

UNIVERSITY OF KWAZULU-NATAL

**A Comparative Analysis on the Total Cost of Ownership
Between Thin-clients and Fat-clients in an Outsourced Desktop
Environment**

By

Navin Radhalal

204519884

A dissertation submitted in partial fulfilment of the requirements for the degree of

MASTER OF BUSINESS ADMINISTRATION

In the Graduate School of Business

Supervisor: Professor Manoj Maharaj

December 2006

DECLARATION BY STUDENT

This research has not been previously accepted for any degree and is not being currently submitted for any degree. I declare that this Dissertation contains my own work except where specifically acknowledged.

Student Name: Navin Radhalal
Student Number: 204519884

Signature: ...  **.....**

Date: ... *31 December 2006* **.....**

ACKNOWLEDGEMENTS

I would like to thank The Almighty for His divine direction and enabling me to finish this dissertation. I thank him for answering my prayers and making this possible.

Secondly, I sincerely dedicate this to my family for their understanding and support whilst pursuing the MBA degree. During the past three years of attending weekday lectures and weekend group meetings, they have really rallied around to fill the vacuum that was created by my absence from family life.

I would also like to express my gratitude to my supervisor, Professor Manoj Maharaj for his support, patience and valuable words of inspiration during my dissertation. To Mr John M. Joannou, I thank him for allowing me access to perform my research at National Ship Chandlers. I would also like to thank Benny Mungray and the branch managers of National Ship Chandlers for facilitating me. The friendship of John M. Joannou is much appreciated and has led to many interesting and good-spirited discussions relating to this research. I hope that this dissertation would add value to the strengthening of the National Ship Chandlers strategies, businesses in South Africa and the academic arena in respect of the implementation of thin-clients as a desktop platform.

Finally, I would like to thank all those who took time to participate in the survey and I trust that it will serve as valuable input to the challenges that are faced by National Ship Chandlers.

ABSTRACT

More than ever, business leaders are focused on growing revenues, containing costs and providing a higher level of customer support, whilst reducing the cost of business support activities, such as information technology costs. One method of achieving these apparently contradictory goals is through the use of thin-client computing. There has certainly been a contradicting view held by many industry pundits such as Gartner and International Data Corporation on whether this is indeed the case.

This dissertation is a case study that focuses on what thin-client technology's impact is on the Total Cost of Ownership in the desktop computing environment relative to the traditional use of laptops and PCs, now commonly referred to as fat-clients. The factors and elements that contribute to a Total Cost of Ownership (TCO) for desktop computing will be explored. This study endeavors to douse the contradictory philosophies that claim for and against a lower Total Cost of Ownership (TCO) in deploying thin-clients. The literature review presented outlines the contradictions in philosophies. Research will be undertaken on National Ship Chandlers, which is in the largest ship chandler in Africa. National Ship Chandlers was migrated from a fat-client to a thin-client environment in 2002. National Ship Chandlers management seeks to understand whether they have realised a lower Total Cost of Ownership as a result of the migration. In this context, this study seeks to clarify which of the computing environments, thin-clients or fat-clients yield a lower Total Cost of Ownership within an outsourced desktop environment. In so doing it may assist in bringing clarity to the ongoing feud on the contradicting philosophies and technology claims.

There has been no significant academic research undertaken on the Total Cost of Ownership of thin-clients in relation to fat-clients in an outsourced desktop environment. Both qualitative and quantitative research techniques are employed. The conclusions from this will be evaluated and presented. Based on these findings recommendations will be made to National Ship Chandlers management on a strategic direction for their desktop computing environment.

This study reveals that for an outsourced desktop computing environment using thin-clients, National Ship Chandlers could realise an approximate 23% saving over a fat-client implementation. This excludes the benefits that can be realised from aspects of information security, ease of the operational platform and greater system availability. Thin-client technology has provides CEOs and CIOs compelling reasons to deploy as a desktop computing architecture and will continue to grow its' market-share into the future.

TABLE OF CONTENTS

DECLARATION BY STUDENT	II
ACKNOWLEDGEMENTS	III
ABSTRACT	IV
TABLE OF FIGURES.....	VIII
GLOSSARY OF TERMS AND ABBREVIATIONS	X
CHAPTER 1: INTRODUCTION.....	1
1.1 Introduction.....	1
1.2 What is Fat-client (FC) Technology?	1
1.3 What is Thin-client (TC) Technology?.....	2
1.4 Elements of a Total Cost of Ownership (TCO)	2
1.5 Research Environment at National Ship Chandlers.....	5
1.6 Problem Statement.....	7
1.7 Value of the Research	9
1.8 Objectives of the Study	9
1.9 Limitations of the Research	10
1.10 Research Methodology	12
1.11 Structure of Study	13
1.12 Conclusion	14
CHAPTER 2: LITERATURE REVIEW	15
2.1 Introduction.....	15
2.2 Importance of Research Area.....	17
2.3 Thin-client Solutions.....	17
2.4 Motivates and Factors Contributing to a Thin-client TCO Analysis.....	19
2.4.1 TCO Benefit.....	19
2.4.2 Network Bandwidth Impact on TCO.....	21
2.4.3 Operation of Thin-Client Computing (TCC) / Server Based Computing (SBC)...	21
2.4.4 Thin-client Management.....	24
2.4.5 Mobility.....	24
2.4.6 The Incompatibility Hurdle.....	25
2.4.7 Cutting Costs of Thin-Client Computing (TCC)	25
2.4.8 Architecture and Dimensioning	25
2.4.9 Attractiveness of Thin-Client Computing.....	27
2.4.10 Thin-client Acceptance	29
2.4.11 Security with Thin-clients.....	31
2.5 Advantages of a Thin-client Solution	33
2.6 Disadvantages of a Thin-client Solution.....	35
2.7 Motivation for Hypothesis	37
2.7.1 Hypothesis and Structure of Research Process	38
2.8 Conclusion	41
CHAPTER 3: RESEARCH METHODOLOGY	43
3.1 Introduction.....	43

3.2 Quantitative Research	44
3.2.1 Data Collection Techniques and Instruments	45
3.2.2 Population Description and Sample Size	46
3.2.3 Primary Data	46
3.2.4 Secondary Data	47
3.2.5 Other Supplementary Primary Data Techniques	47
3.2.6 Data Collection Procedure	47
3.2.7 Questionnaire Pre-testing	48
3.2.8 Academic Rigor (Reliability and Validity)	48
3.2.9 Reliability and Validity Testing of Fat and Thin-client User Responses	49
3.2.10 Ethical Considerations	50
3.3 Qualitative Research	50
3.4 Conclusion	52
CHAPTER 4: RESULTS OF STUDY	53
4.1 Introduction	53
4.2 Proposed Analysis of Data	54
4.3 Results of Data	54
4.3.1 Reliability and Validity Testing between Fat and Thin-client User Responses ...	54
4.3.2 Age Distribution Landscape	59
4.3.3 Geographic Distribution	59
4.3.4 Job Function Landscape	60
4.3.5 Job Challenge	61
4.3.6 Distribution of Job Dependence on System	61
4.3.7 User's Acceptance of Working with the Computer System	62
4.3.8 Total Average Support Calls per Month of Thin-client vs. Fat-client	62
4.3.9 Total Average Support Calls per Month per Region	63
4.3.10 Thin-client User's Preference to Move Back to Fat-clients	64
4.3.11 Number of Support Calls Logged on Thin-clients Relative to Fat-clients	64
4.3.12 Comparison of Training Requirements for Thin-clients vs. Fat-clients	65
4.3.13 Data Availability and Uptime on Thin-clients	66
4.3.14 Productivity of Thin-client Users When System is Offline	66
4.3.15 Training Requirements and Impact on Productivity	67
4.3.16 Performance Requirements – Thin-clients	67
4.3.17 Thin-client User's CDROM/DVD/USB Usage	68
4.3.18 User's Preference: Thin-client over Fat-client	68
4.3.19 User Training: Citrix System	69
4.3.20 Accessibility to Computer Games: Thin-client Users vs. Fat-client Users	69
4.3.21 Virus Infections: Thin-clients vs. Fat-clients	70
4.3.22 Level of Satisfaction: Thin-client Users	71
4.3.23 Fat-client Users Preference over Thin-clients	72
4.3.24 Perceived Accessibility of Applications on Thin-clients	72
4.3.25 Comparative Analysis of Data Integrity on Fat-clients vs. Thin-clients	73
4.3.26 Fat-client Productivity: User Dependence on Fat-clients	73
4.3.27 Performance: User Dependence on Fat-clients	74
4.3.28 Test Preference of Fat-client Users for Thin-client Device	74
4.4 Factors and Cost Implications of an Outsource of Thin-clients vs. Fat-clients	75
4.5 Total Cost of Ownership Calculation of Thin-clients versus Fat-clients – Outsourced Desktop Environment	80
4.5.1 Protecting the Assets of the Organisation	80

4.5.2 Remote Management and Administration	80
4.5.3 Application Lifecycle Management.....	82
4.5.4 Information Security Management on Thin-clients.....	83
4.5.5 The Cost Calculation Model	84
4.6 Hypothesis Testing and Results.....	87
4.7 Conclusion	88
CHAPTER 5: RECOMMENDATIONS AND CONCLUSION.....	90
5.1 Introduction.....	90
5.2 Evaluation of Objectives of Research.....	90
5.3 Recommendations.....	94
5.4 Areas of Future Research.....	95
5.5 Conclusion	96
REFERENCES.....	99
APPENDICES.....	107
Appendix 1: National Ship Chandlers WAN.....	107
Appendix 2: Questionnaire	108
Appendix 3: Comments on Questionnaire for the Reader	119
Appendix 4: Raw Data.....	129
Appendix 5: Academic Rigor - Reliability Testing	132
Appendix 6: Pricing Case Calculations	147
Appendix 7: Vendor Quotations	152
Appendix 8: Authorisation Letter from National Ship Chandlers to Conduct Research..	157
Appendix 9 : Ethical Clearance Letter.....	160

TABLE OF FIGURES

Figure 1.1: National Ship Chandler’s Wide Area Network and Server Layout	6
Figure 2.1: TCO of Thin-Client versus Fat-Client - Source: Gartner Research, 2002	20
Figure 2.2: Thin-Clients Projections Worldwide from 2003 to 2007 – Source: IDC Report, 2004.....	20
Figure 2.3: Thin-Client Computing or Server Based Computing Architecture – Source: Volchkov, 2002.....	23
Figure 2.4: Bandwidth Usages in Thin-client Computing – Source: Volchkov, 2002.....	26
Figure 2.5: Research Approach & Methodology.....	40
Figure 4.1: Question 1 – Age Distribution Landscape of Thin-clients vs. Fat-clients	59
Figure 4.2: Question 2 – Geographic Distribution of Fat-clients & Thin-clients.....	59
Figure 4.3: Question 5 – Job Function Landscape across Thin-clients and Fat-clients.....	60
Figure 4.4: Question 9 – Evaluation of Job Challenge across Thin-clients and Fat-clients...	61
Figure 4.6: Question 10 – User’s Acceptance of Computer System on Fat-clients & Thin- clients	62
Figure 4.7: Question 12 & 41 – Total Average Support Calls per Month of Fat-clients vs. Thin-clients.....	62
Figure 4.8: Question 2, 12 & 41 – Average Support Calls per Month per Region for Thin and Fat-clients.....	63
Figure 4.9: Question 13 & 23 – Thin-client User’s Preference to Move Back to Fat-clients	64
Figure 4.10: Question 14 & 28 (Inverted) – Support Calls Logged on Thin-clients Relative to Fat-clients	64
Figure 4.11: Question 15, 39 & 44 – Training Requirements for Thin-clients vs. Fat-clients	65
Figure 4.12: Question 17 – Data Availability and Uptime on Thin-clients.....	66
Figure 4.13: Question 20 – Productivity of Thin-client Users When System is Offline	66
Figure 4.14: Question 21 & 30 – Training Requirements of Thin-client Users and Impact on Productivity.....	67
Figure 4.15: Question 22 & 24 – Thin-client User’s Performance Requirements.....	67
Figure 4.16: Question 29 – Thin-client User’s CDROM/DVD/USB Usage	68
Figure 4.17: Question 13, 23 & 31 – Thin-client User’s Preference over Fat-clients	68
Figure 4.18: Question 32 & 33 – Thin-client User Training via Citrix System	69
Figure 4.19: Question 35 & 36 – Thin-client User Access and Availability to Computer Games	69
Figure 4.20: Question 54 & 55 – Fat-client User Access and Availability to Computer Games	70
Figure 4.21: Question 37 & 45 – Impact of Viruses on Thin-clients vs. Fat-clients	70
Figure 4.22: Question 40 – Level of Satisfaction of Thin-client Users	71
Figure 4.23: Question 43 & 46 – Fat-client User’s Preference over Thin-clients	72
Figure 4.24: Question 47 – Perceived Accessibility of Applications on Thin-clients.....	72
Figure 4.25: Question 16 & 48 – Comparative Analysis of Data Integrity on Fat-clients vs. Thin-clients.....	73
Figure 4.26: Question 51 – Evaluation of Job Challenge landscape for thin-clients and fat- clients	73
Figure 4.27: Question 52 – Performance: User Dependence on Fat-clients.....	74
Figure 4.28: Question 56 – Test Preference of Fat-client Users for Thin-client Device	74
Figure 4.29: IBM’s Four TCO Categories with over 40 cost drivers – Source: IBM DMS, 2005.....	75
Figure 4.30: Building Blocks of IBM DMS – Source: IBM DMS, 2005	76

Figure 4.31: IBM DMS Offering Breakdown – Source: IBM DMS, 2005 77
Figure 4.32: COBIT Information Technology Governance Framework – Source: IBM DMS,
2005..... 78
Figure 4.33: IBM Desktop Managed Service Portfolio – Source: IBM DMS, 2005..... 79
Figure 4.34: Cost against Number of Fat-clients versus Thin-clients – Source:
Harvard Computing, 2002 81

GLOSSARY OF TERMS AND ABBREVIATIONS

ABBREVIATION	TERMS	DEFINITION
IT	Information Technology	Concerned with the use of technology in managing and processing information, especially in large organisations.
TCO	Total Cost of Ownership	Is a financial estimate designed to help consumers and enterprise managers assess direct and indirect costs related to the purchase of any capital investment, such as (but not limited to) computer software or hardware.
TC	Thin-client	A thin client is a computer (client) in client-server architecture networks which depends primarily on the central server for processing activities.
FC	Fat-client	A fat client (also known as a thick client or rich client) is a client that performs the bulk of any data processing operations itself, but does not necessarily rely on the server. The fat client is most common in the form of a personal computer, as the PC or laptops can operate independently.
SBC	Server Based Computing	Is a model where applications are deployed, managed, supported and executed from central server-farms. Screen, keyboard and mouse information is exchanged between the client and the server farms. No applications actually reside and execute on the desktop client.
TCC	Thin-client Computing	Same as Server Based Computing (SBC)
LAN	Local Area Network	An interconnection of computers that are in relatively close proximity to each other, such as within a building.
WAN	Wide Area Network	A wide area network or WAN is a computer network that covers a broad geographical area (i.e., any network whose communications links cross metropolitan, regional, or national boundaries)
Kbps	Kilobits per second	A kilobit per second (kbit/s or kbps) is a unit of data transfer rate equal to 1,000 bits per second. It is sometimes used to mean 1,024 bits per second, using the binary meaning of the kilo- prefix, though this is rare and non-standard.
Mbps	Megabits per second	A megabit per second (Mbit/s or Mbps) is a unit of data transfer rate equal to 1,000,000 bits per second or 1,000 kilobits per second. 8

		Megabits per second is equivalent to 1 Megabyte per second (i.e. 8 Mbps = 1 MBps). Hence 1 Megabits per second = 0.125 Megabyte per second (i.e. 1 Mbps = 0.125 MBps)).
Mbytes	Mega Bytes	A megabyte is a unit of information or computer storage equal to approximately one million bytes.
IDC	International Data Corporation	International Data Corporation (IDC) is a market research and analysis firm specialising in information technology, telecommunications and consumer technology.
ICA	Independent Computing Architecture	A proprietary protocol for an application server system, designed by Citrix Systems
IBM	International Business Machines	International Business Machines Corporation is a multinational computer technology corporation headquartered in Armonk, New York, USA. The company is one of the few information technology companies with a continuous history dating back to the 19th century.
MS	Microsoft Corporation	The company is the world's largest software company by sales, profit or market capitalisation.
HCI	Human Computer Interaction	Is the study of interaction between people (users) and computers.
VPN	Virtual Private Network	A virtual private network (VPN) is a private communications network often used within a company, or by several companies or organisations, to communicate confidentially over a publicly accessible network.
VoIP	Voice Over Internet Protocol	Is the routing of voice conversations over the Internet or through any other IP-based network.
COBIT	Control Objectives for Information and related Technology	Is a set of best practices (framework) for information (IT) management created by the Information Systems Audit and Control Association (ISACA), and the IT Governance Institute (ITGI) in 1992.
ITIL	Information Technology Infrastructure Library	Is a framework of best practice approaches intended to facilitate the delivery of high quality information technology (IT) services.
ASP	Application Service Provider	Is a business that provides computer-based services to customers over a network.
TI2	-	Gartner's software tools used to calculate a total cost of ownership.
HQ	Head Quarters	Another term for the head office of an organisation.

