0	4	0	0	**10**
Help to shape company culture	1	2	4	1	1	0	1	0	**10**
CAPEX and P&L responsibilities	0	0	1	0	1	0	1	0	**3**
Marketing of new technologies to external parties	0	0	1	0	0	0	0	1	**2**
Acquisition assessment	1	0	0	0	0	0	0	1	**2**

Table 10 : CTO Responsibilities

A key point to note from the above results is that board responsibilities rank as the most important responsibility for the CTO, which can be interpreted as the fact that the CTO does not only play a technical role at a board level but has a larger more important role to play.

'I cannot succeed without having a large network and community of people around me, so that's why I know most of my peers. So networking is definitely very important as well as opportunity but that's something you can't control.'

Participant 6

'To become a CTO you need to have a certain level of technical expertise which differentiates it from the other C suite positions where you don't necessarily have to have any specialised skills'

Participant 7

'I believe one of the most important roles of a CTO is to always be reading and talking to people in the industry and knowing what's going on in the environment around you'

Participant 2

5.12 Conclusion to Research Results

This Chapter presents the research findings from the research sample, based on the research questions defined in Chapter Three.

It was not the object to split the research sample into two distinct groups of marketing and operational CTOs, however as the data was being coded this pattern emerged and was strong enough to warrant distinction.

There is enough evidence from research results to deduce that the CTO role is demanding highly skilled individuals with a core competence in technology as well as a breadth of skills in other areas demanded by other C-Suite roles.

This breadth of executive management skills coupled with the depth of skill in technology demands a more capable individual than the other C-Suite roles and this could lead to the CTO role becoming the major player on the board within technology driven companies in the future.

These findings and other pertinent comments collected from the research sample will be discussed in the next chapter. Tying it in with the literature from Chapter two.

Chapter Six - Discussion of Results

6.1 Introduction

In this chapter we will explore the research findings outlined in Chapter Five and then will be discussed in terms of the literature presented in Chapter Two. Answers to the research questions will then be presented.

The research sample as defined in Chapter Four was eight CTOs from technology driven organisations. As with Ferdows and Adler's (1990) study, all CTOs interviewed were male and the search for female CTOs to be interviewed was unsuccessful. Each interview conducted was approximately one hour in length.

The interviews varied in terms of the depth of insight but all were successful in meeting their defined objectives.

A scientific software tool called Atlas.ti was used to code the transcribed interviews. The coding of the transcribed data was a tremendous amount of work. It required two rounds of coding as the first round had to be disregarded as there was too much researcher bias creeping into the coding. After consultation with a third party qualitative data analyst, the coding was redone with codes generated from the word cruncher tool on key phrase frequency of mention.

Codes were created from the major themes and patterns in the respondents answers – these codes were then grouped into skills and responsibilities of a CTO (after excluding those codes which were not significant enough to infer any meaning).

The codes were then further refined by creating code families and codes were grouped together due to their relationship to each other, for example if one code formed part of another code, was the same thing, etc. A full list of codes and the code families and co-occurrence tables can be found in Appendix 9.3.

6.2 Discussion of Research Questions

In Chapter Five we observed that there was a distinction between an operational and a marketing CTOs and whether or not they are predominately internally or externally focused in terms of their organisational responsibilities.

When coding the transcribed interviews, operational (day to day operations) activities and marketing activities fell into the same code family of corporate strategy execution as depicted in Figure 2 below.

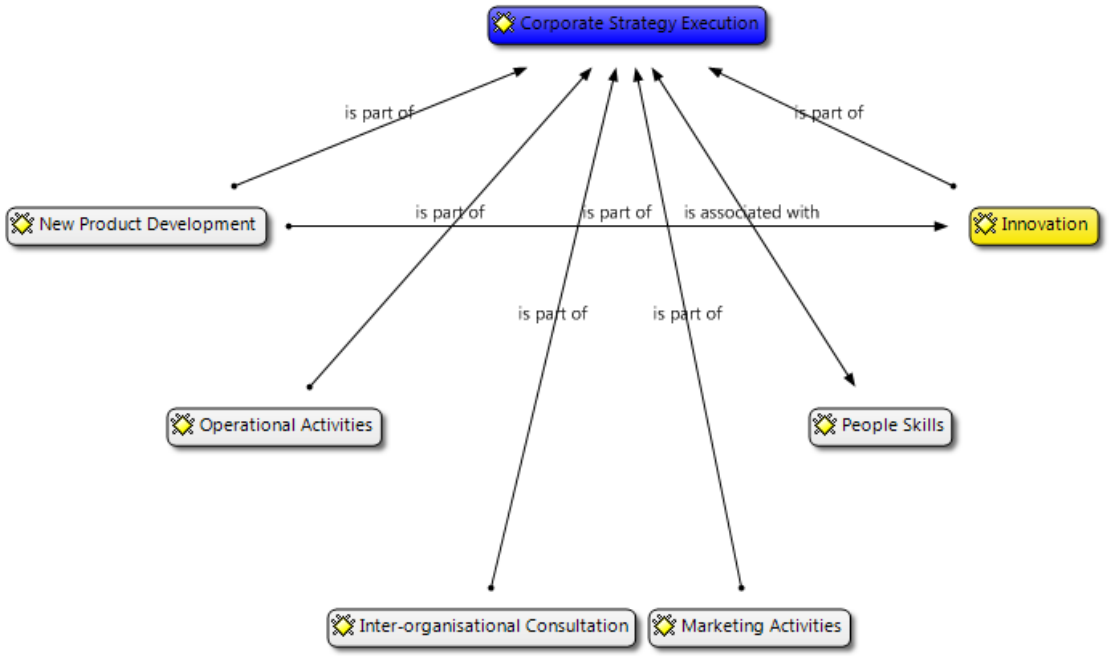

Figure 2 : The Corporate Strategy Execution Code Family

Both marketing and operational CTOs perform operational and marketing activities. The key differentiator is that a marketing CTO would be predominately more externally focused and market the organisation's products and services to external parties for example, to customers, whereas an operational CTO would market new products and services internally to the board for approval and then to business units and the sales force who in turn would onward market these products and services to external customers.

Therefore, there is enough evidence to conclude that the two differing types of CTOs have the same set of responsibilities, and therefore skills required to meet those responsibilities as each other and they are just either directed internally or externally to the organisation.

6.3 Research Question 1 - What are the strategic responsibilities of a CTO?

In Chapter Five we evaluated the data that emerged from the transcribed interviews and a list of CTO responsibilities was formed. These were further refined using the graphical representation of the different code families where appropriate.

Below is the new consolidated list of the top ten CTO responsibilities that emerged from the coded data that was presented in Chapter Five:

- Keep abreast with external technology changes
- Innovation and new product development
- Corporate strategy definition
- Board responsibilities
- Corporate strategy execution
- Consult to inter-organisational business units about technology
- External parties/communities
- Help to shape company culture
- CAPEX and P&L responsibilities
- Marketing of new technologies to external parties

There are two differences in the above list and the data presented in Table 10 in Chapter Five.

1. The below two attributes were merged to form one responsibility, as the coded data spoke to that fact they were both a part of the same coded family:

- Innovation
- New product development

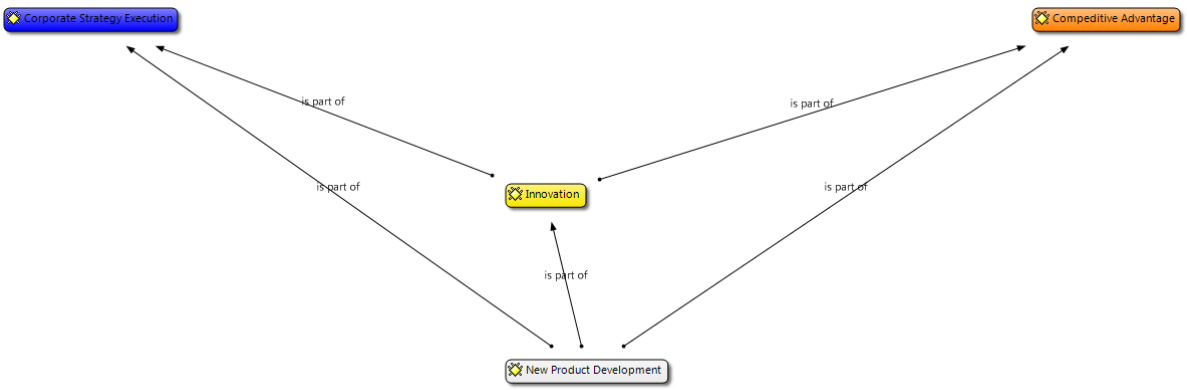

Figure 3 : The Innovation Code Family

The two attributes speak to the same responsibility of a CTO and therefore needed to be grouped together.

1. The other difference is the fact that acquisition assessment was nested into board responsibilities depicted in the code tree in Figure X below, therefore these two responsibilities were combined into one board responsibilities responsibility to form the top ten list.

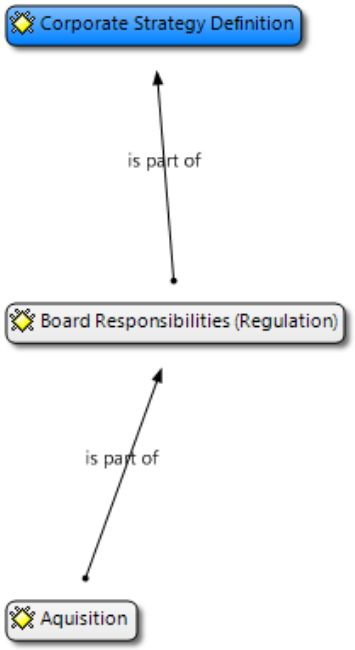

Figure 4 : Board Responsibility Code Tree

The above data will be linked to academic literature in section 6.5 of this chapter.

6.4 Research Question 2 - What are the skills required to meet the strategic responsibilities of a CTO?

A summation of the requisite skills for a CTO was presented in Chapter Two. The table of skills was not given to any interviewee and yet almost the same list of skills was spoken to by the interviewees. Below is a comparison between the two data sets.

In order to understand the below comparison between the skills presented in academic literature and the skills that emerged from the research questions, there needed to be a basic understanding of the coding used in the data analysis and the way the data was chosen to be represented.

From Table 9 in Chapter Five the below two skills were removed from the data set as they did not feature in the top 10 list of skills by frequency of mention:

- Engineer by trade
- Day to day operations

For ease of comparison, the following conversions were made to the codes to present the findings in an easy to interpret manner:

- The ‘Marketing and Motivating’ code was translated into ‘Leaderships Skills’ as both marketing of new technology and its adoption and motivating the work force are leadership functions
- Both the ‘Expert in Field’ and ‘Confidence’ codes were combined to form the ‘Visionary Skills’ attribute, as being able to formulate a vision requires expert knowledge and being able to communicate and sell that vision requires confidence, so the two disparate skills work nicely together to provide a visionary skill set

- The 'Breadth of Knowledge' code was translated into 'Business Management Skills' as the breadth of knowledge spoke to having experience in other areas of the business like HR and finance so this emphasises the importance of general business management skills.

Skills From Literature	Skills from Data
Networking	Networking
Vision and Confidence	Visionary Skills
Technical Expertise	Technical Expertise
Field Experience	Field Experience
Interpersonal Skills	People Skills
Leadership	Leadership Skills
Business (not just tech) Savvy	Financial Skills
Selling	Selling
General Management Skills	Business Management Skills
Conversing at Executive Level	
	Adaptability

Some of the unexpected findings from the research data were that the research sample felt that project management skills as well as line management experience were not important enough to feature in the top 10 list of skills required by a CTO, contradictory to literature. The research sample felt it was important to create a culture of innovation and to have a passionate work force. However there was a general trend that having had years of line management experience did not make for a better CTO.

The research sample also did not feel that formal business education was necessarily important for a CTO to have. Technical expertise and general business management skills were crucial however the panel did hold numerous business degrees, these experts have a very high level of technical expertise and most of them started their technical careers as a field engineer or on a support desk. In contrast to other positions within the top management

team, a CTO can hold a high position of power within an organisation without the list of qualifications generally expected from a CEO.

Below is the skills code family tree that emerged from the coded interview transcriptions by grouping the individually coded skills mentioned by the interviewees.

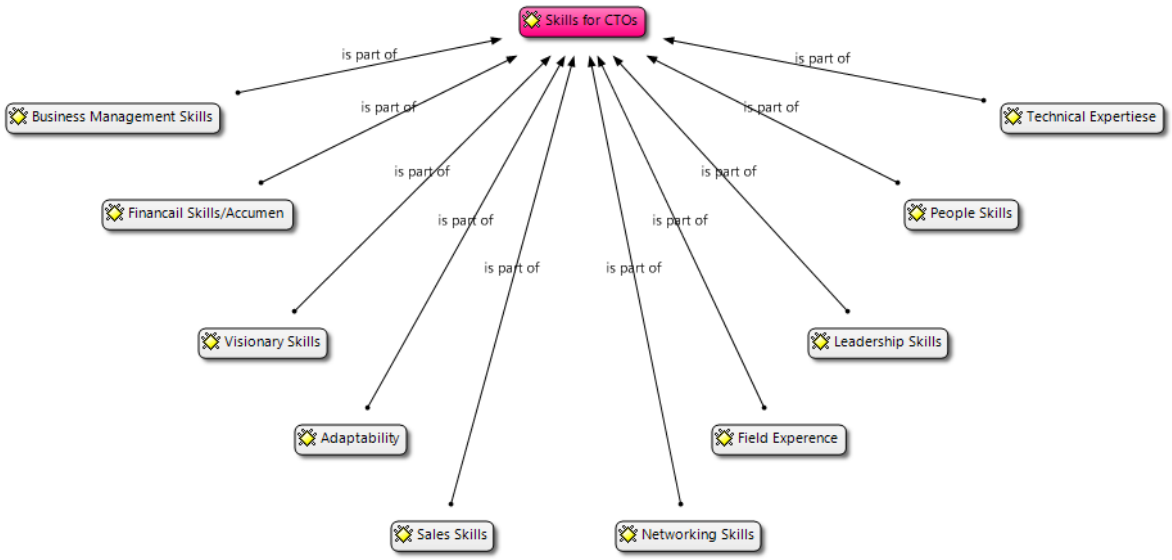

Figure 5 : The Skills Code Family

6.5 Establishing an understanding of the responsibilities of a CTO

Each of the strategic responsibilities were then explored in terms of the academic literature presented in Chapter Two.

Smith and Ferdows and Adler both mentioned that “managing the external technology environment” (Ferdows and Adler, 1990, p. 59) and “monitoring next technologies” (Smith, 2003, p. 29), were key responsibilities of the CTO. This speaks to the fact that the interviewee respondents felt that keeping abreast of external technology changes was a primary function of a CTO.

It is widely acknowledged by the academic community that the CTO is the custodian of innovation within the organisation, and this was further validated by the interviewee's responses. Most interviewees also spoke to the fact

that they had a large role to play in helping to define corporate strategy and Hartley (2011) believes that "integrating technology and corporate strategy is one of the primary functions of a CTO" (Hartley, 2011, p.58).

Medcof and Atkinson (2009) believe that the CTO must "ensure the harmonization of firm and technology strategy" (Medcof and Atkinson, 2009, p. 6), a sentiment echoed by the interviewees when they spoke to how tightly coupled the corporate and technology strategies are in their organisations. Medcof and Atkinson as well as Ferdows and Adler also believe another one of the functions a CTO must facilitate in order to achieve harmonisation of corporate and technology strategy is promoting inter organisation coordination and communication around technology issues, helping to drive innovation and utilise technology to solve business problems. This was also stressed by six out of eight participants in the research interviews.