CAL	Client Access License	A Client Access License is Microsoft's name for various "keys" which must be purchased and enabled to allow various functionality on Windows NT based servers.
SQL	Structured Query Language	Is the most popular computer language used to create, modify, retrieve and manipulate data from relational database management systems.
CIO	Chief Information Officer	Is a job title for the head of information technology group within an organisation. They often report to the chief executive officer.
CEO	Chief Executive Officer	Is the chairman of the board or an organisation.
SPSS	Statistical Package for the Social Sciences	Is among the most widely used programs for statistical analysis in social science.
MTBF	Mean Time Between Failures	Is the "average" time between failures, the reciprocal of the failure rate in the special case when failure rate is constant.
MTTR	Mean Time To Repair	Is the average time that a device will take to recover from a non-terminal failure. Examples of such devices range from self-resetting fuses (where the MTTR would be very short, probably seconds), up to whole systems which have to be replaced.
ECT ACT (SA)	Electronic Communications & Transactions Act, 2002	The Act provides for the facilitation and regulation of electronic communications and transactions; to provide for the development of a national e-strategy for the Republic; to promote universal access to electronic communications and transactions and the use of electronic transactions by small medium and micro enterprises; to provide for human resource development in electronic transactions; to prevent abuse of information systems; to encourage the use of e-government services; and to provide for matters connected therewith.
GPRS	General Packet Radio Services	Is a mobile data service available to users of GSM and IS-136 mobile phones. GPRS data transfer is typically charged per megabyte of transferred data, while data communication via traditional circuit switching is billed per minute of connection time, independently of if the user actually has transferred data or been in an idle state.
Java Programming	-	Is an object-oriented programming language developed by Sun Microsystems in the early 1990s

CHAPTER 1: INTRODUCTION

1.1 Introduction

Over the last ten years, the **Total Cost of Ownership (TCO)** for desktop computing activities has been dropping (Coleman, 1998). Institutions that actively addressed and developed strategies and programming to reduce the major computing cost components are now realizing the benefits. Companies that have not addressed TCO are continuing to experience out-of-control cost increases for desktop computing. Addressing only the purchase price for desktop computing will not make a sufficient difference.

Factors and elements that make up the TCO for desktop computing will be explored. Coleman (1998) has identified the following components costs: Purchase Price of Hardware and Software, Training, Applications, Maintenance, Environmental Changes and Technical Support that contribute to a TCO calculation. Furthermore, Coleman (1998) suggests that organisations that have not addressed at least three components are probably not realising a cost reduction.

Sweeping changes and improvements in technology continue to challenge organisations to reshape and redefine how best to deploy computing power. According to Coleman (1998), unless organisations have a handle on what is required to acquire, implement, and support desktop computing, it may prove too expensive to stay current. By addressing the components that make up the TCO, an organisation will be in a position to take full advantage of the latest innovation in computing, communication, educational and training techniques, and information technology.

This paper will specifically explore the **Total Cost of Ownership (TCO)** of thin-clients (TC) versus fat-clients (FC) as a desktop computing platform in an outsourced desktop environment.

1.2 What is Fat-client (FC) Technology?

A fat-client is defined as a user's personal computer that contains its own applications that are run on the machine. New programs are installed on the local hard disk. The user's computer performs most or all of the application processing with little or none performed by the server.

This is the typical way people use their computers or/and laptops (Computer Desktop Encyclopedia, 1998).

1.3 What is Thin-client (TC) Technology?

This technology is sometimes referred to as Server-based Computing (SBC) or Thin-client Computing (TCC), as all the computing intelligence is moved from the client desktop to the central server (David, 2002).

According to David (2002), the fundamental approach behind thin-client computing is simple. Instead of running applications locally on PCs with all of their associated challenges and costs, applications run centrally with only keyboard, video and mouse updates transmitted across the network. Bandwidth usage is minimal compared to traditional PC/server environments, with wireless LAN (Local Area Network) being ideal for the clients. The server backbone linking the terminal servers, data servers, mail servers, and so on is the only LAN connection that needs high capacity. In a traditional fat-client (Personal Computer/Laptop) environment, applications are stored locally, and data is stored centrally. When a file is opened, the entire file is transferred to the local PC, with the results being saved back across the LAN/WAN (Wide Area Network) to the central storage area. Server/client architecture (such as SQL and Oracle[®]), handle this process slightly differently, but processing still takes place at the local PC. This requires high bandwidth to each PC (David, 2002).

The client becomes “dumb” as all the intelligence and processing is handled centrally on the server. Only screen and mouse updates occur on the thin-client across the computer network. Therefore it was termed “thin-client”.

1.4 Elements of a Total Cost of Ownership (TCO)

TCO has many different base elements that vary slightly from one institution to another. Coleman (1998) defines some of these elements to include: the actual cost of the hardware and software, user training, the IT maintenance and support staff, the network application support of a client machine, connectivity to the network backbone, contracted technical support and the personnel involved in purchasing, accounting, and inventory. Although there are a number of strategies to lower TCO, the trend towards network computing, built around the idea of server centric, thin-client technologies seem to be the most promising.

Since the inception of Total Cost of Ownership (TCO) in 1987, a variety of elements have been included in the definition. Institutional total cost of ownership is more than the original purchase of hardware and software. Six different base elements that make up the cost components for the desktop computing are defined. Institutional cost components may be different but, some variations of these elements will cover the expenditures now facing an enterprise (Coleman, 1998). The six base elements are:

1.4.1 Purchase price for all hardware and software:

Purchase price should include all direct and indirect purchases for a desktop. Generally we are referring to the desktop computer, operating systems, base set of utilities applications, and communication equipment and software. Some examples of indirect cost would involve a departmental fileserver or department printer.

1.4.2 Training costs for the new user:

Training costs should include all direct and indirect expenditure for training activity required in effectively running the desktop computer. Formal and informal training usually occurs with the installation of every desktop. Cost and method of training vary from local vendors to out-of-town vendors, or local experts to local classes, or computer based training.

1.4.3 Application changes – Application maintenance and compatibility:

Application change costs should include all direct and indirect expenditures for changes necessary in enterprise systems that maybe implemented in the future or to maintain compatibility within the current systems. This may vary from tools needed for transaction in a client, including server enterprise systems to locally developed applications.

1.4.4 Maintenance and Support Costs, staff that keep desktops operational:

Maintenance and support costs include the personnel and labor force needed to adequately support a desktop computer environment. These may include functions such as a telephone support line, desktop service specialist, desktop installers and troubleshooters, customer service center

operations for walk-up help and staff involved in acquiring and maintaining cost effective contracts for hardware and software.

1.4.5 Environmental changes required to permit connectivity with the organisation's communication backbone;

Environmental change costs should include both direct and indirect expenditures necessary in providing communication linkage to the organisation's communication backbone. These will range from the software and network interface card in the computer and end with the maintenance of the communication environment for the enterprise. Typically, the communication port charge is the only component counted. However, the entire communication environment is not in place for desktop computing.

1.4.6 Contracted technical support contract(s), personnel, and procedure(s) in place for the desktop.

Contracted technical support costs should include direct and indirect costs to acquire and maintain vendor contracts and agreements which provide expert level support. This support includes warranty and maintenance agreements along with second and third level software expertise. Organisations cannot maintain an expert for all the hardware and software being deployed across the enterprise.

The above-mentioned variables will be the extraneous variables that will be used in this study as part of a defined hypothesis to drive a TCO for National Ship Chandler's desktop environment.

National Ship Changers is the largest Chandler in South Africa and in Africa. They service on average of 300 ships a month, with an annual turnover in excess of R264 million. The desktop environment will be modeled as an outsourced TCO, comparing both thin-clients and fat-clients.

1.5 Research Environment at National Ship Chandlers

National Ship Chandlers currently have 3 remote sites that are interconnected into their head office at 456 Sydney Road, Congella, Durban. Richards Bay, Port Elizabeth and Cape Town connect into the head-office in Congella, Durban. All sites are interconnected via a Motorola Voice-over-IP Data Wide-Area Network (WAN) which interconnects into their PABX (Private Automatic Branch Exchange) across all sites.

Prior to 2002, all National Ship Chandlers users utilised either Personal Computers (PC) or Laptops on their desktop. National Ship Chandler's clients number 95 of which 42 are located at their head office building in Durban. Due to the small size of the remote sites it is not feasible to employ support staff for each of the sites including Durban. Two designated staff members from each site are trained to offer first and second level support. Any further support would require outside consultancy. It was decided in 2002 that National Ship Chandlers would ease their maintenance and support by deploying thin-clients as a replacement to 42 of their 95 fat-clients (laptops and personal computers).

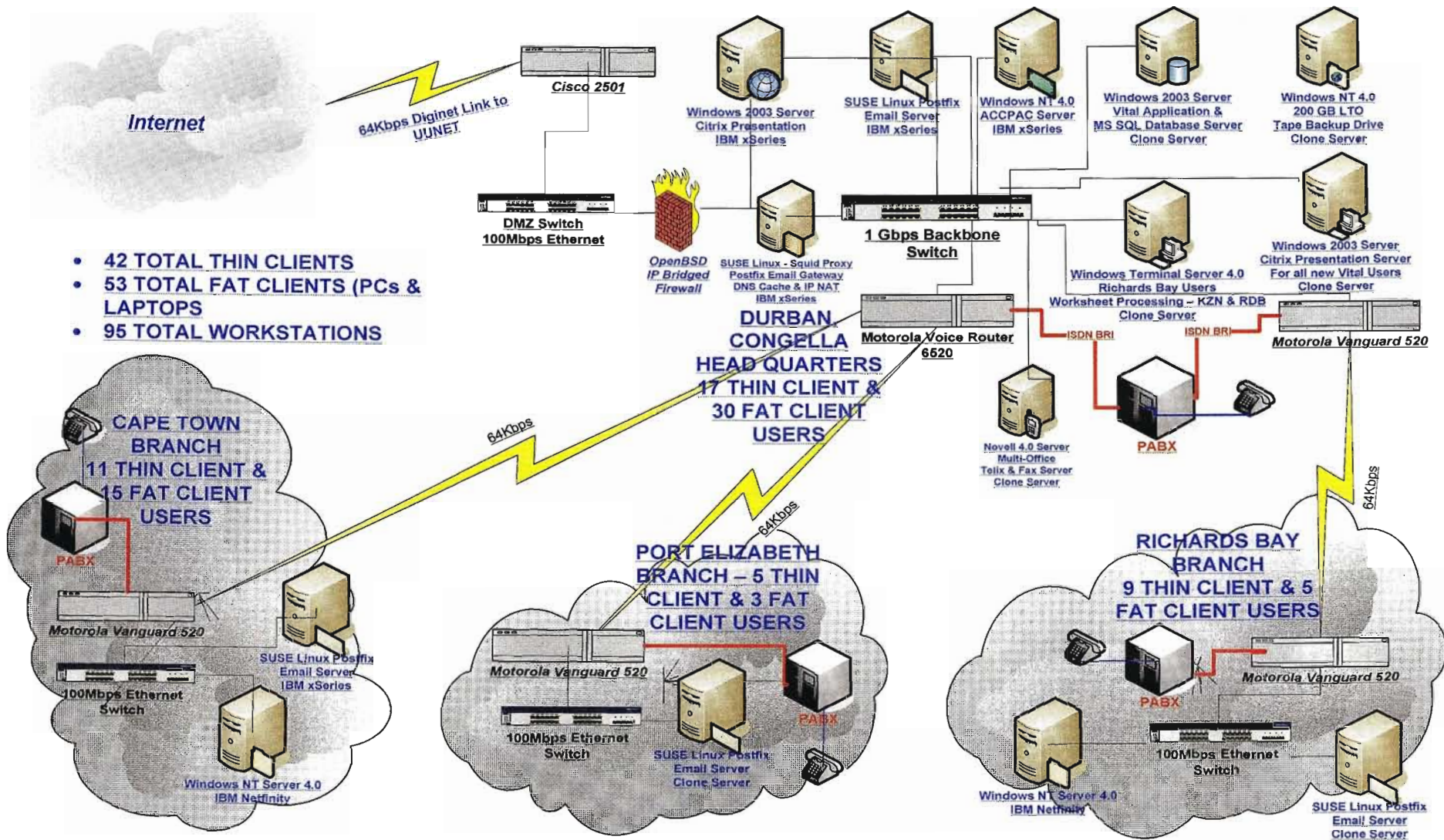


Figure 1.1: National Ship Chandler's Wide Area Network and Server Layout

Figure 1.1 depicts the IT infrastructure at National Ship Chandlers across the country, including the distribution of fat-clients and thin-clients. The thin-client decision was taken in light of the fact that the thin-client required minimal administrative attention. This is because it does not have many of the peripheral devices a traditional fat-client has, that is stiffy-drives, hard-drive, adapter cards, complex operating system (OS) and application software. All these components added to the complexity of the client and therefore increased the exposure to failure. It also lent itself to highly-qualified personnel having to troubleshoot issues on the device due to its high complexity. For reasons of simplicity of a thin-client's hardware, price, ease of troubleshooting and ease to swap-out with standby thin-clients, these were deployed.

Based on the abovementioned benefits and maintenance and support factors, National Ship Chandlers deployed 42 thin-clients, replacing 42 PCs. Management and specialist work-personnel were only allowed to retain their PC or laptop and had to motivate to the management reasons for their retention. Thus there are 53 fat-clients (laptops and PCs) and 42 thin-clients at National Ship Chandlers today.

1.6 Problem Statement

Very little research has been undertaken at an academic level into thin-client technologies and their impact on businesses. This may be attributed to the monopoly that software behemoth Microsoft hold in the world together with their effective marketing strategies. An intense search through online academic libraries and books stores such as Amazon.com and Barnesandnoble.com have literally yielded many books published on the thin-client technology itself but none on thin-clients as a strategic option on the desktop platform. Neither have there been any academic journal publications on thin-clients in relation to realising a Total Cost of Ownership (TCO) in businesses. Many articles are published by independent technology research companies like International Data Corporation (IDC), MetaGroup and Gartner Research and these will also be reviewed.

Outsourcing the desktop environment is strategic for National Ship Chandlers because it is consistent with their turn-around strategy of consolidation, cost reduction and realignment of business to core competencies. In 2001 Gartner announced the average desktop cost \$10,000 a year to own including software. Fat-clients were costing five times the purchase price to

maintain (Lowber, 2001). Today this figure remains unchanged (IT World CIO Report, 2005).

National Ship Chandlers management believe that due to increasing costs of annual software licensing and the continuous decline of PC and Laptop costs, a thin-client on the desktop is not a cost-effective option for the organisation. The organisation has already migrated 42 fat-clients to thin-clients in 2002. The Chief Executive Officer (CEO) also wants to outsource the entire desktop environment as this in line with the organisation's rationalisation, cost-reduction and refocus on core business deliverable strategies for National Ship Chandlers (Interview with CEO, 2006).

Two motives will be investigated and studied in detail:

- National Ship Chandlers management would like to undertake a post-mortem review of their transition from fat-client (PC/laptop) environment to their new thin-client environment.
- Based on the to-date hardware, software and support costs a detailed comparative analysis has to be investigated outlining whether a thin-client environment yields a lower TCO than a fat-client, in an outsourced desktop environment for National Ship Chandlers.

No research has been undertaken within the South African context for a Total Cost of Ownership (TCO) on fat-clients versus thin-clients in an outsourced desktop environment.

According to Masding (1991), to actually get a true TCO figure is extremely difficult. There is an almost inexhaustible list of things you have to include. The direct costs of user support, hardware maintenance, software updates, training, lost productivity while users (and co-workers) try to figure out what's gone wrong, security, downtime, administrative costs and a host of other headings, including depreciation and finance charges. With a laundry list that long, coupled with the increasing cost of hiring, it's no surprise that a business's TCO quickly climbs to about \$10,000 a year. Technical advances drive it down, but the people-related costs in the calculation push it obstinately back up.

The above mentioned issues outlined by Masding will be crystallised for the National Ship Chandlers environment through qualitative and quantitative research in this study.

The results of this study will assist National Ship Chandler's CEO to make an informed business decision on whether to migrate back to a fat-client environment (personal computers and laptops), maintain the status-quo thin-client environment or migrate more fat-clients to a thin-client computing platform.

These requirements dictate an in-depth study of the Total Cost of Ownership (TCO) for each of the fat-client and thin-client environments and contrasting attributes of each. In order to achieve effective delivery and contextualise the requirement, the TCO will be modelled as an outsourced service for each environment. The desktop outsource initiative is also the strategic intent of the organisation.

1.7 Value of the Research

Based on the findings of this research, National Ship Chandlers management will be in a position to make an informed business decision to outsource their desktop environment on a thin-client or fat-client platform, whichever yields a lower TCO. A lower TCO implies cost reduction on expenditure for National Ship Chandlers as a whole and therefore adding shareholder value. Outsourcing the desktop environment also allows the organisation to focus on delivering on its core business competencies, which also meets the organisation's strategic initiatives. It will also assist in indicating whether National Ship Chandlers have indeed experienced a lower TCO in transitioning in 2002 from their fat-client platform to the current thin-client platform.

This paper will also assist in contextualising a TCO on thin-clients within a South African business environment, where the dynamics of support infrastructures and IT personnel are very different from those of first world countries, where previous research was conducted e.g. Dell Computer Corporation also run thin-client desktop platforms for their Manufacturing, Corporate and Financial departments.

1.8 Objectives of the Study

- To determine all extraneous variables not already identified that will contribute to costing a TCO for a desktop environment

- To outline in detail all extraneous variables.
- To evaluate end-user acceptability of thin-client usage.
- To identify the impact of training and change-management in migrating from PCs to thin-clients.
- To construct a cost model for the TCO for both a thin-client and fat-client environment within National Ship Chandlers, based on an outsourced desktop solution.
- To evaluate and contrast the cost structures against each other.
- To provide recommendations for strategic direction into the future for National Ship Chandler’s desktop environment.

1.9 Limitations of the Research

This studying is limited to an organisation within the Maritime, Supply Chain Logistics industry in South Africa and may therefore not be comparable to other companies in the various other industries. However the computer infrastructure at National Ship Chandlers warrants adequate size to undertake this study. It will be conducted and calculations made under specific time-constraints, economic conditions and circumstantial factors stipulated below:

Location	:	South Africa – Four sites, Durban (HQ), Richards Bay, Port Elizabeth and Cape Town
Year and Period	:	August - October 2006
Company	:	National Ship Chandlers (Pty) Ltd
Industry	:	Maritime, Supply Chain Logistics
Personnel	:	220 of which 95 use Information Technology Systems
Head Office	:	Durban, South Africa
Fixed Exchange Rate	:	\$1 US – R 7.00
Remote Offices/Depots	:	3

Current IT Infrastructure : ITS budget reduced by 30%

- All application systems (Quotations and Invoicing, eMail, Financials, Access Control) centrally located at head quarters in Durban
- Sites are interconnect via a Motorola Wide Area Network (WAN) with Voice over IP (VoIP)
- 95 users utilise the IT infrastructure with either a thin-client, laptop or PC. 42 of the 95 users utilise thin-clients; 53 are fat-clients (laptops and PCs)
- 47 of the 95 desktop (fat and thin) users are located at the Head Quarters Building in Durban; of the 47 desktop users 17 are thin-clients and 30 fat-clients
- TCO is calculated utilising hardware vendors – IBM for fat-clients and WYSE for thin-clients
- TCO does not explore the use of Open Source Software
- TCO is calculated using IBM's Desktop Management Service (DMS) offering for fat-clients.
- Survey conducted will be via questionnaires to all 95 users and interviews with the operations manager at each of the 4 sites.
- For purposes of this study cost analyses will be compared directly between thin-clients and PC fat-clients only.

Based on a broad and in-depth research across the internet, academic libraries and journals it was noted that no academic research has been undertaken with respect to Total Cost of Ownership (TCO) of thin-clients in an outsourced desktop environment. The literature search yielded no published journal articles or texts outlining this. It is therefore an emergent field of study for academic research within South Africa. There are many published texts that

cover the different components that constitute thin-client technologies. These will be analysed and maybe adopted in this study.

1.10 Research Methodology

A descriptive quantitative survey design, using questionnaires to gather data has been used since it best meets the objectives of the protocol and allows the researcher to make conclusions. A literature review will be conducted to find information relevant to the study.

1.10.1 Target Population

The population of this study was all desktop users, both fat-client and thin-client. This includes any user that utilises the Information Systems at National Ship Chandlers irrespective of fat-client (PC or Laptop) or thin-client. As of October 2006, when this study was undertaken there were 95 desktops users of which 42 were thin-clients and 53 fat-clients.

1.10.2 Sample

The entire population was used, since the total population consists of about ninety-five people.

1.10.3 Data Collection Method and Instrumentation

The instrument in the form of questionnaires was piloted randomly amongst twenty information systems user staff to test the reliability thereof. Thereafter, questionnaires were distributed to the entire population by hand. The entire population received the questionnaire due to the small size of the population. Employees were given a week to complete the questionnaire.

1.10.4 Analysis of data

Since the study is of a descriptive nature, the raw data was coded and organised according to the questions asked. The data obtained was summarised and coded using Microsoft Excel, which stores and organises data. Microsoft Excel was also used for its graphics facilities to illustrate the findings. SPSS (Statistical Package for Social Sciences) version 13.0.1 was used to analyse data and to identify relationships amongst the variables.

The study will utilise both qualitative and quantitative research techniques in order to fulfil the objectives outlined in section 1.8.

1.11 Structure of Study

1.11.1 Chapter One – Introduction

The first chapter of the research covers the general background to the research, definitions of the technologies being researched, the environment that the study will be undertaken at, motivation and value of the research, objective of the study, limitations of the research, and a summary of the methodology used and ends by running through the organisation of the study.

1.11.2 Chapter Two – Literature Review

This chapter reviews the literature that both support and dismiss thin-client technologies. Based on trends in information technology development and the strategic future of the desktop platform, journal articles are reviewed with definitions and quotes on the projection of its' future. Key elements that comprise a TCO are also discussed and concluded. A problem statement and hypothesis are formulated with a flowchart outlining the structure of the study.

1.11.3 Chapter Three – Research Methodology

In this chapter the methodology that is going to be used will be discussed. Both qualitative and quantitative techniques are used. Data collection techniques and instruments together with the population size and sample size defined. Sources of primary and secondary data are also stipulated. The data collection procedure is detailed together with questionnaire pre-testing and reliability and validity testing. The ethical considerations are tabled and adhered to, followed by the qualitative research outline.

1.11.4 Chapter Four – Results of Study

In this chapter the research question and investigative questions are discussed. Data is modelled and correlate using different techniques to infer intelligence and trends. Where possible conclusive findings are drawn based on the data modelling. All elements of the total cost of ownership (TCO) are identified and

utilised to cost the thin-client and fat-client environments. Based on this the hypothesis and null-hypothesis is tested.

1.11.5 Chapter Five – Recommendations and Conclusion

In this chapter a recommended strategic direction is provided to National Ship Chandlers for the desktop computing environment. This chapter concludes by emphasising the benefits and space where thin-client technologies can be adopted within industry.

1.12 Conclusion

This chapter provided an overview of the National Ship Chandlers desktop computing environment and the challenges they are confronted with. The definitions of the technologies are discussed, including elements that should comprise a total cost of ownership. Objectives of the study and limitations were explicitly outlined. A brief research methodology is also presented and concluded with the proposed structure of the study. The next chapter provides a literature review outlining the compelling evidence for and against thin-client technologies. It also cites elements that may contribute to comprising a total cost of ownership calculation for a thin-client environment.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

Enterprise thin-clients can offer organisations an opportunity to achieve two seemingly contradictory goals: improving security while lowering IT costs. Thin-clients are diskless desktop devices that rely on a centralised server for their computing power. In contrast with a typical PC that may download applications via a client/server environment, thin-clients are fully dependent on servers: all data and applications are stored on servers.

These systems have been touted for years as a low-cost means of enabling certain sectors of employees to work more effectively and efficiently. Thin-clients have enjoyed strong annual growth but have yet to catch on in large numbers. However, IDC foresees accelerated growth for thin-clients. Shipments will increase from 1.3 million worldwide in 2002 to 3.4 million in 2007, with compound annual growth rates (CAGRs) of 22.8% for units and 12.2% for revenue between 2003 and 2007. During this period, sales will double in the United States and more than triple in Europe and Asia (International Data Corporation Report, 2004).

According to the IDC (2004) this growth will be largely based on the ability of thin-clients to help guarantee security by plugging many of the security holes created by PCs: user error, viruses residing on hard drives, and nonstandard security features across different machines. Because thin-clients by definition centralise computing processes and decision making, they make it easier for IT departments to control security standards. Employees worry less about making mistakes that could compromise security. Thin-clients even carry a lower risk of theft because they are useless when disconnected from the network.

Enterprise thin-clients also provide financial advantages. Some of these relate to the hardware itself, with a lower acquisition cost per machine and lower overall maintenance costs. Central control also provides financial advantages by helping maintain standardisation and lowering the cost of software updates (O'Donnell, 2002).

O'Donnell (2002) furthermore indicates that the combination of security and price is driving the popularity of thin-clients in security-conscious organisations. Meanwhile, improvements in related server-centric technologies have made thin-clients viable to a wider variety of users. Important upgrades include a more PC-like experience, Web services, and wireless networks.

Organisations worldwide depend on information technology to enhance operations, provide global information connectivity and ensure serviceability to their customers which is paramount to sustaining and growing their business. Nearly every type of operational or administrative activity uses information technology in some manner. The proliferation of information technology has spread to the point where organisations in many instances now have nearly as many desktop personal computers (PCs) as it does staff.

The architecture that supports the majority of these organisation's processing is based roughly on a 1990 defined distributed processing model in which user PCs perform the vast majority of actual computing. The supporting computer network infrastructure enables information transfer and access to centrally managed databases and software applications. However, by financial necessity, this architectural model has been implemented in a distributed fashion. That is, departments and functional units within organisations have independently procured and installed their own computer networks, often with divergent and incompatible systems. The net result is a distributed, diverse and PC-laden architecture that is costly to procure, maintain, and secure (Mulders, 2002).

Many organisations moved to the distributed processing architecture approximately twelve to sixteen years ago because the old main-frame/terminal paradigm was unable to sustain desired operational capacity and flexibility. Furthermore, the distributed processing model was less difficult to implement and operate in the geographically and organisationally distributed environments. However, recent advances in bandwidth and processor capability have facilitated the re-emergence of more centralised processing models. At the forefront is a model that replaces the individual PCs with a 'thin-client' which itself does not perform any processing nor hold data. Instead, processing and data are shifted to a more centralised computer server. The potential advantages offered by the thin-client model include considerably lower personnel and equipment costs, improved information protection, and better system management and standardisation. Consequently, thin-client technology offers a very compelling alternative to the current distributed processing architecture.

Mulders, (2002) further expresses that organisations are continually searching for better ways to manage their information technology investments and to ensure that they remain relevant and affordable into the future. Because thin-client technology offers a promising enhancement to vast, distributed, divergent and costly computer systems, organisations

should adopt a thin-client model to improve the performance, security, and efficiency of its information technology architecture.

2.2 Importance of Research Area

In September of 2001, Gartner Research International published a decision framework document on a comparative analysis for the TCO between a thin-client and a fat-client. Their analysis revealed that organisations deploying thin-clients should not expect substantial TCOs unless they employ best practices on desktop management and migration (Lowber, 2001).

Most enterprises deploy thin-client applications primarily to reduce their total cost of ownership (TCO) by centralising software applications on servers. Gartner's TCO analysis for thin-client desktop deployment shows that the real TCO benefit depends on the extent to which best practices of managing fat-client PCs are adopted, as well as on the migration costs for moving to thin-client deployment. Because a minority of enterprises employ best practices for managing fat-client PCs, thin-client deployment for targeted desktop users, as well as for targeted applications, will offer substantial savings to most enterprises.

It is therefore significant that the comparison between the TCO of thin-client versus fat-clients are properly contextualised within an organization, derived from the business and IT strategy. Unless best practices of desktop management and migration are employed the TCO hailed for the past decade could never be realised.

At the end of this study a full analysis of all outsource costs will be analysed for both a thin-client outsource and a fat-client outsource. The costs of each will then be compared. Furthermore through literature surveys conducted in the next section on factors influencing a thin-client TCO are analysed. These factors identified will be used to establish additional costs that may normally be overlooked during the costing of the outsourced environment.

2.3 Thin-client Solutions

The client/server model replaced the mainframe/terminal model in part because the latter was not able to keep up with user demands for greater computing power and flexibility. Until recently, the benefits realised by a distributed processing architecture out-weighed the advantages of a more centralised architecture. However, advances in both processing and

communications bandwidth technologies now favour a centralised processing model and have prompted an industry-wide re-examination of the current distributed PC-dominated client/server model (Williams, 2001).

These advances have not fostered a return to the old mainframe per se, but do signal an evolution that capitalises on the strengths of both the centralised mainframe/terminal and distributed client/server paradigms. One of the most rapidly growing implementations of this new way of thinking is called ‘thin-client’ architecture (Mulders, 2002).

A *thin-client* is defined as a “processing client in a client/server environment that performs very little data processing. The *client* processes only keyboard input and screen output, and all application processing is done in the server.” (Techencyclopedia, 2001).

Additionally, data is also stored on the server instead of the thin-client, and the lack of a floppy disk drive is usually one way to identify a thin-client device.

The thin-client concept is in clear contrast to the current desktop architectures, which involves PC ‘thick’ or ‘fat-clients’, however, thin-client technology is still normally implemented using the very same three-tier client/server architecture. The major difference lies in the client itself, and it is the removal of processing and data storage from the end-user device that is both the essence and the power of thin-client architecture.

According to Carr (1999), the variations on the thin-client theme are growing, but there are two fundamental thin-client trends that dominate the market today. The first is the ‘traditional thin-client’ which is analogous to the mainframe/terminal paradigm: desktop applications are shifted back to central servers, and the end-user device gains access to the server through a normal network connection such as that which permeates most organisation’s architectures. Products are now available which host most Windows-compatible desktop applications on a server and provide the user with an operating environment that is indistinguishable from the localised PC experience.

Consequently, a user can have a thin-client end-user device that has the same ‘look and feel’ as the previous fat-client.