Half of the research sample demonstrated that they have an active role to play in committees and academic institutions external to their organisation which validates Smith's (2003) belief that "one of the six main strategic responsibilities of the CTO is representing the organisation to marketing and the media" Smith (2003, p. 31).

Smith (2003) believes the CTO has a big role to play in creating a technology friendly culture within the organisation and it is the belief of the interviewees that in order to successfully promote innovation in the work place, it needs to be built into the culture of the organisation. This entrepreneurial/innovative culture was mentioned by five interview participants as a CTO responsibility, the frequency of which made a corporate culture responsibility one of that of a CTO working within a technology driven organisation.

Financial skills came across very strongly in the research interviews in the organisational responsibilities of a CTO working within a technology driven organisation. It was stated that CTOs must be able to effectively run a technical profit and loss cost centre and make CAPEX decision based on the technology environment required to support the technology strategy. Gwyenne (1996) agrees with the respondents when she says, "taking responsibility for profits and losses gains credibility for the CTO where it counts - at the highest levels of management" (Gwynne, 1996, p. 17).

Having power at board level is also an important responsibility of a CTO and having the financial scope defined above increases the CTO's power base in the top management team, again confirmed by Medcof (2007) when he states that "CTO's will not have credibility with their CEOs and other executives unless they are seen to have business as well as technical savvy" (Medcof, 2007, p.27).

6.6 Establishing an understanding of the skills required for a CTO

A general theme that came across in interviews with participants was that a CTO needed a breadth of skills in a variety of business functions and not just a depth of knowledge in technical expertise. Medcof (2007) supports this view by stating that 'those who aspire to strategic leadership as Chief Technology Officer must look beyond their roots in technology and develop their careers in light of the realities of how decisions are made in top management teams' (Medcof, 2007, para. 1).

One participant clarified this view very nicely by using Tim Brown's (2011) definition of T and I shaped people where the participant said that a CTO need to be a T shaped person and not an I shaped person.

To explain this analogy the horizontal line of the T represents a breadth of skills in many different functions of the business for example financials, people management, etc. The vertical line represents a depth of skills within one particular function and in terms of a CTO; this depth refers to a depth in technical expertise. The vertical line of the I represents a depth in only one function and as mentioned above, for a CTO this would be that of technical expertise.

As presented in section 1.2.2 the top ten list of skills required by a CTO to meet their strategic responsibilities are:

- Technical Expertise
- Adaptability
- Financial Skills
- Business Management Skills
- Networking Skills

- Field Experience
- People Skills
- Sales Skills
- Visionary Skills and Leadership Skills

All of the attributes in the above list are in-part mentioned with the literature that was explored in Chapter Two of this research study.

To reiterate Medcof and Atkinson (2009) emphasised the importance of CTOs having the following skills to meet their strategic responsibilities "technical skills are specific to the technical field in which the individual has training or work experience. Interpersonal skills are those that enable one to manage people effectively. Administrative/Conceptual skills have to do with the ability to understand how the organizational system works, what it is capable of doing, planning, and managing execution. These are most critical for senior leadership who carry out these functions at the highest level." (Medcof and Atkinson, 2009, p. 6-7).

6.7 A Skills and Responsibilities Matrix Model for a CTO

In defining the model below the codes that related specifically to CTO skills and responsibilities were then plotted on the X and Y axis respectively and the co-occurrence of when each skill was mentioned while discussing a specific responsibility was then tabulated.

To reiterate the step in the analysis process that was adopted - the codes were then further refined by creating code families and codes were grouped together due to their relationship to each other e.g.: if one code formed part of another code, was the same thing etc. To reiterate a full list of codes and the code families and co-occurrence tables can be found in Appendix 9.3 and Appendix 9.4.

The table below gives us a diagrammatic representation of the responsibilities of a CTO and the skills required to meet each one of those responsibilities within technology driven organisations.

Skills / Responsibilities	Technical Expertise	Adaptability	Financial Skills	Management Skills	Skills	Leadership Skills	Field Experience	People Skills	Sales Skills	Visionary Skills
Board Responsibilities	√		√		√					√
Corporate Strategy Definition			√				√			√
Corporate Strategy Execution		√		√		√				√
Innovation and New Product Development enabling Competitive Advantage	√	√					√	√		√
Keep abreast with External Technology Changes	√	√								√
CAPEX and P&L Responsibilities			√							√
External Parties/Communities	√			√	√					√
Consult to inter-organisational Bus about tech	√		√		√				√	√
Help to Shape Company Culture				√				√		
Marketing of new technologies to external parties	√						√		√	

Table 11 : A Responsibilities and Skills Matrix for a CTO working within a Technology Driven Organisation

6.8 Conclusion

The above research allows us to conclude that the strategic responsibilities of a CTO and the skills necessary to meet those strategic responsibilities within technology driven organisations are:

Strategic Responsibilities of a CTO within technology driven organisations:

- Keep abreast with external technology changes
- Innovation and new product development
- Corporate strategy definition
- Board responsibilities
- Corporate strategy execution
- Consult to inter-organisational business about technology
- External parties/communities
- Help to shape company culture
- CAPEX and P&L responsibilities
- Marketing of new technologies to external parties

Skills required by a CTO to meet the above strategic responsibilities:

- Technical expertise
- Adaptability
- Financial skills
- Business management skills
- Networking skills
- Leadership skills
- Field experience
- People skills
- Sales skills
- Visionary skills

Therefore answering both research questions presented in Chapter Three.

Chapter Seven - Conclusion

7.1 Research Findings

The initial intent of this research was to define a list of strategic responsibilities and skills required by CTOs to meet those challenges within technology driven organisations. The findings from both the research. Both literature reviews and the interviews did provide a consolidated list of strategic responsibilities and skills required. The process of deriving this list and supporting it with the evidence collected through my research process met the overall objective of this assignment.

It is very important that all executives understand the role of the CTO and the best skill set required by the candidate they choose to fill this position in order to maximise the organisations competitive advantage.

7.2 The Skills and Responsibilities Matrix for a CTO

The skills and responsibilities matrix was developed by the researcher in conjunction with the research findings of Hartley, Smith, Medcof, Thurlings and Debackere, Ferdows and Adler, Flynn and Edler, Meyer-Krahmer and Reger, and was then augmented with the summarised list of skills and responsibilities documented as part of the research interviewee responses.

The CTO skills and responsibilities matrix for CTOs working within technology driven organisations should help a wide range of stakeholders to gain a better understanding of the CTO role and the required skills and competencies to excel in this position.

This is an important piece of research because having a better understanding of the strategic responsibilities and the skills required by a CTO within technology driven organisations, will aid this wide range of stakeholders to gain a better understanding to the role itself – a role that is still not fully understood.

7.3 Recommendations

The skills and responsibilities matrix defined in this research study has slightly varying applications for practitioners wanting to utilise the insight gained by defining this model. Below are a few practical applications for harnessing the full value of the model.

HR Practitioners

The skills and responsibilities matrix defined in the research study could be utilised as a skills development roadmap for succession planning for senior executives earmarked for progression to the top management team into a CTO role.

Aspiring CTOs

The skills and responsibilities matrix provides a roadmap to the C-Suite. As an aspiring CTO, one must work on developing the skills outlined in the model and on gaining exposure in different business situations that allow them to gain the necessary experience to fulfil the required skill set. By doing this they will be positioning themselves to be equipped to set up into a technical leadership position when their organisation requires.

Executive Placing Agents

The skills and responsibilities matrix defined in the this research study provides a necessary tool to executive recruiters evaluating candidates for a CTO role working within a technology driven organisation in order to evaluate potential candidates and their current skills.