The second and more recent trend, called ‘web-enabled thin-client’, uses Internet tailored applications provided by an Application Service Provider (ASP) (Kleaveland, 2000). In this case, applications reside on a server that is connected to the Internet and users require only a standard browser to gain access to them.

2.4 Motivates and Factors Contributing to a Thin-client TCO Analysis

2.4.1 TCO Benefit

According to Gartner, the overall TCO benefit for thin-clients over well-managed PCs is only about 1 percent, but it is about 32 percent compared with unmanaged PCs. Well-managed PCs are typically locked down (i.e., the users cannot install their own software), possess a suite of management tools (i.e., software distribution, remote control, inventory) and are maintained through an active asset management process. Thin-client deployment also offers a quick return on investment, with a payback period of three months for thin-clients compared with unmanaged PCs, and eight months compared with managed PCs.

The analysis was performed using Gartner’s (2001) TI² (“TI squared”) software, with assumptions based on 2,500 desktops and 35 servers accessed by users from a central site and from two remote sites. The overall annual TCO was:

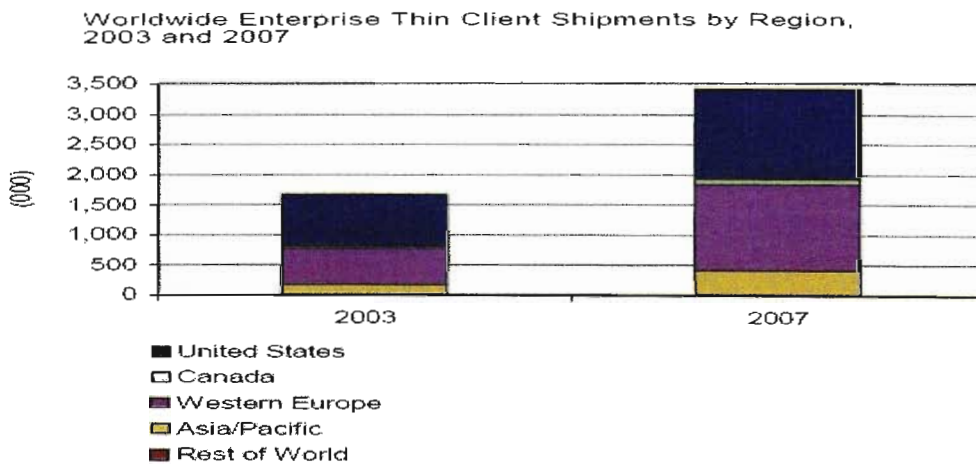
- \$12.9/R100.8 million (or \$5,160/R40,351 per user) for thin-clients (Windows Terminals), \$13.4/R104.8 million (or \$5,360/R41,915 per user) for “fat managed” Windows 2000 PCs
- \$17.1/R133.7 million (or \$6,840/R53, 489 per user) for “fat unmanaged” Windows 2000 PCs.

The above Gartner study does not cover aspects of user training, hardware maintenance and support costs, and number of personnel utilised to support thin-client platform versus fat-client platform. Figure 2.1 below depicts a saving per annum of R14.4 million per annum utilising a thin-client versus the average managed fat-client. This results in a saving of R7, 351 saving per client when utilising thin-clients! This study will undertake to model a TCO for both thin-clients and fat-clients in a totally managed outsourced environment for National Ship Chandlers South Africa.

Gartner Research September 2001	Thin-Clients	Managed Fat-Clients	Unmanaged Fat-Clients	Average between managed & unmanaged Fat-Clients	Savings using Thin-Clients vs. TCO costs of Fat-Clients on Average
Total Cost of Ownership on 2500 clients, 35 servers, centralised applications, 2 remote sites – Per Annum	R 100.8 Million	R 104.8 Million	R 133.7 Million	R 119.2 Million	R 14.4 Million
Per User / Annum	R 40,351	R 41,915	R 53,489	R 47,702	R 7,351 Per User
\$1.00 US – R 7.00					

Figure 2.1: TCO of Thin-Client versus Fat-Client - Source: Gartner Research, 2002

In 2003 the International Data Corporation (IDC) reported that worldwide shipments of thin-clients would exceed 200% by 2007 as per Figure 2.2. Gartner on the other hand report that a mere 1% saving will be realised if fat-clients are properly managed. This would suggest that many organisations would not purchase thin-clients due to the lack of cost savings Gartner predict, which is contrary to IDC projections. This study will attempt to qualify these contradictions within the context of the case study at National Ship Chandlers.



Source: IDC, 2003

Figure 2.2: Thin-Clients Projections Worldwide from 2003 to 2007 – Source: IDC Report, 2004

“Sales will begin to grow more quickly as companies look at how to gain more for their IT dollars. This is also an opportune time to consider clients

because many companies currently need to replace large numbers of machines as part of a long-overdue PC refresh cycle. Finally, many companies are adopting thin-clients as part of integrated solutions, such as kiosks, carts, or wireless deployments.” (International Data Corporation Report, 2004)

As IT software matures over years so does managing ones IT infrastructure and therefore today IT systems should be extremely efficiently managed. To eliminate the criteria of an inefficiently managed thin-client environment a total managed, outsourced desktop environment will be costed for fat-clients and similarly for thin-clients. This will eliminate the possibility of comparing an unmanaged fat-client environment to a thin-client.

2.4.2 Network Bandwidth Impact on TCO

According to Christiansen, Schauser and Munke (2004), a lower total cost of ownership, ubiquitous access from anywhere, and advances in network technology have lead to a paradigm shift from client/server architecture to thin-client computing. For interactive logins, end-to-end latency is the paramount performance criterion. Furthermore, applications and the thin-client server compete for resources, and the available resources are continuously changing. Therefore bandwidth implications and costs of thin-clients versus fat-clients have to be carefully tracked as this would directly impact the Total Cost of Ownership. According to Citrix Systems their thin-client computing technology requires a minimum of 8Kbps (kilo bits per second) for operation (Christiansen, Schauser and Munke, 2004).

2.4.3 Operation of Thin-Client Computing (TCC) / Server Based Computing (SBC)

Many in IT considered the thin-client or network computer a terminal with neither a hard disk nor locally installed software that uses only network resources. This was considered a solution to all the problems associated with the traditional client-server model. However, commercial requirements and realities have revealed that professional applications are not always compatible with a Web-based mode. For example, certain applications required the transmission of huge amounts of data between server and client, and cannot be redesigned for a Web-based mode. For this and other reasons, many businesses chose not to redevelop their applications and continue to use the traditional client-server model (Volchkov, 2002).

Now, however, there is a middle ground between an immediate Web-based, thin-client solution and traditional client-server. This hybrid solution runs traditional client applications on terminal servers that transmit only the screen image to the remote user, reducing network traffic, avoiding installation of client software on a remote workstation, and facilitating administration and deployment. Thin-client computing (TCC) technology is making IT personnel take a second look at client-server alternatives.

Volchkov, (2002) views Citrix as one of the pioneers in TCC. In 1995, it modified Windows NT 3.5 to make it multi-user and capable of supporting thin-clients on special terminals (Windows based terminals such as those from Wyse and Televideo). The company called the commercial product WinFrame. On 12 May 1997, Microsoft and Citrix signed a joint development and marketing agreement, under which Microsoft could use Citrix technology. This agreement became the basis for the multi-user server in Microsoft's Windows NT 4.0 Terminal Server Edition. It will also form the basis of any future development of multi-user systems for Windows NT 4.0, Windows 2003 Server, and beyond.

Citrix currently uses the Windows 2003 Server multi-user system and developed its own independent computing architecture (ICA) for reproducing the user interface on a separate terminal. This architecture only transfers mouse clicks, characters typed on the keyboard, and screen refreshments over the network, reducing Citrix's Independent Computing Architecture (ICA) bandwidth use to less than 20 Kbits/s. Citrix also provides numerous tools for resource, user and access management. Microsoft also developed its own remote desktop protocol (RDP) for connecting Windows clients to the terminal server. ICA supports Macintosh, Unix, Linux, OS/2 and Java clients or browsers that use Netscape plug-ins or Active X for MS Explorer. RDP supports Windows 32-bit clients. Despite Microsoft's presence in the SBC market, Citrix's technology complements that of the software giant and provides several additional functions. The two companies have ongoing strategic alliances. Figure 2.3 depicts operations of Thin-Client Computing (TCC), also referred to as Server Based Computing (SBC).

Thin-Client Computing / Server Based Computing

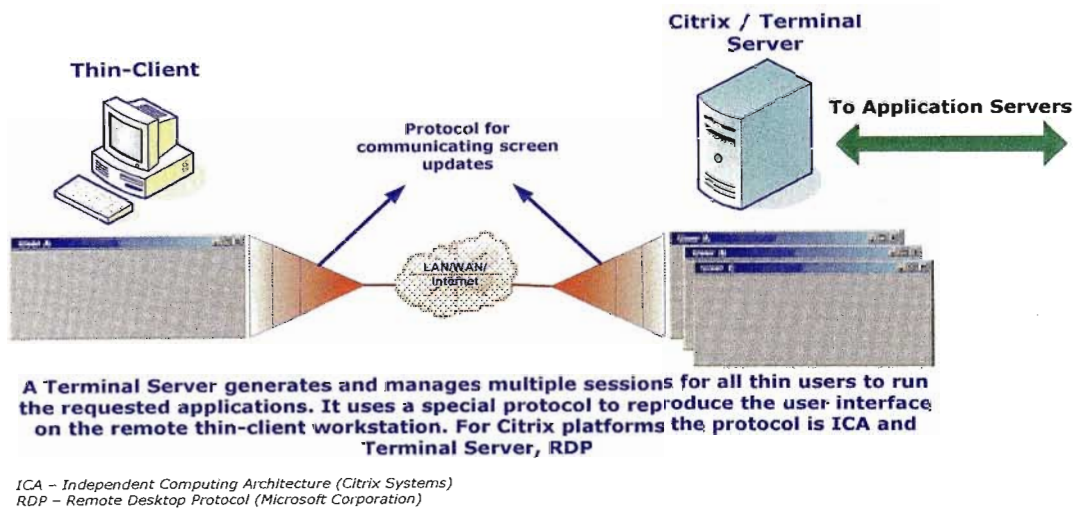


Figure 2.3: Thin-Client Computing or Server Based Computing Architecture – Source: Volchkov, 2002

The latest market surveys show that TCC will continue to expand, despite increased generalisation of Web-based applications. According to analysts, demand for TCC technology in the Windows environment will continue over the next several years, but Web technology will supplant it in the long term. The Giga Group forecasts that the TCC market will grow over the next five years, representing a viable alternative to Web-based computing (Friedlander, 2002).

TCC technology has disadvantages also, among the most important are that the terminal server represents a single point of failure. TCC is not very suitable for deploying small business applications requiring local country or language support. Applications (particularly graphic-intensive ones) can also experience performance problems or become unavailable because of network problems, heavy printing demands, and large file transfers over low-bandwidth connections. The principal advantages are reduced maintenance and support for client terminals, a standardised corporate client terminal, and centralised resources management. All of these in turn make it easier to support increased employee mobility and the deployment of heavy client-server applications at remote locations or subsidiaries because of less bandwidth usage. TCC lets applications work with incompatible terminals. For example, TCC can let OS/2 terminals run Windows applications (Volchkov, 2002).

2.4.4 Thin-client Management

TCC infrastructure facilitates centralised corporate management by allowing system administrators to impose standard software configurations and control access privileges. Centralised control reduces the travel of administrators to various business locations and gives users a standard, updated version of applications. Citrix gives system administrators tools for centralised application management, automatic ICA client updating, license management, and load balancing. A tool for application installation and publication reproduces applications across server clusters. The ICA data stream uses RSA (Rivest-Shamir-Adleman) encryption to protect information. Users can have access on local and remote resources to print locally, copy and paste between local and remote applications, map COM ports and access local peripherals (Volchkov, 2002).

2.4.5 Mobility

Many businesses consider mobility a conspicuous strategic advantage. However, traditional mobility solutions carry significant risks directly associated with the difficulty of managing laptops. It is difficult to keep software and antivirus protection up to date, maintain adequate levels of local data protection, and provide user training. According to the Giga Group, the trend toward mobility is strong. More than 10 percent of users are working outside the LAN for more than 50 percent of their working time. So the question for IT departments is how to offer good mobile service while minimising maintenance problems. Because TCC eliminates installation of software at the client and supports all client terminals, it can help companies become more mobile. When traveling, a user can log onto the corporate server from a laptop and start an ICA session after establishing a VPN (Virtual Private Network) connection. The user can then work with all applications just as if he or she was in the office. TCC technology allows the user to connect to any type of network (dial-up, Internet, or extranet), access a portal (Citrix Portal), and use a VPN (a corporate VPN or the Citrix Extranet product) (Volchkov, 2002).

A user who travels to a different company location can use any available terminal or a dedicated one; both are usually connected to a WAN (wide-area network). A standardised identifier, usually in the “visitor” or “guest” category, provides network

authentication. The user then logs onto a TCC remote system for mobility with his usual internal identifier and has access to all of his applications.

2.4.6 The Incompatibility Hurdle

Some companies that have invested in OS/2[®] or Macintosh client terminals can run Microsoft, Unix, and Java[®] client-server applications on these terminals by using SBC technology. Citrix, for example, supplies client ICAs for different categories of clients, including those running OS/2, Mac OS, Linux, Windows/CE, and Java. The SBC approach can optimise investment and extend client terminal life (Volchkov, 2002).

2.4.7 Cutting Costs of Thin-Client Computing (TCC)

Optimising maintenance and the rapid deployment of client-server applications are the primary benefits of using TCC technology. According to the Giga Group, no significant saving in license costs is evident. In contrast, a longer client terminal life and removing local application servers can compensate for server costs.

In addition to license purchases for the system itself (MetaFrame or Windows 2003 Server Edition) and some number of client access licenses (CALs), a company must purchase Terminal-Server CALs, unless the client terminals are running under Windows 2003. Microsoft has implemented a complex system to ensure compliance with these rules.

Calculating return on investment requires understanding all the potential benefits, such as those for administration, mobility, improved performance, use of existing communications lines, and client terminal life. According to Giga, TCC technology can reduce costs by 20 percent per terminal and calls to help desks by 30 to 60 percent (Volchkov, 2002).

2.4.8 Architecture and Dimensioning

According to Volchkov (2002), before deploying TCC technology a company must establish future system architecture and dimension resources (number of servers, their locations and communication line capacities), according to projected system growth. There are two examples from opposite ends of the business spectrum:

- a company with small branches nearby and centralised data processing will choose architecture with centralised terminal-servers;
- a business with decentralised data processing that has developed dispersed departmental applications will choose decentralised terminal-server architecture.

In either case, the terminal servers must be near the application servers. Communication line bandwidth also plays an important part, even if the thin-client protocol uses little bandwidth. Multiple channels must be open for concurrent users.

Testing requires using the appropriate applications under actual usage conditions (if possible), not only to confirm feasibility but also to measure bandwidth for determining future system dimensions and architecture. At Pictet (a Geneva-based private bank), Volchkov's tests using Citrix showed that executing Adobe Acrobat and Microsoft PowerPoint applications over the ICA protocol take up significant bandwidth for large files containing a lot of color and graphics (Volchkov, 2002).

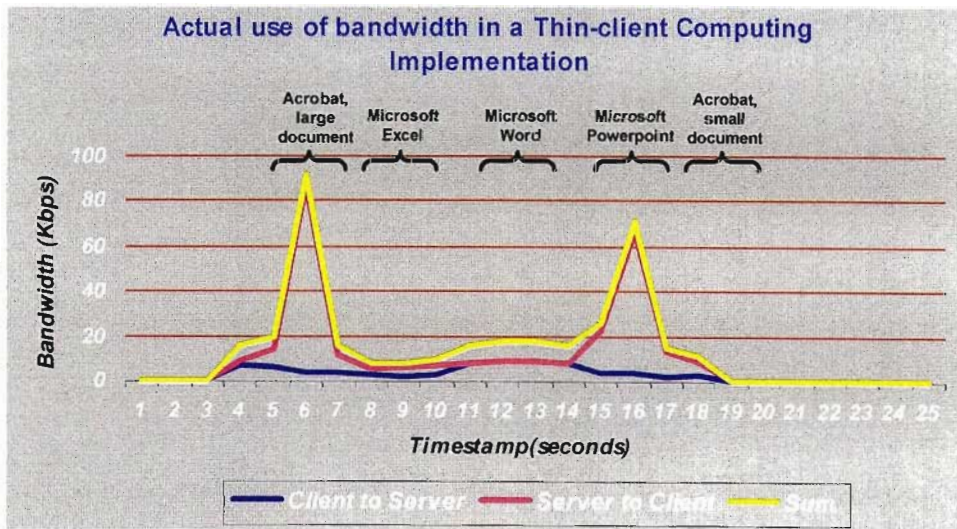


Figure 2.4: Bandwidth Usages in Thin-client Computing – Source: Volchkov, 2002

Figure 2.4 shows, for example, the bandwidth consumption over time during the execution of various, common programs to simulate the work of a single user over a 256Kbps WAN (wide area network).

Testing covered the following five cases:

- *Acrobat*, large document. Load a greater than 40 Mbyte document, scroll, close it, and minimise Acrobat.
- *Excel*. Create a document with a graph, save it, close it, and minimise Excel.
- *Word*. Create a document, save it, close it, and minimise Word.
- *PowerPoint*. Load a large (greater than 12 Mbyte) document, scroll, close it, and minimise PowerPoint.
- *Acrobat*, small document. Load a less than 500 Kbyte document, scroll, close it, and minimise Acrobat.

Based on the tests, Volchkov (2002) decided to first deploy Citrix technology to allow mobile users to work from remote locations. The next step was the deployment of heavy client-server applications in branch offices to reduce the number of local servers or bandwidth usage with client-server applications over the WAN. TCC technology is mature and presents many opportunities for IT departments. It is a viable alternative to the all-Web model, allowing the deployment of traditional client-server applications over the Internet and WANs while reducing maintenance and support costs. After the e-business and all Web trend, companies are seeking ways to consolidate their infrastructures and optimise the usage of their application assets. TCC can be of great help to achieve this goal.

2.4.9 Attractiveness of Thin-Client Computing

According to Tolia, Andersen and Satyanarayan (2006), two distinct factors motivate interest in thin-clients. The first is concentration of personal computing into central server farms. In large organisations, the physical dispersion of personal computing hardware complicates system administration. Isolating an infected machine, forcing certain security upgrades, or restarting a crashed machine are examples of actions that typically require physical access to the hardware. Concentrating all computing in centralised server farms simplifies this physical access. Rather than walking from machine to machine, access is available at the system administrator's fingertips in a server room.

These considerations are especially relevant at enterprise scale, where the total cost of ownership of personal computers is of growing concern. As hardware costs plummet, an increasing fraction of the total lifetime cost of owning a personal computer goes to its ongoing maintenance rather than to its initial purchase. Thin-clients offer the possibility that concentration of state will lead to reduced total cost of ownership.

The second reason according to Tolia, Andersen and Satyanarayan (2006), for interest in thin-clients is user mobility. A user can authenticate at any thin-client and have immediate access to a unique computing environment. This thin-client anonymity harkens back to timesharing, where a user could log in at any dumb terminal. It enhances collaboration and spontaneity and simplifies the logistics of hardware deployment.

“What performance goals should thin-client computing strive for so that users will embrace it? The most critical performance measure is the crispness of interactive response. For example, when a user presses a mouse button, she expects the popup menu to appear with no perceptible delay; in freehand drawing, she expects the onscreen curve to track her mouse movements with no lag; when enlarging or shrinking an object, she expects the onscreen rubber-banding effect to smoothly and precisely track her mouse. This is the standard of interactive performance today, and users are loath to settle for less.”
(Tolia, Andersen and Satyanarayan, 2006)

Over a 40-year period, the HCI (Human Computer Interaction) community has built up a substantial body of knowledge about the impact of interactive response times on user satisfaction and task productivity. Examples of work in this area include those by Guynes (1988), Martin and Corl (1986), Miller (1968), Rushinek and Rushinek (2002), and Shneiderman (1997). From these studies, a broad consensus has emerged on acceptable response times for trivial interactions:

- User productivity is not impacted by response times below 150 milliseconds. This is therefore a good quantitative definition of crisp response.

- In the range from 150 ms (millisecond) to one second, users become increasingly aware of response time. They strongly prefer response times well below one second.
- Above one second, users become unhappy. When forced, users can adapt to response times over one second, but this is accompanied by frustration with the system and a drop in productivity.

Good response time is the key to overall satisfaction with an interactive session. User anxiety is positively correlated with poor response time. Also relevant is the finding from psychology and economics that negative experiences have much greater impact than positive experiences on judgment and risk taking. The implication for thin-clients is that poor response time incidents will be over-weighted in users' memories. Even a few sluggish interactions in an otherwise acceptable interactive session may be sufficient to turn off a user.

According to Tolia, Andersen and Satyanarayanan (2006) user growth, network evolution, and introduction of new applications are common events in the IT infrastructure of any large organisation. An organisation that uses thin-clients must pay careful attention to the network latency and bandwidth impact of such events. This implies greater attention to system management than is apparent from a first glance at thin-client computing. It is not yet known how this will impact the hoped-for reduction in total cost of ownership associated with using thin-clients.

2.4.10 Thin-client Acceptance

Corporate IT departments have complained for years about the endless cycle of software upgrades, the short life cycle of PCs, and high maintenance costs. The problem, say critics, is that the thin-client model is too rigid, that it requires expensive servers, and that most end users insist on local processing and storage. If the network is down, they point out, operations halt. Others point out that market developments have worked against the thin-client (Krikke, 2004).

“The original motivation for the development of thin-clients was to save money on making the hardware,” says Leibson (Krikke, 2004). Furthermore Leibson suggests that thin-clients were supposed to save money by giving companies a cheaper box to

put on workers' desks instead of expensive, US\$5,000 PCs. But the concept ran into trouble because PCs got much cheaper much faster than anyone expected.

According to Krikke (2004), any \$500 PC can act as a thin-client on a desktop, so there's no longer an economic justification for a special desktop box called a thin-client. Leibson also points out that Ethernet has made it easy to link PCs to corporate networks. That's not to say the thin-client model is dead. Millions of people around the world use the stripped-down terminals for computing tasks that don't require powerful PCs. Citrix Systems, the world's leading thin-client solutions provider, claims its flagship product MetaFrame Access Suite has nearly 50 million users in more than 120,000 organisations worldwide. Wyse Technology, the world's number one supplier of thin-clients, has an installed base of over 2 million and reports growing interest in server-centric or server-based computing among corporations, governmental departments, and educational institutions. According to IDC, the overall thin-client market grew 7 percent year-on-year in the second quarter of 2004.

“There's no doubt thin-clients can offer substantial benefits, especially in environments where computing tasks are clearly defined and require little local processing. Thin-clients prevent end users from changing the device's configuration or loading unauthorised software. IT departments can create secure portals and offer remote access to company data. Roaming users don't need to sync data, and no data is lost when a TC is stolen. Unlike PCs, Thin-clients have no floppy drives, fans, or other moving parts, making them highly reliable. The average mean time between failures is about 175,000 hours, compared to 25,000 hours for PCs, according to a Gartner study.” (Krikke, 2004)

Jain (1999) suggests that apart from the cost savings, thin-clients have the additional benefits of low power consumption, reliable fanless operation in dusty regions where fans would suck dirt into the case, and ease of use for non computer-literate users through a customised, server-controlled environment.

Handley (2004) believes that entertainment will be the killer application for thin-client computing. Hotels already use set-top boxes to generate additional revenue by

providing visitors with a video-on-demand system in each room that streams movies from a central server for a small fee. Streaming applications can be extended to IP set-top boxes that operate from the consumer's living room and provide video-on-demand, Internet TV/radio, and even communication services such as VoIP (Voice over IP) and video conferencing from cable TV or broadband Internet service providers.

Furthermore, according to Handley (2004) thin-clients will not replace conventional PCs, but that the thin-client market should grow at a rapid pace. Thin-clients enable a host of applications that are not practical with a PC. This means they present new marketing opportunities and device categories.

2.4.11 Security with Thin-clients

According to O'Donnell (2004), when backed up by robust network security, thin-clients provide security advantages via three avenues: increased centralisation, changes in how the user interacts with the machine and the nature of the hardware itself.

2.4.11.1 Centralisation

The key security improvements from thin-clients come via centralisation. When security procedures are administered centrally, companies can achieve improvements around:

- **Updates.** Organisations can more easily make sure they have the latest security features on every desktop. Keeping up with what software resides on hundreds of individual hard drives is a complex task. Many security problems occur when machines are attacked by viruses or other elements for which there are already well-known defenses. Many companies rely on users to install bug fixes sent by IT. This approach can result in unprotected PCs and an overall lack of continuity among the security software installed on different machines.
- **Monitoring and automation.** In the PC client/server world, IT departments strive to have a full view of the security environment, with an eye on spotting and handling virus infections, security issues, and

other problems the moment they happen. Another goal is to automate security tasks as a way to save money and improve response times. Thin-clients allow IT to more easily set up these security procedures across all user machines.

- **Network security.** Thin-clients allow companies to deal with all security as *network* security, with less worry about the desktop environment. Viruses are typically unable to reside on these solid-state machines. In the PC world, networks can be repeatedly re-infected by viruses that lurk on employee hard drives.

2.4.11.2 User Interaction

Many security breaches come through user error e.g. accidentally sending sensitive email, opening spam, and visiting unauthorised Web sites. Thin-clients allow organisations to better control these activities. For instance, content management tools can be easily applied to all thin-client users. Central backup and control of data can help ensure that employees do not make common mistakes that can allow intrusions or cause data loss (O'Donnell, 2004).

2.4.11.3 Hardware Differences

Thin-clients are generally not worth stealing because they do not function when disconnected from a central server. Furthermore, they do not have hard drives that can hold sensitive data. These features contrast sharply with the value proposition of notebook computers, which are the fastest growing end-user computer type in corporations. Notebooks take a sensitive hard drive and make it mobile and thus easy to steal and hard to recover. While notebooks are ideal for certain groups of users i.e. mainly those for whom mobility is a top priority, companies should be careful about getting on the bandwagon to a full changeover to notebooks. Thin-clients can be ideal for many workers and, in the era of wireless networks, are not necessarily impediments to mobility within a workplace (O'Donnell, 2004).

2.5 Advantages of a Thin-client Solution

Within current literature, the most often-cited benefit of thin-client architecture is its greater fiscal and operational efficiency when compared to PC-based architecture. Because of improved system control, “centralised deployment and management with a thin-client solution can offer significant advantages, including reduced hardware expenses, lower total cost of ownership, simplified network administration, and increased end user productivity.” (Zurovitch, 2000).

The costly PC upgrade cycle can be broken since most software and hardware upgrades will now take place at the server, and it is considerably more economical to upgrade servers than PCs (Zurovitch, 2000).

While thin-client devices will need occasional maintenance or replacement, the frequency of this activity will be considerably less than with PCs given their relative simplicity. Secondly, system managers will expend considerably less effort configuring, maintaining, and upgrading user workstations because nearly all changes will occur in one place, that is, at the server. Improved network management and control implies decreased personnel overhead costs, improved system reliability, and enhanced operational effectiveness. These factors combine to reduce the thin-client total cost of ownership and improve capability, making thin-client architecture advantageous for many user environments. The cost, control and productivity benefits of thin-client architecture have also been noticed in the business world. A recent Computerworld survey found that 35% of today’s businesses are already using thin-clients in one form or another (Goldsborough, 2002).

The potential for significant cost reduction alone is very persuasive. Therefore, thin-client architecture can enhance desktop architectures because it directly addresses the previously mentioned problems of costly PC life cycle upgrades and system management overhead.

The next significant advantage of thin over fat-clients is that the former are more reliable at the local level simply because they are not as complex and are less subject to user tampering (Williams, 2001).

Additionally, with centralised file storage and automatic file backup, loss of data files due to local hard-drive crashes are rendered impossible. Improved end-user device reliability is a compelling advantage. Another key strength of the thin-client architecture is that the server-

focused configuration is able to bring together heterogeneous operating systems including Unix, Windows, Macintosh, and other thin-client operating systems.

In effect, previously incompatible systems can be integrated at the server. This built-in flexibility can be applied across organisations to improve interoperability and assist with the integration of legacy systems. An added benefit of integration is that fewer desktops will be required because legacy systems will be combined at the server, and the end user will require only one device to interface with previously separate systems. This ability to integrate diverse systems is one of the main reasons why the Bank of Nova Scotia commenced a national thin-client project (Sun Microsystems, 1999).

Morgan (2001) suggests that the greatest operational advantage provided by thin-client architecture is improved information security. Malicious attacks on computer networks and systems are on the rise, and computer viruses are becoming more powerful and causing greater damage.

Limitations in the current architecture require aggressive anti-virus suites and separate processing domains to reduce the threat of information compromise. Thin-client architecture can improve this situation in two ways. First, because data is shifted from the end-user device to a server, the opportunity for information compromise is eliminated at the desktop. Since there are far fewer servers than workstations that require protection, the task of safeguarding information against attack becomes exponentially simpler and less costly (McDougall, 2000).

Furthermore, virus eradication is a far easier task when only servers must be cleansed in comparison to the far more numerous PCs. Recent research also shows promising advances in technology that will allow “data to be moved between computer domains that have different sensitivities.” (Hankins, 1999).

Such a technology, effective only within server-centric thin-client architecture, could merge organisation’s separate computer domains and provide a seamless interface at the user’s desktop.

Even if the other compelling advantages of thin-client architecture are discounted, the potential information protection benefits alone justify thin-client implementation within any organisation.

Thin-client architecture strengths include increased cost-effectiveness, reliability, interoperability, and security. These benefits are recognised in the business environment, and

the adoption of thin-client technology is such that the Gartner Group, a leading information systems consulting agency, predicts that “30% of all desktop computers will be thin-clients by 2003.” (McDougall, 2000).

According to Zurovitch (2000), not only can organisations realise significant total cost of ownership reduction through consolidated maintenance and centralised support for existing users, but they can also easily extend access to critical legacy data and applications to new groups of local and remote users.

The application of thin-client technology to desktop architecture can produce similar results. Moreover, while the aforementioned thin-client architecture weaknesses of flexibility, capability, and survivability are reasonable, they can be mitigated through careful application and configuration of thin-client solutions. Consequently, thin-client technology can improve operational capability in current desktop architectures while potentially saving considerable personnel and equipment resources. Overall, thin-client architecture offers a very promising improvement to existing desktop architectures.

2.6 Disadvantages of a Thin-client Solution

One of the greatest disadvantages of the thin-client architecture is that it does not provide substantial user computing flexibility. This is because user-level customisation and individual PC and peripheral modifications cannot be made to support a wide variety of functions and processes. Conversely, the fat-client model provides data storage and processing from the user, effectively increasing flexibility at the local level. Furthermore, the existence of many different and often incompatible systems across many organisations clearly implies that a single information technology solution such as the thin-client model cannot fit all situations.

As it is potentially less flexible, thin-client architecture need not, and probably should not, be applied as an all-encompassing solution. Thin-client systems can be modularised and compartmentalised for groups of users with similar needs and expectations. Generally homogeneous information system requirements are prime candidates for thin-client implementation, as most users in departments or functional structures perform similar processing tasks on the same software. With the availability of both traditional and web-enabled thin-clients, system designers have even greater flexibility to tailor a thin-client implementation for a given requirement (Mulders, 2002).