Academics

I hope that this research study contributes to the greater understanding of the CTO role and is used as an input into future research studies to continually enhance the greater understanding of the role and the importance of technology as a whole to organisational performance.

7.4 Limitations of Research

After conducting the research using the method outlined in Chapter Four, the following limitations of the actual study were observed:

1. The research sample used in this study was only drawn from technology driven organisations as defined in Chapter One.

2. The research sample that emerged was only male, despite the efforts of the researcher to try and obtain a female interviewee to form part of the research sample.

3. Due to the fact that the interviews were only a maximum of one hour in length, the data obtained for analysis was limited to that of what was shared by the interviewee within that hour.

The research sample used was only South African and does not represent a global sample even though some of the interviewees worked within global organisations.

7.5 Future Research Ideas

1. There is a need to look at non-technology driven organisations to assess the role of the CTO or equivalent and document the differences in the skills and responsibilities matrix, if any emerge.

2. Empirical research mapping the fit of the organisations CTO to the skills and responsibilities matrix developed in this research study to ascertain if there is a correlation between fit of the skill set and the organisations performance.

3. It would be beneficial to take the skills and responsibilities matrix developed in this research study and see how it best applies to technology driven industries at large and note any shortcomings, if any.

7.6 Summary

This research study has found that the CTO role has a wide range of strategic responsibilities to the organisation and requires a breadth of skills that are not necessarily demanded of other C-Suite positions.

This study's findings are consistent with that of Deevi (2011) and other academics that believe the CTO role is complex and requires a broad variety of skills, therefore a CTO needs a breadth of skills that are required by other C-Suite positions in addition to technical expertise.

The skills and responsibilities matrix developed from this research will empower other members of the board to ensure that the CTO position is filled by an individual that has the skills necessary to meet their strategic responsibilities, demonstrate their contribution to the organisations performance by the contribution they make to the organisations revenues and future competitiveness.

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Appendices

9.1 Interview Consent Form

GORDON INSTITUTE
OF BUSINESS SCIENCE
University of Pretoria

Research Informed Consent Form

23 May 2012

To whom it may concern,

I am conducting research on the Strategic Role and Responsibilities of a Chief Technical Officer (CTO) as a part of the requirements of the completion of a Masters in Business Administration at GIBS. The key objectives of the study are too;

- *Understand the role of the CTO within the definition and execution of corporate strategy*
- *Compile a comprehensive list of skills required by CTOs to perform their function other than those which are technical*

Our interview is expected to last about an hour, and will help me understand what influence Chief Technical Officers have in corporate strategy definition and optimal skill set required to meet their strategic responsibilities within technology driven organisations. ***Your participation is voluntary and you can withdraw at any time without penalty****. All data will be kept in the strictest of confidence and your identity will never be revealed. If you have any concerns, please contact me or my supervisor.*

Researcher: Prudence Spratt

Email: pspratt@gmail.com

Phone: 0826742117

Research Supervisor: Karl Hofmeyr

Email: hofmayrk@gibs.co.za

Phone: 0117714125

23 May 2012

Researcher Signature **Date**

Interviewee Signature **Date**

9.2 Interview Guide

Interview Guide - Expert Interview

What are the strategic responsibilities of a chief technology officer and what are the skills required to meet these responsibilities within technology driven organisations

Hello my name is Prudence Spratt and I am conducting this interview in partial fulfilment of my Masters of Business Administration degree at the Gordon Institute of Business Science.

As part of this interview I am seeking to ascertain what **the strategic responsibilities** of a CTO are and **what skills are required** to meet those responsibilities within technology driven organisations.

You have been **asked to participate** in this interview because of your role as a CTO in _____ organisation and you are therefore considered an expert within this field.

This interview should take **approximately 60 minutes**. Please answer the questions to the best of your ability.

As you read in the informed consent form, your responses will be kept confidential and you will never be identified by name or role when we report the results of these interviews, your responses will also be recorded. You are free to stop participating or withdraw at any time. Let me know if you would like to skip a question for any reason.

May I start the interview now?

[Start Recording]

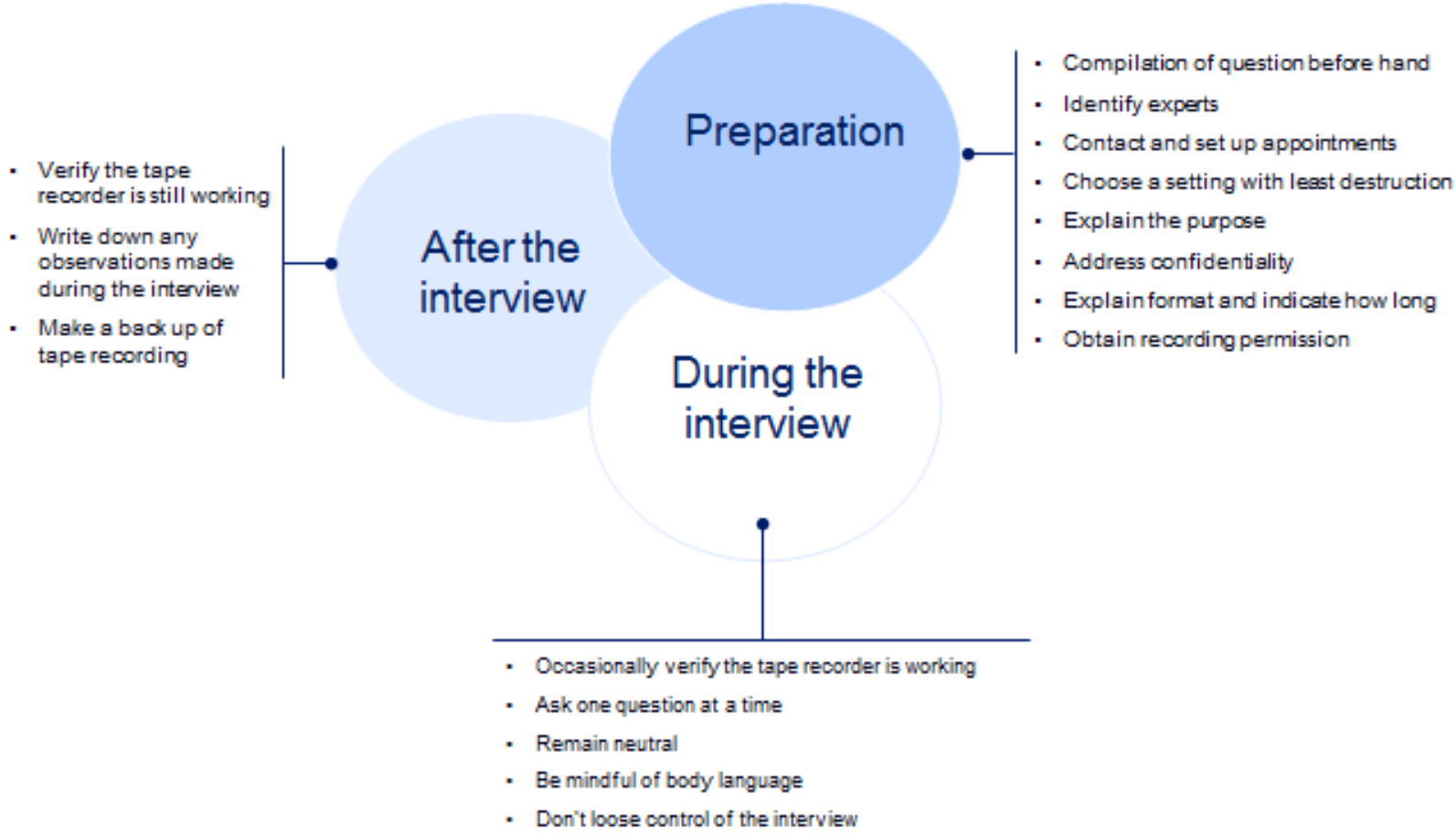
Question	**Probe**	**Interpreting**
What role do you play in helping to define the corporate strategy of your organisation? OR What deliverable are you required to submit which are used as inputs in defining the organisations corporate strategy?	Why do you think/say this?	So what you are saying is....?
Other than technology specific ones, what skills do you believe are necessary for a CTO working within a technology driven organisation to have?	What are your other thoughts on the matter?	Is it correct that...?
What role do you play in the innovation of new technologies, or new technology enabled business process optimisation projects? *What skills do you believe make you better at leading innovation for your organisation?*	Could you please explain that a little more for me?	To clarify you mean that...?
How does your organisation utilise technology to gain a competitive advantage within the marketplace? *What are some of the specific roles you have played with implementing these technology enablers?*	Please can you elaborate a little more on your thoughts about this?	To make sure I understand you correctly, you believe that....?
How dependant is the corporate strategy on the technology strategy? If possible please provide some examples of technology enablers of corporate strategy.	Could you perhaps give me a bit more detail/ examples about your response?	**Would it be accurate to quote you by saying that....?** **(Saunders and Lewis, 2012)**

Table 12: List of Interview Questions

In your opinion did I leave out any important topics?

Do you have any additional questions for me?

Interview logistics mind map:



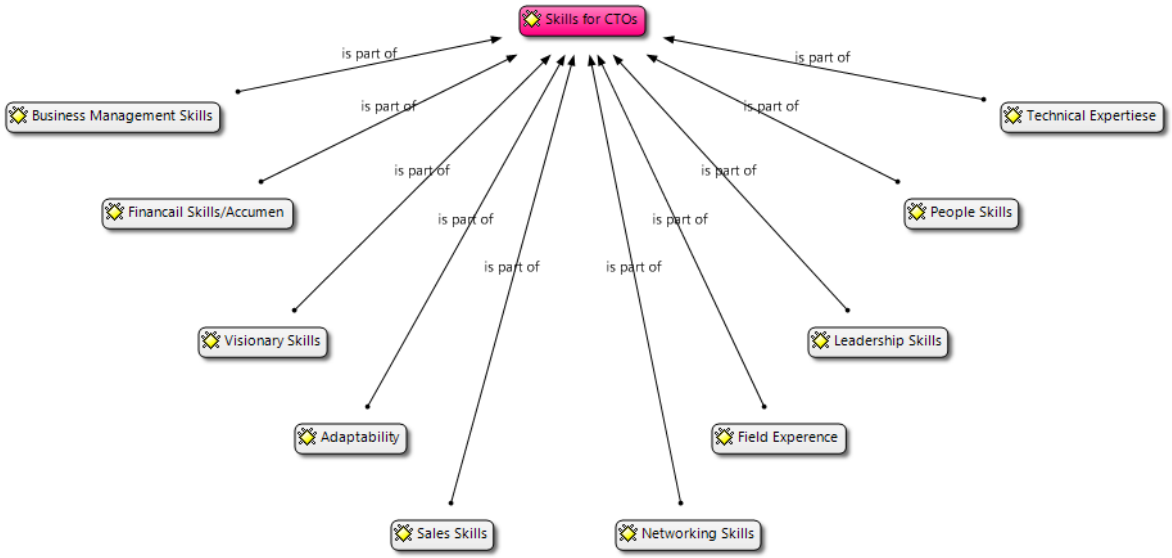
(Valenzuela and Shivastava, 2008

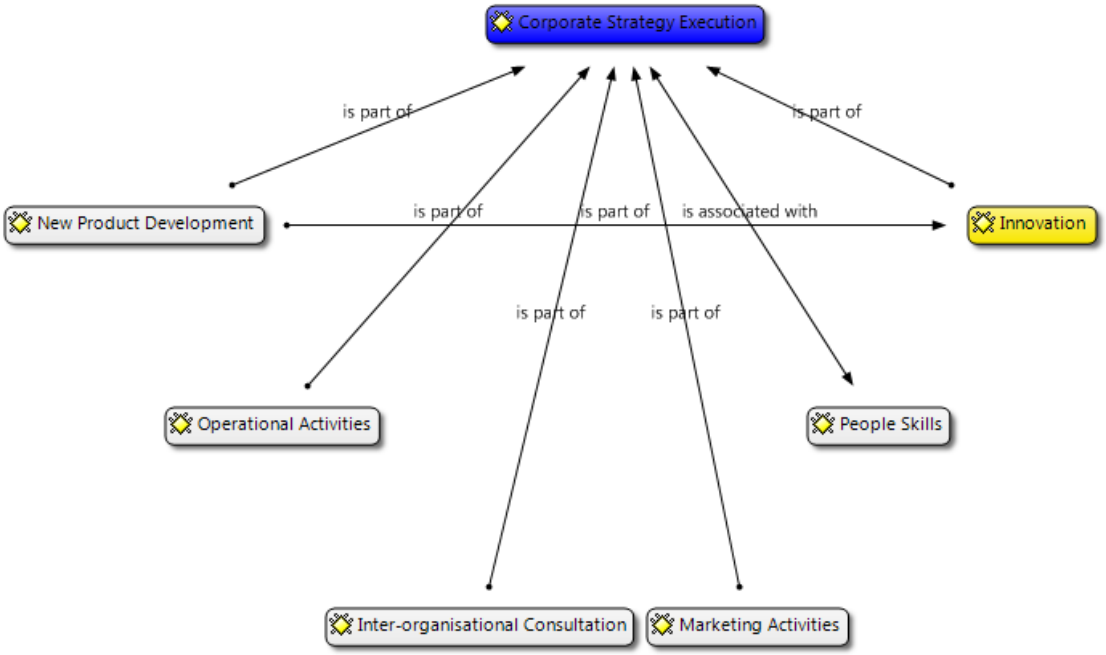
9.3 Codes Co-occurrence Table

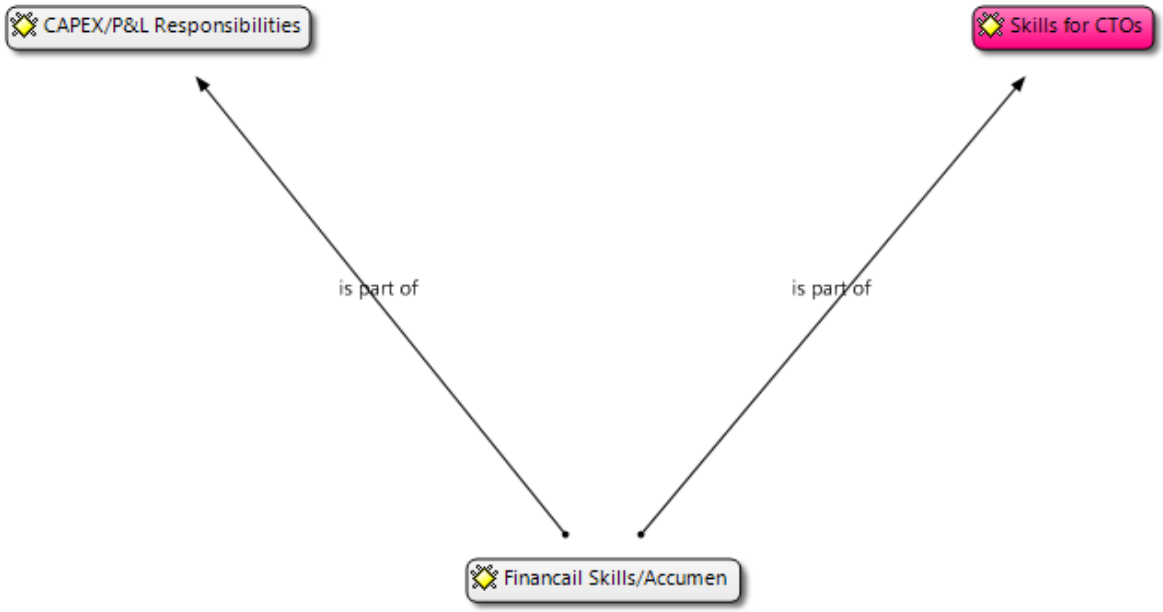
	Adaptability	Affiliated to Committees of Groups	Aquiritian	Board Responsibilities (Regulation	CAPEX/P&L Responsibilities	Competitive Advantage	Confidence	Corporate Strategy Definition	Corporate Strategy Executi	Engineer	Field Experience	Financail Skills/Accume	Formal Business Education	Innovation	Inter-organisational Consultation	Marketing Activities
Adaptability	0	0	0	0	0	0.07	0.16	0	0.07	0	0	0	0	0.18	0	0
Affiliated to Committees of Groups	0	0	0	0.04	0	0.09	0	0	0.04	0	0	0	0	0	0	0
Aquiritian	0	0	0	0.18	0	0	0	0.05	0.06	0	0	0	0	0	0	0
Board Responsibilities (Regulation	0	0.04	0.18	0	0	0	0	0.17	0.06	0	0	0.07	0	0	0.07	0
CAPEX/P&L Responsibilities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.07	0
Competitive Advantage	0.07	0.09	0	0	0	0	0.11	0.1	0.11	0	0	0	0	0.19	0.04	0
Confidence	0.16	0	0	0	0	0.11	0	0.04	0.1	0	0	0	0	0.04	0	0
Corporate Strategy Definition	0	0	0.05	0.17	0	0.1	0.04	0	0.13	0	0.04	0.07	0	0.03	0.11	0
Corporate Strategy Execution	0.07	0.04	0.06	0.06	0	0.11	0.1	0.13	0	0	0	0	0	0.06	0	0
Engineer	0	0	0	0	0	0	0	0	0	0	0.15	0	0	0.09	0	0
Field Experience	0	0	0	0	0	0	0	0.04	0	0.15	0	0.05	0	0.04	0	0
Financail Skills/Accumen	0	0	0	0.07	0	0	0	0.07	0	0	0.05	0	0	0	0.04	0
Formal Business Education	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Innovation	0.18	0	0	0	0	0.19	0.04	0.03	0.06	0.09	0.04	0	0	0	0.03	0
Inter-organisational Consultation	0	0	0	0.07	0.07	0.04	0	0.11	0	0	0	0.04	0	0.03	0	0
Marketing Activities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Marketing CTO	0	0.09	0	0	0	0	0	0	0.06	0	0	0	0	0	0	0
Motivation/Passion/Inspiration	0	0	0	0	0	0	0.18	0	0.05	0	0	0	0	0	0	0
Networking	0	0.11	0	0.04	0	0	0	0	0	0.06	0	0.04	0	0	0.1	0
New Product Development	0	0.05	0	0	0	0.13	0	0.03	0.08	0	0	0	0	0.11	0	0
Operational Activities	0	0.07	0	0	0	0	0	0	0.05	0	0	0	0	0	0.13	0
Operational CTO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
People Skills	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0.04	0	0
Power Base	0	0	0	0.05	0	0.06	0	0.05	0	0	0.09	0	0	0	0	0
Reporting Line - Direct Reports	0	0.07	0	0	0	0	0	0	0.05	0	0	0.11	0	0	0	0
Sales	0	0	0	0	0	0	0	0	0	0	0.14	0	0	0	0.05	0
Shaping Culture	0	0	0	0	0	0.04	0	0.08	0.04	0	0	0	0	0	0	0
Skills for CTOs	0	0	0	0	0	0.06	0	0	0	0	0	0	0	0	0	0
T Shaped	0	0	0	0.04	0	0	0	0	0	0	0	0	0	0	0	0