However, in choosing where and how to apply a thin-client solution Mulders (2002) suggests, “It is crucial to gain a thorough understanding of the various types of users, including their individual requirements and expectations to whom access will be provided.” Nevertheless, with careful selection and application, thin-client architecture can be flexible enough to meet many organisations’ diverse needs.

Thin-client architecture’s axiomatic requirement for relatively greater bandwidth and processor power creates another potential weakness. This is because a thin-client implementation requires an enhanced infrastructure relative to a similar fat-client implementation. However, recent telecommunications bandwidth offerings have provided high-speed data access to nearly every desktop, creating the potential for a high-bandwidth environment. Also simply adding more servers can increase computer server processing power. So neither bandwidth nor servers within organisations necessarily limit the capability of thin-client architecture. This conclusion is supported by initial test results at the Canadian Forces College which indicate that thin-client architecture performs better in many respects than did the previous fat-client system. Furthermore, the information manager of a large Asian telecommunications provider also found that his thin-client implementation performed at least as well with his Microsoft Office applications as it did when he was using current-generation PCs, and found that performance for non-Microsoft applications was exceptional. Thus, while processor power and bandwidth are valid thin-client concerns, they can be mitigated in the many organisations’ environments (Castonguay, 2001).

Operational and business systems rely heavily on information technology, the latter’s survivability and reliability is paramount. One of the greatest strengths of the current architecture is that a network or server failure does not necessarily shutdown the user because he is still able to function somewhat autonomously on his PC. With thin-client architecture, the failure of either a server or network will immediately terminate service and it is these potential limitations in survivability and reliability that cause considerable operational concern (Bernier, 2001).

While system survivability concerns are valid, installing redundant, fault-tolerant servers that automatically switch users and carry on existent work sessions can mitigate the crashed-server risk. Furthermore, in today’s increasingly integrated information environment, a fat-client network failure is nearly as catastrophic as a thin-client failure because the user will

not, in either case, have access to any distributed functionality such as E-mail, Internet/Intranet, enterprise applications, or data. In one case, the risk can be mitigated, and in the other, the risk differential between fat and thin-client systems is really not so great. As a result, the associated survivability risks can be managed and rationalised. Thin-client system weaknesses include potential shortcomings in flexibility, capability (due to increased demands on bandwidth and processing power), and survivability.

2.7 Motivation for Hypothesis

“The ability to determine some of the costs attributed to a Total Cost of Ownership (TCO) isn't as straightforward as you might imagine. Not only can it be hard to pinpoint precisely how to apportion some easy-to-measure items (the time your purchasing department spends on acquiring desktop PCs and the time your help desk spends sorting out end user issues) but some costs are almost impossible to measure. These grey areas include the cost of downtime, peer-to-peer support and time spent on user-solvable problems. Often enough have TCO models shown that a huge slew of the overall TCO lays in such imponderables, typically around 50 percent, if not higher.” (Masding, 1991).

Due to constant fall in prices of computer hardware and the rise in software licensing, is the TCO for the thin-client environment increased and therefore warrant a move back to a fat-client desktop platform in National Ship Chandlers? All factors contributing to a TCO will be identified, measured and consolidated to provide executive management with a directive for a decision on National Ship Chandler's future desktop platform.

This study will endeavour to answer the following questions:

- What are the variables that contribute to a Total Cost of Ownership (TCO) in National Ship Chandler's desktop environment?
- Using these variables, is the Total Cost of Ownership of a thin-client less than the Total Cost of Ownership of a fat-client (personal computers and laptops) in the National Ship Chandlers desktop environment? This will be tested against a hypothesis and a null-hypothesis.

2.7.1 Hypothesis and Structure of Research Process

This is a draft statement that this study will analyse, experiment, test and conclude. The null hypothesis, alternative hypothesis and other extraneous variable that will be studied are formulated.

Hypothesis: H₁: The Total Cost of Ownership (TCO) of a Thin-client (TC) **IS** **lower/less than** the Total Cost of Ownership (TCO) of a Fat-client (FC) in an outsourced desktop environment.

$$TCO_{TC} < TCO_{FC}$$

Null-Hypothesis: H₀: The Total Cost of Ownership (TCO) of a Thin-client (TC) **IS GREATER** **than** the Total Cost of Ownership (TCO) of a Fat-client (FC) in an outsourced desktop environment.

$$TCO_{TC} > TCO_{FC}$$

Independent Variables: Thin-clients and Fat-clients in an outsourced desktop environment

Dependent Variables: Lower Total Cost of Ownership

Extraneous Variables:

- Purchase price of all hardware and software
- Training costs of new owner of device
- Software application cost change to maintain compatibility
- Maintenance and support costs for keeping the desktop hardware device operational
- Environmental changes required to permit connectivity on the computer network
- Technical support contract(s), personnel and procedure(s) in place for the desktop device
- Information Security
- System Availability and business productivity loss due to unavailability thereof.

This study will endeavor to seek the truth in the thin-client battle against its current rival, the fat-client. Therefore hypotheses H_1 and null-hypothesis H_0 are evaluated and tested within the National Ship Changers outsourced desktop environment.

What follows is a structure of what the dissertation process will be and the following sections provide an overview of what will be covered in the detailed study. Figure 2.5 depicts the rationale of the research approach.

**University of KwaZulu Natal MBA 2006
Dissertation Research Process**

**A Comparative Analysis on the Total Cost of Ownership
Between Thin-clients & Fat-clients in an Outsourced Desktop Environment**

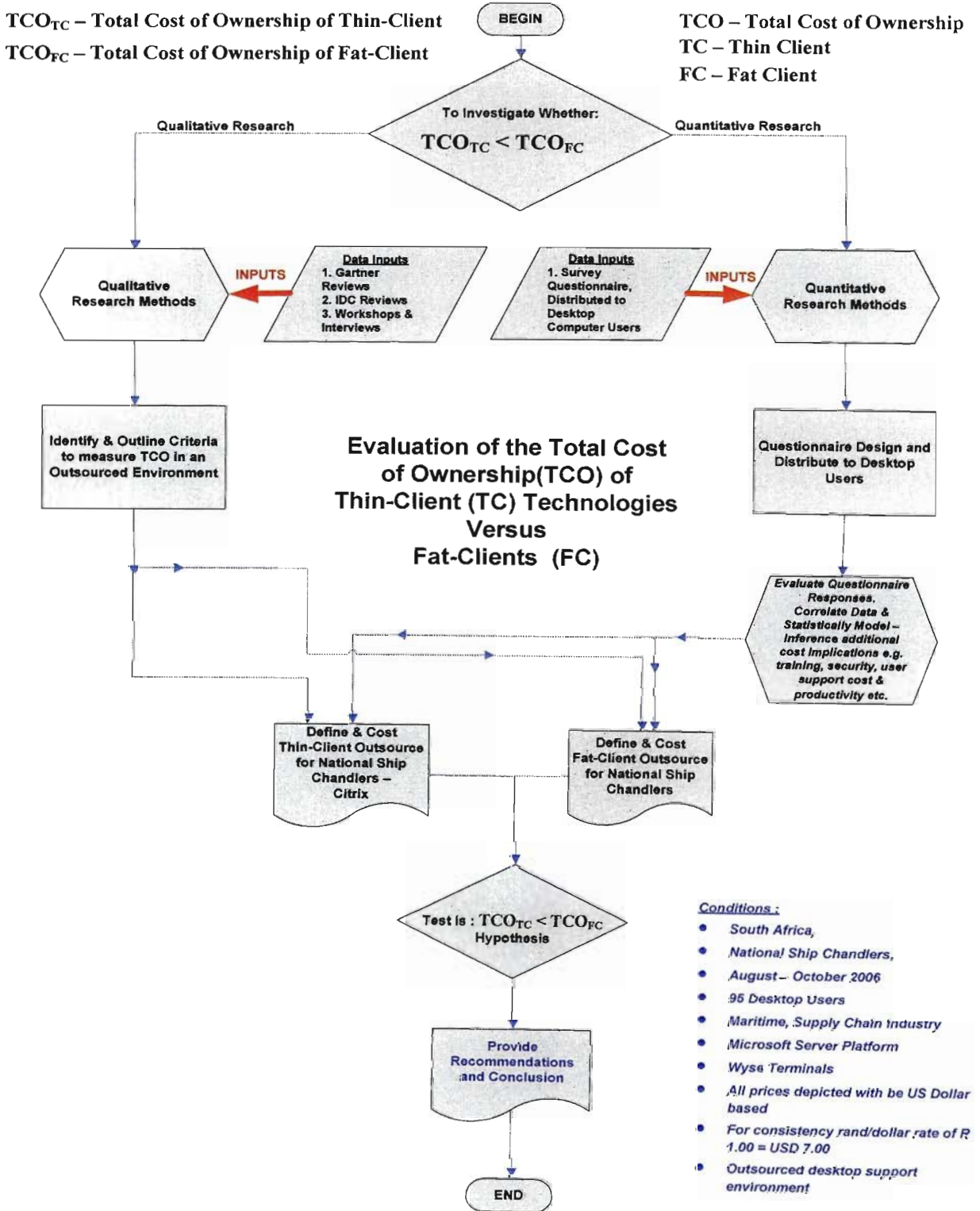


Figure 2.5: Research Approach & Methodology

2.8 Conclusion

Recent advances in processing and bandwidth technologies have prompted an industry-wide re-examination of PC-dominated client/server architecture, and suggest a return to a more centralised processing model (Mulders, 2002). Thin-client architecture, at the forefront of this technological evolution, offers an attractive alternative to the current PC-rich architecture. By transferring processing and data storage from the end-user device to its connected server, thin-client architecture offers many benefits resulting from centralised control and management. Advancements in thin-client technology create systems able to afford users a computing experience with the 'look and feel' of normal PC-based software applications, all the while benefiting from centralised processing and data storage. In effect, the best characteristics of both the mainframe/terminal and client/server models can be realised. These benefits are substantial enough that national corporate and government organisations are even now testing and implementing thin-client solutions.

Potential improvements in cost, management, interoperability and security offered by thin-client architecture are very attractive. Furthermore, the enhanced information protection benefits of thin-client architecture are most compelling. While there are some risks associated with local system flexibility, capacity, and overall system vulnerability, these risks can be reduced or eliminated with the careful selection and configuration of the right thin-client solutions. Hence, thin-client architecture is a logical progression for many organisations' desktop architecture.

When thin-clients first came out several years ago, some vendors tried to sell them using the argument that they cost far less than PCs. Indeed, thin-clients do cost far less on average than PCs, but they also come with fewer components and little or no memory. The real savings come over time in the Total Cost of Ownership (TCO) (O'Donnell, 2002). This includes not only original sales price but, more significantly, lower maintenance costs. Because thin-clients have fewer parts, and often no moving parts, they generate less heat. Therefore, they are less likely to break down. Thin-clients are also generally faster and easier to set up than PCs, even for untrained users in remote offices. Furthermore, systems are entirely interchangeable. A very large part of the cost of replacing PCs is replicating the hard drive so that users can keep their files and applications. With thin-clients, users are associated with a collection of data and applications on a central server that can be accessed from any thin-

client. If the machine on their desk breaks, they can be up and working as quickly as a new one can be plugged in. This capability helps avoid one of the biggest costs in corporate computing, user downtime.

As noted above, thin-clients allow centralised control and upgrades of software. While this manageability is especially important for security software, it is relevant for all types of software (IDC, 2004). Software upgrades can be costly, and problems caused by different employees using different versions of software can be even worse. Thin-clients avoid both of these problems while reducing overall complexity.

Handley (2004) believes that entertainment will be the killer application for thin-client computing. When the use of thin-client technologies in business requires complex additional computing functions that requires more than mere screen and mouse updates, such as multimedia streaming, video-on-demand, voice-over-data or voice recognition, thin-client technologies does not prove a suitable technology.

Thin-clients generally involve far less attention from IT. All computing and software problems are handled remotely, at the server level. This approach allows fewer IT staff to manage more machines across a larger geographical area. Because thin-clients break down less frequently than PCs, IT staffs make far fewer trips to actual machines. Hardware problems can be managed by swapping out machines and then fixing the thin-client at the central IT location or shipping it back to the manufacturer.

The literature review positively supports thin-client computing technologies, outlining the many benefits and great cost savings that could be realised if implemented effectively. Gartner, IDC and other information technology analysts also accept these findings but also express significant reservations on the degree of savings that could be realised. This study undertakes to clarify both the opinions of thin-client users' experiences within the context of National Ship Chandlers in South Africa.

For this study to be effectively undertaken a clearly defined research methodology is required and has to be expedited accordingly. Chapter 3 outlines in detail how both qualitative and quantitative techniques are used.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

It is imperative in any research to establish the design under which the research will be conducted. Research methods refer to tools and techniques used to obtain and analyse data (Saunders *et al.*, 2003). Understanding the research methods employed in this study is paramount because it sets out guidelines which help to obtain answers to the research questions (Cooper & Schindler, 2001).

Based on extensive literature surveys no academic attention has been afforded to Total Cost of Ownership (TCO) of thin-client technology in an outsourced desktop environment. If at all any, little academic research has been awarded to the technology components that constitute the thin-client technologies i.e. types of networks utilised, design of software and server-side technologies. Neither are there any published texts in assisting in merely drafting a model for a Total Cost of Ownership.

This study will utilise both qualitative and quantitative techniques in trying to obtain a conclusion due to the nature of the problem and the intrinsic attributes that contribute to a Total Cost of Ownership.

Qualitative research approaches have traditionally been favoured when the main research objective is to improve our understanding of a phenomenon, especially when this phenomenon is complex and deeply embedded in its context. Its many methodologies and techniques have helped researchers get a better grasp of a variety of management situations. Qualitative research has now grown into a wide domain, having evolved much beyond its original scope of qualitative data collection. However, a consensus has yet to be reached to determine the exact qualitative research boundaries and the main components of a qualitative research design (Lee *et al.*, 1999). There exist few roadmaps with detailed instructions to guide the researcher through this methodological maze. For some researchers, such ambiguity can constitute a source of anxiety.

However, some others will view it as an opportunity for innovation, that is, an opportunity to "break the mould" and conceive a research strategy that will meet the researcher's specific needs and objectives. Understanding a phenomenon that has barely been researched requires a qualitative approach that is both adaptive and innovative.

There is a strong suggestion within the research community that research, both quantitative and qualitative, is best thought of as complementary and should therefore be mixed in research of many kinds. Das (1983) states that:

“...qualitative and quantitative methodologies are not antithetic or divergent, rather they focus on the different dimensions of the same phenomenon. Sometimes, these dimensions may appear to be confluent: but even in these instances, where they apparently diverge, the underlying unity may become visible on deeper penetration ... The situational contingencies and objectives of the researcher would seem to play a decisive role in the design and execution of the study.”

Quantitative techniques will to be utilised to establish cost factors that may significantly contribute to the costing of a TCO for thin-clients, which will be used as inputs into the quantitative analysis. Based on questionnaire responses in the quantitative analysis phase additional cost factors maybe included in the quantitative analysis phase.

In qualitative research, factors such as user training, user communiqué from management (change-management), the user’s adaptability and appropriateness to their environment, end-user support frequency and responsiveness will be explored. These factors will contribute to calculating a TCO for the thin-client environment in an outsourced desktop environment.

3.2 Quantitative Research

Quantitative research methods will be employed to conclude end-user support and responsiveness. In addition training requirements for the current thin-client environment at National Ship Changers will be established. This will be achieved through a questionnaire that will be handed to all users in the Durban office. For users located at the Cape Town, Richards Bay and Port Elizabeth offices the questionnaires will be emailed to the respective regional managers. Management at each of these office locations will leave a copy at reception for users to collect. The researcher will follow-up to all respondents via telephone. These responses will be scanned and emailed to the researcher. There are 95 users scattered across South Africa utilising desktops of which 42 are thin-clients and 53 fat-client.