Technical Expertiese	0.03	0.04	0	0.02	0	0.03	0.08	0	0	0	0.03	0	0	0	0.03	0
Thought Leader/Market Awarness	0.11	0.12	0	0.02	0.03	0.17	0.06	0.02	0.05	0	0	0.05	0	0.05	0.03	0

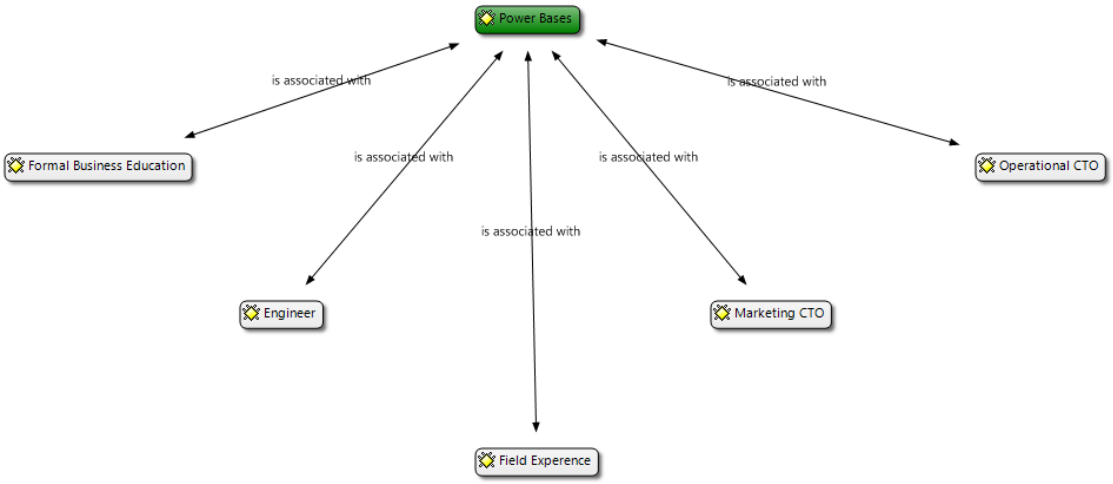
	Marketing C	Motivation/Passion/Inspiration	Networkin	New Product Development	Operational Activities	Operational CTO	People Skil	Power Base	Reporting Line - Direct Repo	Sales	Shaping Cultura	Skills for CTOs	T Shaped	Technical E	Thought Leader/Market Awarne	TOTALS:
Adaptability	0	0	0	0	0	0	0	0	0	0	0	0	0	0.03	0.11	0.62
Affiliated to Committees of Groups	0.09	0	0.11	0.05	0.07	0	0	0	0.07	0	0	0	0	0.04	0.12	0.71
Aquiritian	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.28
Board Responsibilities (Regulation	0	0	0.04	0	0	0	0	0.05	0	0	0	0	0.04	0.03	0.02	0.77
CAPEX/P&L Responsibilities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.03	0.11
Competitive Advantage	0	0	0	0.13	0	0	0	0.06	0	0	0.04	0.06	0	0.03	0.17	1.21
Confidence	0	0.18	0	0	0	0	0	0	0	0	0	0	0	0.08	0.06	0.77
Corporate Strategy Definition	0	0	0	0.03	0	0	0	0.05	0	0	0.08	0	0	0	0.02	0.92
Corporate Strategy Execution	0.06	0.05	0	0.08	0.05	0	0	0	0.05	0	0.04	0	0	0	0.05	1
Engineer	0	0	0.06	0	0	0	0	0	0	0	0	0	0	0	0	0.3
Field Experience	0	0	0	0	0	0	0	0.09	0	0.14	0	0	0	0.08	0	0.6
Financail Skills/Accumen	0	0	0.04	0	0	0	0.1	0	0.11	0	0	0	0	0	0.05	0.53
Formal Business Education	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Innovation	0	0	0	0.11	0	0	0.04	0	0	0	0	0	0	0	0.05	0.86
Inter-organisational Consultation	0	0	0.1	0	0.13	0	0	0	0	0.05	0	0	0	0.03	0.03	0.71
Marketing Activities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Marketing CTO	0	0	0	0.08	0.17	0	0	0	0	0	0	0	0	0	0	0.39
Motivation/Passion/Inspiration	0	0	0	0	0.1	0	0	0	0.09	0	0	0	0	0	0.06	0.48
Networking	0	0	0	0	0	0	0	0	0	0	0	0	0.06	0.07	0.09	0.55
New Product Development	0.08	0	0	0	0.06	0	0	0	0	0.05	0	0.07	0	0	0.22	0.88
Operational Activities	0.17	0.1	0	0.06	0	0	0	0	0	0	0	0	0	0.04	0	0.63
Operational CTO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
People Skills	0	0	0	0	0	0	0	0	0.08	0	0.13	0	0	0.04	0	0.38
Power Base	0	0	0	0	0	0	0	0	0	0.09	0.17	0	0	0.05	0	0.55
Reporting Line - Direct Reports	0	0.09	0	0	0	0	0.08	0	0	0	0	0	0	0	0.03	0.42
Sales	0	0	0	0.05	0	0	0	0.09	0	0	0	0.1	0.07	0.04	0.03	0.57
Shaping Culture	0	0	0	0	0	0	0.13	0.17	0	0	0	0	0	0	0	0.45
Skills for CTOs	0	0	0	0.07	0	0	0	0	0	0.1	0	0	0	0	0	0.23
T Shaped	0	0	0.06	0	0	0	0	0	0	0.07	0	0	0	0.08	0	0.24
Technical Expertiese	0	0	0.07	0	0.04	0	0.04	0.05	0	0.04	0	0	0.08	0	0.05	0.69
Thought Leader/Market Awarness	0	0.06	0.09	0.22	0	0	0	0	0.03	0.03	0	0	0	0.05	0	1.19

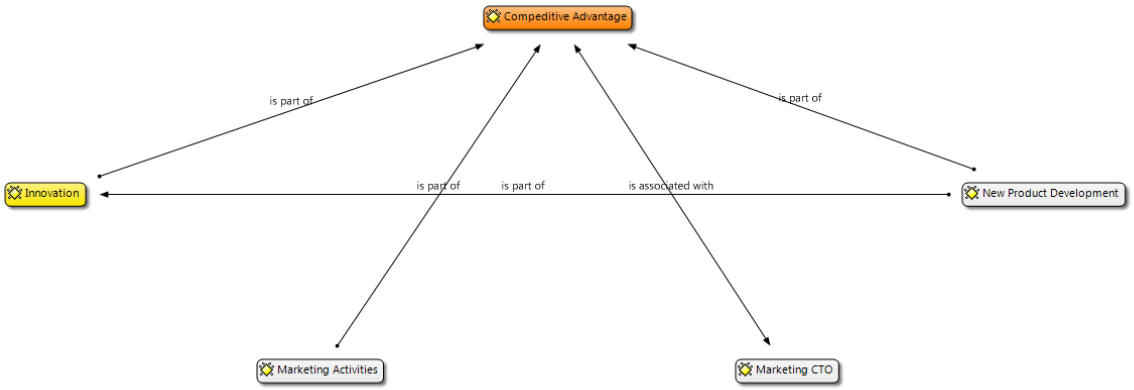
9.4 Code Family Trees

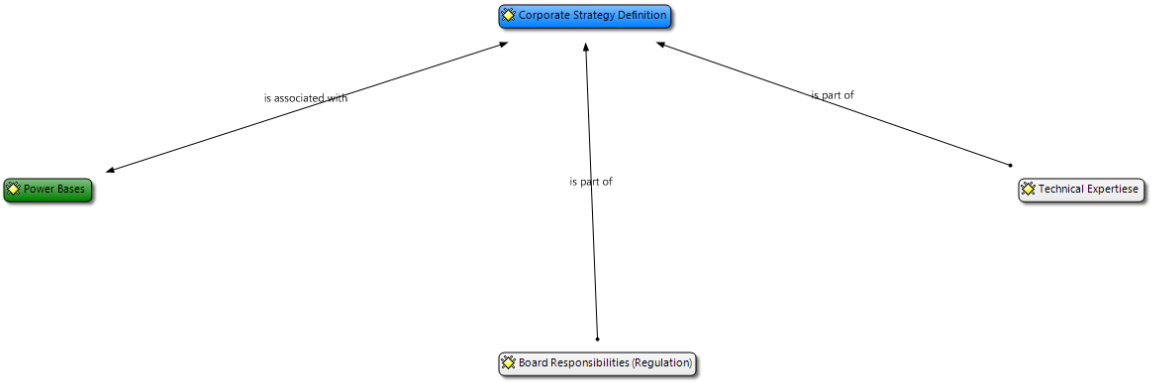


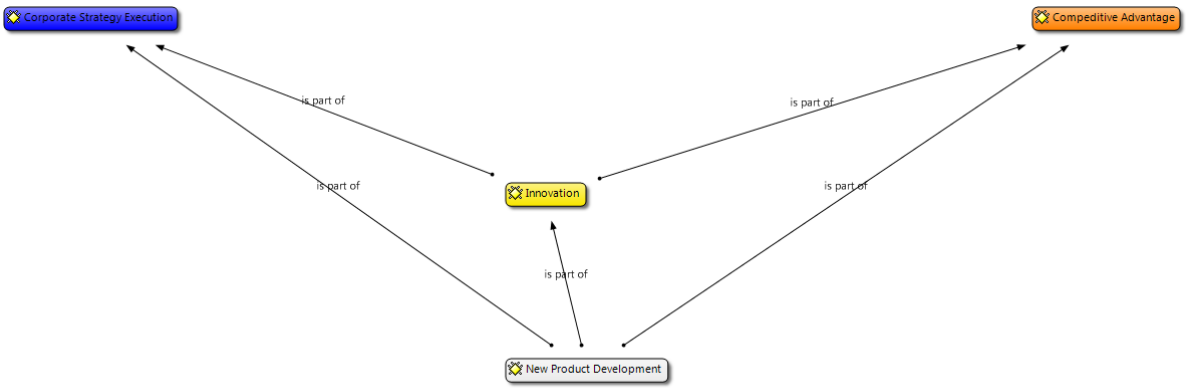



CAPEX/P&L Responsibilities
Skills for CTOs
is part of
is part of
Financail Skills/Accumen


Power Bases
is associated with
is associated with
Formal Business Education
is associated with
is associated with
Operational CTO
is associated with
Engineer
Marketing CTO
Field Experence


Compeditive Advantage
is part of
is part of
Innovation
is part of
is part of
is associated with
New Product Development
Marketing Activities
Marketing CTO


Corporate Strategy Definition
is associated with
is part of
Power Bases
is part of
Technical Expertiese
Board Responsibilities (Regulation)


Corporate Strategy Execution
Compeditive Advantage
is part of
is part of
is part of
Innovation
is part of
is part of
New Product Development

9.5 Top 10 Interview Words Frequency

Word	P 2	P 3	P 4	P 5	P 6	P 7	P 8	P 10	Total
TECHNOLOGY	26	15	26	32	38	37	18	10	**202**
STRATEGY	9	15	11	15	25	23	15	12	**125**
ORGANISATION	26	9	12	7	14	13	6	5	**92**
CTO	8	6	14	6	30	17	5	1	**87**
CORPORATE	8	6	8	9	16	15	11	6	**79**
BUSINESS	11	11	13	10	6	9	4	2	**66**
PEOPLE	4	12	6	2	12	6	5	5	**52**
INNOVATION	3	3	5	5	12	6	3	5	**42**
MARKET	3	2	0	3	8	6	5	5	**32**
CUSTOMER	0	3	1	10	6	5	5	0	**30**