Results from the questionnaire will assist in identifying and quantifying additional cost factors that would contribute to a higher or lower TCO for thin-clients versus fat-clients in an

outsourced desktop environment. Furthermore the survey will give National Ship Chandlers an understanding of the end-user impact of the migration of fat-clients to the thin-clients in 2002. It will also assist in defining the level of satisfaction on current services received within the thin-client environment. The sample size will be the entire population of 95 due to the small number.

3.2.1 Data Collection Techniques and Instruments

Often data gathered in the social sciences, marketing, medicines, and business, relative to attitudes, emotions, personalities, and descriptions of people's environments involves the use of Likert-type scales. The invention of the Likert scale is attributable to Likert (1932), who describes this technique for the assessments of attitude.

McIver and Carmines (1981) describe the Likert scale as follows, "A set of items, composed of approximately an equal number of favourable and unfavourable statements concerning the attitude object, is given to a group of subjects. They are asked to respond to each statement in terms of their own degree of agreement or disagreement. Typically, they are instructed to select one of five responses: strongly agree, agree neither disagree nor agree, disagree, or strongly disagree. The specific responses to the item are combined so that individuals with the most favourable attitudes have the highest scores while individuals with the least favourable (or unfavourable) attitudes will have the lowest scores. While not all summated scales are created according to Likert's specific procedures, all such scales share the basic logic associated with the Likert scale".

Spector (1992) identified four characteristics, which make a scale a summated rating scale. First, a scale must contain multiple items. The use of summated in the name implies multiple items will be combined or summed.

Secondly, each individual item must measure something, which has an underlying, quantitative measurement continuum. In other words, it measures a property of something, which can vary quantitatively rather than qualitatively. An attitude for example, can vary from being favourable to being very unfavourable.

Thirdly, each item has no “right” answer, which makes the summated rating scale different from a multiple-choice test. Thus, summated rating scales cannot be used to test for knowledge or ability. Finally, each item in a scale is a statement, and respondents are asked to provide a rating for each statement. This involves asking subjects to indicate which of several response choices best reflects their response to the item. The Likert Scale used for the Questionnaire Survey at National Ship Chandlers and data is illustrated in Table 3.1.

Thin-clients: Questions 21-40	Fat-clients: Questions 41-57
Strongly agree	Strongly agree
Agree	Agree
Neither Agree of Disagree	Neither Agree of Disagree
Disagree	Disagree
Strongly disagree	Strongly disagree

Table 3.1: Likert Scale

3.2.2 Population Description and Sample Size

The population to which the survey relates to are employees of National Ship Chandlers that utilise a thin-client, personal computer or laptop. There are in total 95 desktop users of which 42 are thin-clients and 53 fat-clients (PC or laptops). Due to the small population size and the accessibility to respondents the sample size is the total population of 95 users who were censured.

3.2.3 Primary Data

The primary research techniques to be used are questionnaires distributed to all users and in-depth workshops interviews with outsource managers.

In-depth workshops with outsource managers from IBM will culminate in a clearly defined costing model for an outsourced desktop environment for both thin-clients and fat-clients. The costing models will also include real world costs for implementing the required infrastructure for research environment defined. The costs of infrastructure and software licensing will be obtained from local suppliers and

attached. This includes telecommunications costs. Service provisioning costs will also be incorporated with interviews with IBM engineers.

The costing models will be analysed in detail with industry best-practices and contrasted against each other. The costs for the thin-clients and fat-clients will be tested against the hypothesis and null-hypothesis.

3.2.4 Secondary Data

Secondary data employed in this study includes journal articles, research papers presented on thin-client technologies and white papers from the internet. Little academic research has been undertaken on the Total Cost of Ownership impact on thin-client environments versus fat-clients in an outsourced desktop environment. Although there have been many business research publications that cover specific aspects of the topic.

3.2.5 Other Supplementary Primary Data Techniques

Direct and personal observation techniques shall also be used during the course of interviews to supplement the primary and secondary data. Since IBM is the researcher's workplace, it will be easy to discuss with outsource managers about particular issues regarding the costing of the desktop environments.

3.2.6 Data Collection Procedure

The study commenced with an authorisation letter from Graduate School of Business, University of KwaZulu-Natal that was presented to National Ship Changers management to grant the researcher permission and access to conduct the research.

Questionnaires were handed out to all workstation users (Laptop, PC and thin-client) at National Ship Changers. Structured and open-ended questions were asked to allow respondents to give their opinions. The researcher ensured that the questions were clear, brief, specific and not biased. Respondents were communicated as to when the questionnaire responses were required by. The responses were also retrieved by the researcher collecting them from respondents at the Durban site. For Cape Town, Richards Bay and Port Elizabeth sites, after follow-up phone calls to both users and management the responses were scanned and emailed back to the researcher.

Face-to-face interviews and workshops with IBM® outsource managers were undertaken, where interview guide questionnaires were sent to the selected respondents a day or two ahead, to allow them time to prepare for interviews. Interviews lasted an average 90 minutes. The researcher ensured that the wording of individual questions and themes in the questionnaire was properly done.

Supplier quotations for software and hardware infrastructure will also be sourced. These will be concluded from the interviews and minimum requirements defined from within the research environment, namely National Ship Chandlers Chief Information Officer (CIO) and Chief Executive Officer (CEO). The implementation of this infrastructure will also be calculated by interviews with IBM management and implementation engineers.

3.2.7 Questionnaire Pre-testing

For effectiveness and efficiency, questionnaire pre-testing will be done prior to undertaking the full survey to identify and eliminate errors that may cause problems to respondents while answering the questions in the questionnaire (Sudman & Blair, 1998). Flaws in the questionnaires will be identified and restructured to ensure that the design of both the questionnaire and individual questions is in good order. This will increase the validity of the research. It will also assist in determining the turnaround for responses on questionnaires as these will be received electronically via email. The significant advantage of the pre-test will assist in calculating the minimum sample size for the sample frame.

3.2.8 Academic Rigor (Reliability and Validity)

Reliability is the extent to which a test is repeatable and yields consistent scores. In order for a test to be valid it must be reliable. Validity and reliability are an important part of any study. It helps to identify some ways of dealing with results. This depends however on the measurement tool used (Cooper & Schindler, 2001).

Validity refers to the extent to which the test measures what it is intended to measure. This may be internal or external validity. Internal validity looks at the accuracy of information from respondents and it is hoped to check the reality of that information.

On the other hand, external validity of quantitative research ensures that the finding can be generalised or inferred to the entire population. In this study the information can be generalised for all remote sites in National Ship Chandler's desktop user environment.

This enables the modelling of various sources of information from different categories of employees, which are administrative, finance, clerical, management and support staff can be dependable and consistent for the research. It is hoped that the techniques and instruments used will ensure that their analysis and interpretation of the data will be both reliable and valid.

The significant note on validity is that the results of its tests cannot be exclusively concluded because matters of opinion are tested. It is therefore a combination of empirical testing and understanding combined, that will infer a result.

3.2.9 Reliability and Validity Testing of Fat and Thin-client User Responses

Each of the 95 desktop users was requested to complete a questionnaire consisting of 41 questions for thin-client users and 28 questions for fat-client users. The users numbered 42 thin-clients (accessing the network via a thin-client terminal connected to a central server) and 53 fat-clients (PC and laptop users). The purpose of the analysis is to check the reliability (repeatability of scores) and validity (extent to which a question measures what it is supposed to measure) of certain questions.

The test-retest method of estimating a test's reliability involves administering the test to the same group of people at least twice. Then the first set of scores is correlated with the second set of scores. Correlations range between 0 (low reliability) and 1 (high reliability, highly unlikely they will be negative!).

Internal consistence is commonly measured as Cronbach's Alpha (based on inter-item correlations) - between 0 (low) and 1 (high). The greater the number of similar items the greater the internal consistency. That's why you sometimes get very long scales asking a question a myriad of different ways – if you add more items you get a higher Cronbach's alpha. Generally, alpha of .80 is considered as a reasonable benchmark.

Cronbach's alpha measures how well a set of items (or variables) measures a single one-dimensional latent construct. Cronbach's alpha is a coefficient of reliability (or consistency). The formula for the standardised Cronbach's alpha is:

$$\alpha = \frac{N}{N-1} \left(\frac{\sigma_X^2 - \sum_{i=1}^N \sigma_{Y_i}^2}{\sigma_X^2} \right)$$

Source: (Cronbach, 1951)

3.2.10 Ethical Considerations

This section highlights some of the important ethical issues that the researcher took care of, in order to gain access and conduct the research with utmost anonymity and confidentiality. Although respondents physically handed in their responses to the reception at their respective locations they were assured complete anonymity. An authorisation letter was sought from Graduate School that was then presented to National Ship Chandlers management for permission to undertake the research. This was responded to by the National Ship Chandlers CEO formally authorising the research. A copy of this letter is attached as Appendix 8.

Individual consent from participants will be sought and appointments made before conducting the interviews. Confidentiality will be assured as this also forms part of the commitment to National Ship Chandlers, for non-disclosure of Intellectual Property (IP) information. For transparency, a copy of the dissertation will also be submitted to the National Ship Chandlers CEO.

3.3 Qualitative Research

Qualitative research methods will be undertaken to conclude a costing for both a thin-client and fat-client outsourced environment. Interviews/meetings with desktop managers from desktop outsourcing service provider, IBM South Africa will be undertaken to calculate the most accurate costs for the National Ship Chandlers desktop environment.

A **qualitative interview** is different from everyday conversation in the following ways. First it is a research tool and a good interviewer must prepare questions in advance, and later

analyse and report results. The interviewer guides the questions and focuses the study. Good interview skills require practice and reflection. Finally, beyond the acquisition of interview skills, interviewing is a philosophy of learning. The interviewer becomes a student and then tries to get people to describe their experiences in their own terms. The results are imposed obligations on both sides. The qualitative researcher's philosophy determines what is important, what is ethical, and the completeness and accuracy of the results (Rubin & Rubin, 1995).

Several researchers have argued that structured interviews are unnatural and restrictive. Informal interviews delve deeper. For example, if you want to find out why someone acted in a certain way, ask him/her. One must negotiate an explanation that is consistent and believable. This results in an explanation of the meaning of the action for the people (Alasuutari, 1998). The interviewer follows up an interview with more questions for clarification or understanding. The key is to establish "rapport and trust" (Alasuutari, 1998). During the interview, a person may change his/her interpretation.

Due to the nature of data that has to be gathered, that is a detailed costing for National Ship Chandler's desktop environment for both thin-clients and fat-clients, semi-structured interviews will be conducted. The interviews that were conducted was to derive managed outsource costs for each of the components in both a managed fat-client and thin-client environment. Information or data required from the customer to achieve this will be:

- Physical address of remote sites from closest outsourcer's (IBM) support centre
- Number of clients at each of the 4 remote sites
- A profile depicting the criticality of all users which will assist in defining quicker response and repair turnaround.

Furthermore this approach will interrogate the Gartner report that claimed that the TCO for a managed fat-client environment is 1 percent greater than the TCO for a thin-client environment, as mentioned in section 2.3. The TCO for the fat-client environment calculated in an outsource scenario will be tabulated together with the TCO for the thin-client environment and contrasted.

3.4 Conclusion

The research design of the study has been clearly outlined in this chapter where various ways of data collection and analysis have been identified. Reliability and validity were also discussed and concluded based on the questionnaire pre-test. The qualitative research methodology will apply the IBM Desktop Management Service (DMS) offering for the fat-client environment in order to compare with the thin-client costing. By utilising IBM's DMS offering ensures that best practices are adhered to and ensures a contending comparison against the thin-client environment. The following chapter models the data results and costs the actual environments of thin-clients and fat-clients comparatively.

CHAPTER 4: RESULTS OF STUDY

4.1 Introduction

For both qualitative and quantitative research all data, correlated data, graphs and costing models will be presented. Statistical modelling and analysis techniques would yield information that will be presented. Findings in respect of interviews will be documented and checked for validity by reflection and interview notes.

In any scientific research, there is need to condense the large sums of accumulated raw data collected into small and manageable sizes by developing summaries and looking for patterns in that data (Cooper and Schindler, 2001). This facilitates easy processing, interpretation and presentation thereafter. Hence after data is collected, it is prepared, analysed and presented as actual findings using relevant statistical techniques. For this study data will be descriptive (nominal) and ranked in nature. Data will be classified into sets or categories. For example, a total of 60 employees under the administrative staff, clerical staff and supervisor staff data categories shall be used. This will facilitate data analysis and discussion in terms of what motivates each of these categories bearing in mind that different people are motivated differently. The degree of the influence of monetary and non-monetary rewards on performance will be analysed which will help to test the hypothesis stated in chapter one of this study. Therefore, a suitable statistical technique that shall be used is SPSS. However, before data is analysed and presented it has to be prepared.

To ensure accuracy, data must be prepared by converting it from raw form to classified or reduced form for appropriate analysis and interpretation and this will be done by editing, coding and tabulating it.

The results of the data from the quantitative analysis, which comprised primarily of the questionnaire survey, will dictate the degree of costs to be attributed to the different elements that comprise a Total Cost of Ownership (TCO). This will be calculated based on the assumption that only thin-clients (TC) will be deployed to all National Ship Changers users, with the exception of power users. Power users are those that require a desktop that has its own processing due to their particular job function and therefore will be give a fat-client. The same will be computed for fat-clients (FC). Depending on the conclusions inferred from the

data analysis certain cost factors may or may not be attributed, at varying degrees to the National Ship Chandlers desktop environment costing model.

The costing model will be compared for both fat-clients (laptop and PCs) and thin-clients. These will be finally tested against the hypothesis and null-hypothesis.

4.2 Proposed Analysis of Data

Since the study is of a descriptive nature, the raw data was coded and organised according to the questions asked. The data obtained was summarised and coded using Microsoft Excel, which stores and organises data. Microsoft Excel was also used for its graphics facilities to illustrate the findings. SPSS version 13.0.1 was used to analyse data and to identify relationships amongst the variables.

All data received was coded using numeric coding. The statistical package SPSS was used to analyse the findings using the scales described above. Bar charts were used to determine the distribution of the data and to investigate the most common responses for each interval per variable. This information was used to show the characteristics of the distribution. A correlation analysis was used to test for relationships and user requirements on training, change-management, end-user-support, levels of satisfaction and factors in the data.

4.3 Results of Data

4.3.1 Reliability and Validity Testing between Fat and Thin-client User Responses

Each of the 95 desktop users was requested to complete a questionnaire consisting of 41 questions for thin-client users and 28 questions for fat-client users. The users numbered 42 thin-clients (accessing the network via a thin-client terminal connected to a central server) and 53 fat-clients (PC and laptop users). The purpose of the analysis is to check the reliability (repeatability of scores) and validity (extent to which a question measures what it is supposed to measure) of certain questions.

The test-retest method of estimating a test's reliability involves administering the test to the same group of people at least twice. Then the first set of scores is correlated with the second set of scores. Correlations range between 0 (low reliability) and 1 (high reliability, highly unlikely they will be negative!).

Note: All calculations below are with the following assumption confined to these calculations and the hypothesis is **NOT** the same as defined in section 2.6, which is defined for the dissertation as a whole.

a. Hypothesis – Assumption of association

b. Null Hypothesis – Hypothesis of NO association

4.3.1.1 Citrix Training - Question 32 and Question 33

Question 32 * Question 33 Cross - Tabulation

Count	q33			Total
	3	5	6	
Q32 3	11	0	0	11
5	0	24	4	28
6	0	3	0	3
Total	11	27	4	42

Table 4.1: Cross Tabulation on Question 32 and Question 33

Directional Measures - Somers'd

			Test Value	Standard Error	T Value	P Value/ Significance
Ordinal by Ordinal	Somers' d	Symmetric	.753	.095	5.507	.000
		Q32 Dependent	.733	.109	5.507	.000
		Q33 Dependent	.774	.110	5.507	.000

Table 4.2: Directional Measures, Somers'd

- a. Not assuming the null hypothesis.
- b. Using the asymptotic standard error assuming the null hypothesis.