9.6 Interview Schedule

Interviewee	Role	Company	Industry Sector	Venue
Andries Delpoort	CTO	Vodacom	Telecomms	Andries Office - Vodacom
Craig Raw	CTO	Quirk	Digital	Teleconference
Jacques Barkhuizen	CTO	Investec	Finance	Investec Meeting Room
Shane Chorley	CTO	Vox	Telecomms	Vox Meeting Room
Mayan Mathen	CTO	Dimension Data	Telecomms	DD Campus - Mayan's Office
David Jacobson	CTO	Synaq	ICT	SYNAQ - David's Office
Prenesh Padayachee	CTO	Internet Solutions	Telecomms	IS - Prenesh'a Office
Lambo Kanagaratnam	CTO	MTN	Telecomms	Lambo's Office - MTN

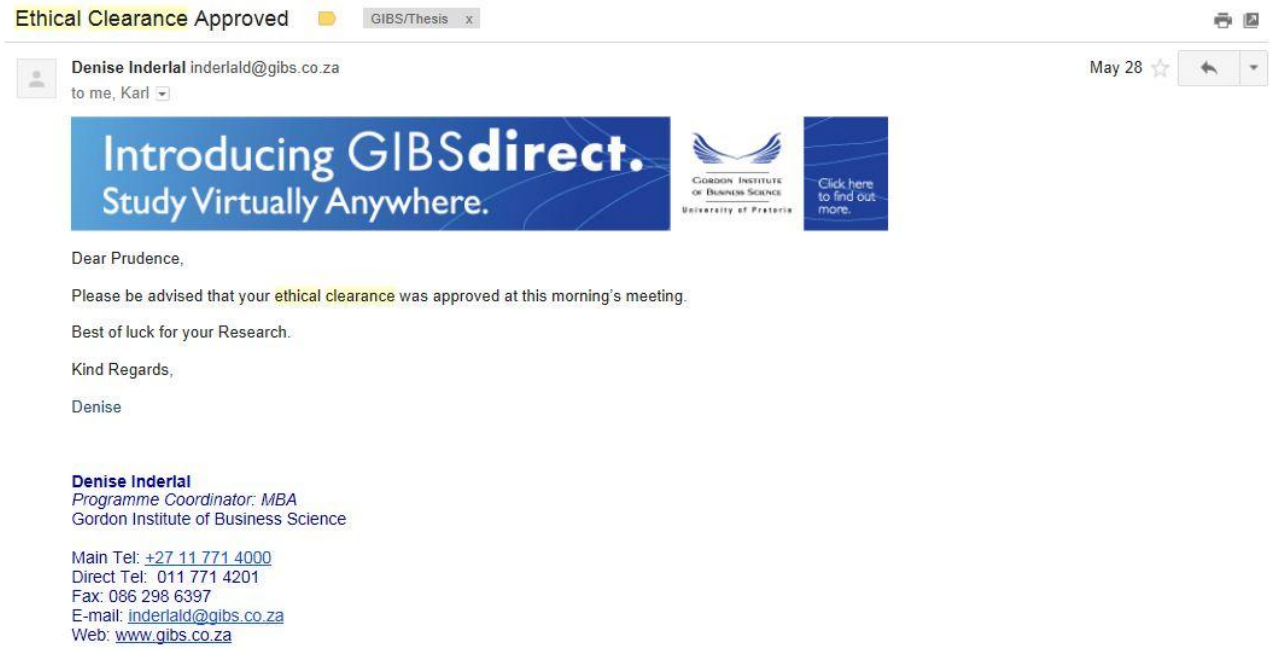
9.7 Codes Vs Primary Documents Table

CODES-PRIMARY-DOCUMENTS-TABLE									
	P1	**P 2**	**P 3**	**P 4**	**P 5**	**P 6**	**P 7**	**P 8**	**TOTALS:**
Adaptability	1	3	4	3	2	0	2	0	**15**
Affiliated to Committees of Groups	1	2	2	1	0	4	0	0	**10**
Acquisition	1	0	0	0	0	0	0	2	**3**
Board Responsibilities (Regulation)	1	1	3	2	1	4	3	2	**17**
CAPEX/P&L Responsibilities	0	0	1	0	1	0	1	0	**3**
Competitive Advantage	4	7	2	0	0	0	1	0	**14**
Confidence	0	1	1	3	0	1	1	0	**7**
Corporate Strategy Definition	3	7	2	0	1	1	2	2	**18**
Corporate Strategy Execution	4	5	2	1	2	1	1	0	**16**
Engineer	0	3	1	0	0	2	0	1	**7**
Field Experience	0	4	0	0	0	1	2	1	**8**
Financial Skills/Acumen	2	6	0	3	1	0	0	2	**14**
Formal Business Education	0	0	0	1	0	1	0	0	**2**
Innovation	3	3	2	3	1	2	3	1	**18**
Inter-organisational Consultation	0	0	3	4	1	0	2	2	**12**
Marketing Activities	0	0	1	0	0	0	0	1	**2**
Marketing CTO	1	0	0	0	0	0	1	0	**2**
Motivation/Passion/Inspiration	0	0	3	2	0	0	1	0	**6**
Networking	0	1	1	4	0	5	0	0	**11**
New Product Development	3	2	0	2	2	1	1	1	**12**
Operational Activities	1	0	1	2	1	0	0	0	**5**
Operational CTO	0	0	0	0	0	0	1	0	**1**
People Skills	2	1	2	0	1	0	1	1	**8**
Power Bases = Expert	0	3	1	0	0	0	0	0	**4**
Reporting Line - Direct Reports	0	1	3	0	0	2	0	0	**6**
Sales	1	1	1	1	1	1	1	1	**8**
Shaping Culture	1	2	4	1	1	0	1	0	**10**
Skills for CTOs	1	1	0	0	0	1	0	0	**3**
T Shaped	0	0	0	2	1	4	1	0	**8**
Technical Expertise	1	4	2	2	1	3	3	3	**19**
Thought Leader/Market Awareness	1	9	3	4	2	3	4	1	**27**
TOTALS:	**32**	**67**	**45**	**41**	**20**	**37**	**33**	**21**	**296**

9.8 Codes Vs Primary Documents Table

	External Parties/ Committees	Board Responsibilities	CAPEX/P&L Responsibilities	Keep abrest with External Technology Changes to facilitate New Product Development enabling Competitive Advantage	Corporate Strategy Definition	Corporate Strategy Execution	Innovate (R&D)	Consult to inter-organisational Bus about tech	Marketing Activities +Power Bases	Shaping Culture	TOTALS:
Adaptability	0	0	0	0.07	0	0.07	0.18	0	0	0	0.32
Confidence = Vision	0	0	0	0.11	0.04	0.1	0.04	0	0	0	0.29
Engineer = Technical Expertiese	0	0	0	0	0	0	0.09	0	0	0	0.09
Field Experence	0	0	0	0	0.04	0	0.04	0	0.09	0	0.17
Financail Skills/Accumen	0	0.07	0.07	0	0.07	0	0	0.04	0	0	0.25
Leadership Skills	0	0	0	0	0	0.05	0	0	0	0	0.05
Networking	0.11	0.04	0	0	0	0	0	0.1	0	0	0.25
People Skills	0	0	0	0	0	0	0.04	0	0	0.13	0.17
Sales Skills	0	0	0	0	0	0	0	0.05	0.09	0	0.14
Technical Expertiese	0.04	0.03	0	0.03	0	0	0	0.03	0.05	0	0.18
Visionary Skills	0.12	0.02	0.03	0.17	0.02	0.05	0.05	0.03	0	0	0.49
General Business Management	0.07	0	0	0	0	0.05	0	0.13	0	0	0.25

9.9 Ethics Approval



Ethical Clearance Approved GIBS/Thesis x

Denise Inderlal inderlald@gibs.co.za May 28
to me, Karl

Introducing GIBSdirect.
Study Virtually Anywhere.
Gordon Institute of Business Science University of Pretoria
Click here to find out more.

Dear Prudence,

Please be advised that your ethical clearance was approved at this morning's meeting.

Best of luck for your Research.

Kind Regards,

Denise

Denise Inderlal
Programme Coordinator: MBA
Gordon Institute of Business Science

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