Symmetric Measures - Kendall's tau-b

		Value	Asymp. Std. Error(a)	Approx. T(b)	Approx. Sig.
Ordinal by Ordinal	Kendall's tau-b	.753	.095	5.507	.000
N of Valid Cases		42			

Table 4.3: Symmetric Measures, Kendall's tau-b

- a. Not assuming the null hypothesis.
- b. Using the asymptotic standard error assuming the null hypothesis.

Reliability Statistics - Cronbach's Alpha

Cronbach's Alpha	N of Items
0.954	2

Table 4.4: Cronbach's Alpha

For the thin-client user environment questions 32 and 33 which tested whether Citrix was used as a medium for training yielded a Cronbach's Alpha of 0.954, this implies a high positive association.

4.3.1.2 Access to Computer Games - Question 35 and Question 36

Question 35 * Question 36 Cross-Tabulation

Count	q36				Total
	3	4	5	6	
Q35 3	9	0	0	0	9
4	0	2	0	0	2
5	0	0	29	0	29
6	0	0	1	1	2
Total	9	2	30	1	42

Table 4.5: Cross Tabulation for Question 35 and Question 36

Directional Measures - Somers' d

Ordinal by Ordinal	Somers' d	Symmetric				
		q35 Dependent	.963	.035	5.745	.000
		q36 Dependent	.997	.003	5.745	.000
			.930	.066	5.745	.000

Table 4.6: Directional Measures, Somers' d

- a. Not assuming the null hypothesis.
- b. Using the asymptotic standard error assuming the null hypothesis.

Symmetric Measures – Kendall's tau-b

	Value	Asymp. Std. Error(a)	Approx. T(b)	Approx. Sig.
Ordinal by Ordinal Kendall's tau-b	.963	.035	5.745	.000
N of Valid Cases	42			

Table 4.7: Symmetric Measures, Kendall's tau-b

- a. Not assuming the null hypothesis.
- b. Using the asymptotic standard error assuming the null hypothesis.

Reliability Statistics Cronbach's Alpha

Cronbach's Alpha	N of Items
0.992	2

Table 4.8: Cronbach's Alpha

Questions 35 and 36 yielded a Cronbach's Alpha of 0.992, which tested the relation between access of computer games to users and managements sanction on the users

playing these computer games. The value is close to 1 which suggests a high positive association.

4.3.1.3 Measuring Thin-client Performance - Question 22 and Question 24

Question 22 * Question 24 Cross Tabulation

Count	q24				Total
	3	4	5	6	
Q22 2	3	0	0	0	3
3	7	5	11	9	32
5	4	1	0	2	7
Total	14	6	11	11	42

Table 4.9: Cross Tabulation for Question 22 and Question 24

Directional Measures - Somers' d

			Test Value	Standard Error	T Value	P Value / Significance
Ordinal by Ordinal	Somers' d	Symmetric	.034	.162	.213	.831
		q22 Dependent	.026	.124	.213	.831
		q24 Dependent	.050	.233	.213	.831

Table 4.10: Directional Measures, Somers' d

- Not assuming the null hypothesis.
- Using the asymptotic standard error assuming the null hypothesis.

Symmetric Measures - Kendall's tau-b

		Value	Asymp. Std. Error(a)	Approx. T(b)	Approx. Sig.
Ordinal by Ordinal	Kendall's tau-b	.036	.170	.213	.831
N of Valid Cases		42			

Table 4.11: Symmetric Measures, Kendall's tau-b

- Not assuming the null hypothesis.
- Using the asymptotic standard error assuming the null hypothesis.

Reliability Statistics - Cronbach's Alpha

Cronbach's Alpha(a)	N of Items
-.093	2

Table 4.12: Cronbach's Alpha

- The value is negative due to a negative average covariance among items. This violates reliability model assumptions.

Questions 22 and 24 yielded a negative Cronbach Alpha of -0.093 which implies that no association can be drawn. This however is due to the fact that thin-clients are windows based “dumb terminals” and therefore do not require any form of training.

4.3.1.4 Listening to CDs and MP3s - Question 25 and Question 26

Question 25 * Question 26 Cross tabulation

Count	q26			Total
	4	5	6	
q25 3	4	24	14	42
Total	4	24	14	42

Table 4.13: Cross tabulation of Question 25 and Question 26

Directional Measures - Somers'd

Ordinal by Ordinal	Somers' d	Symmetric	.(a)
--------------------	-----------	-----------	------

Table 4.14: Directional Measures, Somers'd

a. No statistics are computed because q25 is a constant.

Symmetric Measures - Kendall's tau-b

		Value
Ordinal by Ordinal	Kendall's tau-b	.(a)
N of Valid Cases		42

Table 4.15: Symmetric Measures, Kendall's tau-b

a. No statistics are computed because q25 is a constant.

Reliability Statistics - Cronbach's Alpha

Cronbach's Alpha	N of Items
7.64E-014	2

Table 4.16: Cronbach's Alpha

Questions 25 and 26 could not yield a Cronbach Alpha. This is due to a unanimous response on question 25. The company's policy is that both fat-client and thin-client users are not allowed to listen to music. This therefore yielded a unanimous response.

The same results were applicable for Questions 21 and 30 where question 30 evaluates whether users require additional thin-client training. As per previous note thin-clients are windows based “dumb terminals” and therefore do not require any user to be trained on it.

For all of the abovementioned tests Somer's d and Kendall's tau-b were also applied to compare with the Cronbach's Alpha. All detailed calculations can be found in Appendix 6.

4.3.2 Age Distribution Landscape

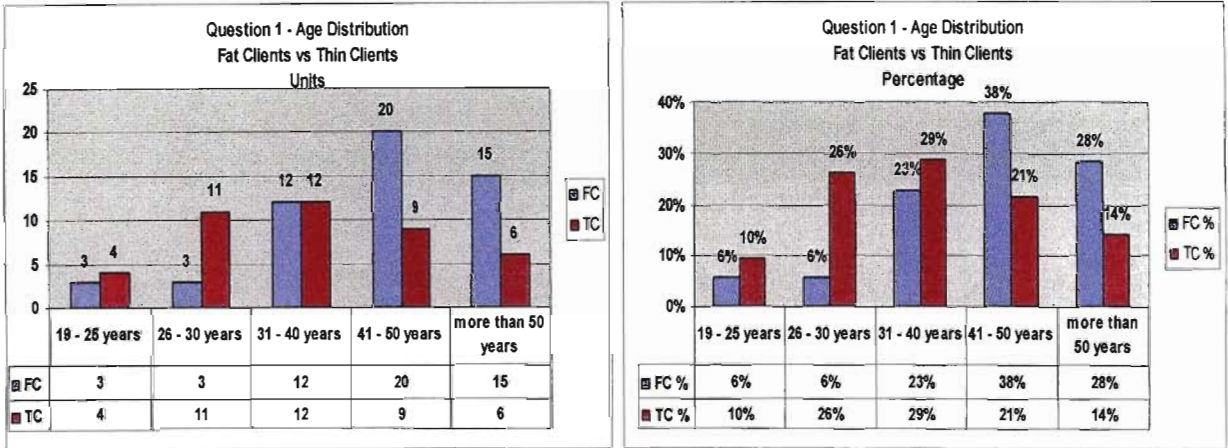


Figure 4.1: Question 1 – Age Distribution Landscape of Thin-clients vs. Fat-clients

Figure 4.1 above suggests that the organisation have very few staff under 30 years of age (only 22%, 21 of 95 users) utilising the desktop computer environment, irrespective of being a fat-client or thin-client user. Research has shown that older generations are more resistant to newer technologies than the younger generations. Sixty-six percent of the fat-client users are 41 years or older, whilst 65% of the thin-client users are 40 years or younger.

4.3.3 Geographic Distribution

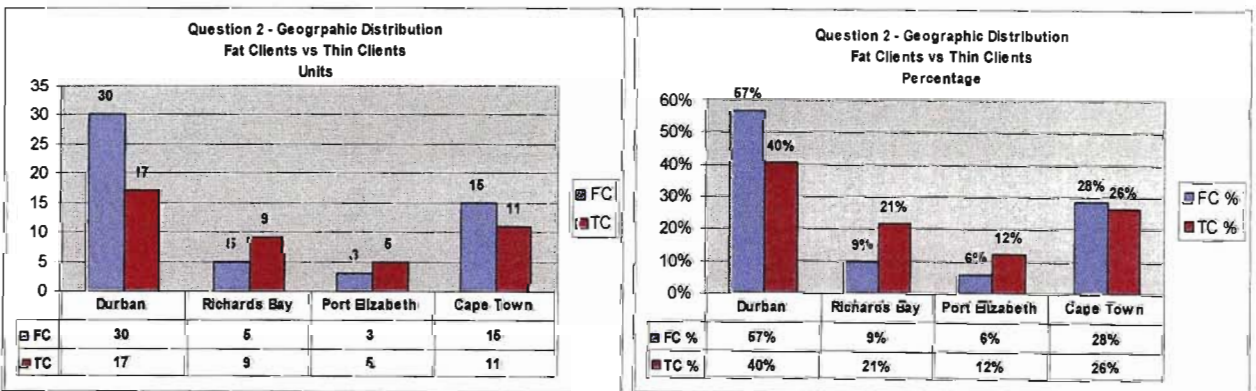


Figure 4.2: Question 2 – Geographic Distribution of Fat-clients & Thin-clients

The majority of fat-client and thin-client users are in head-office, Durban. Although Richards Bay and Port Elizabeth are small sites they have close to double the amount of thin-clients in comparison to fat-clients within their respective sites, whilst in Cape Town and Durban there

are more fat-client than thin-client users. This may be attributed to the fact that they have greater accessibility to IT support on the system. In-house desktop support is not available at remote sites and therefore users depend on telephonic support or third-party support vendors been called in when required. The complexity of thin-clients is significantly less than that of fat-clients. The geographic distribution on number of desktop clients has a direct support cost impact when calculating the TCO.

4.3.4 Job Function Landscape

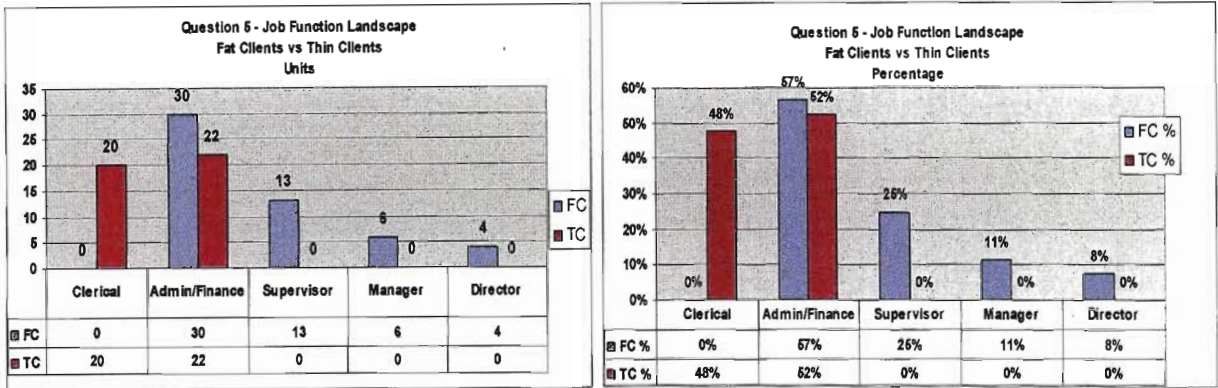


Figure 4.3: Question 5 – Job Function Landscape across Thin-clients and Fat-clients

All of the 20 clerical personnel have thin-clients. 57% of fat-clients are admin/finance users and 100% of the thin-clients are clerical (48%) and admin/finance (52%) users. In Figure 4.3 the graphical representation depicts a clear understanding of whether current thin-client users were correctly profiled to be assigned a thin-client instead of a fat-client. Fat-client users should be the profile of that of ‘power users’, who require the greater functionality available of fat-clients and without total dependence of network availability. Supervisors, managers & directors may be categorised as power-users and do not have thin-clients. Most clerical and admin staff has a thin-client profile, which is based on job function and responsibility and is therefore profiled correctly.

4.3.5 Job Challenge

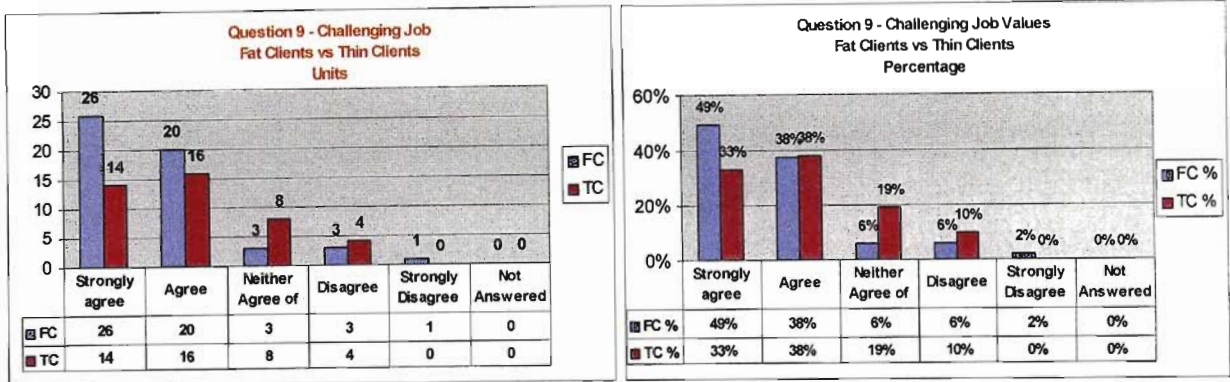


Figure 4.4: Question 9 – Evaluation of Job Challenge across Thin-clients and Fat-clients

A challenging job may be indicative of difficulties that users are experiencing utilising the computer system. Eighty-seven percent of fat-client users expressed that their job is challenging whilst 71% of thin-clients users expressed that their jobs are challenging. Users may require software application training and NOT necessarily usage training of thin-client or fat-clients as both expressed dissatisfaction. Training on how to utilise a specific set of software application is very different from training users on how to operate a personal computer or thin-client device. Users appear to have a clear understanding on operating their desktop device, irrespective of thin-client or fat-client.

4.3.6 Distribution of Job Dependence on System

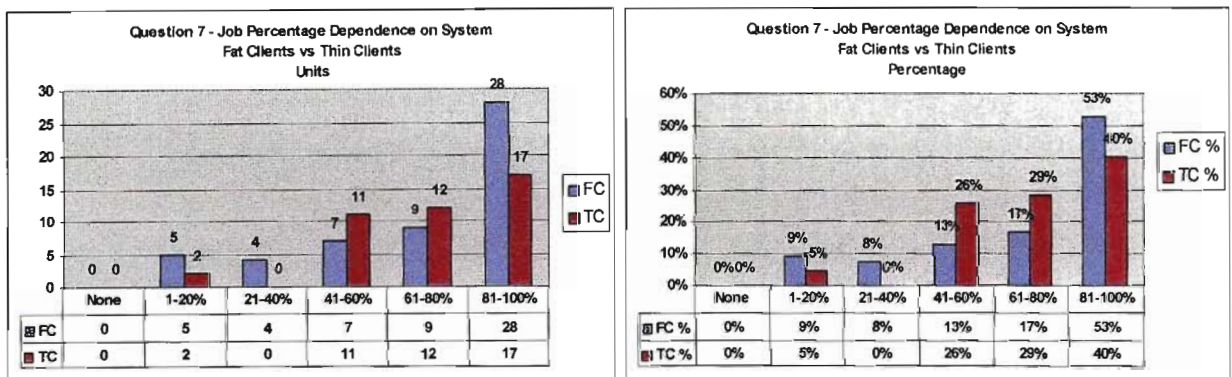


Figure 4.5: Question 7 – Distribution of Job Dependence on System for Thin-clients and Fat-clients

Fifty-three percent of fat-client users have between 81-100% dependence on the system. Forty percent holds the same for thin-client users, which is a high percentage. If the network or thin-client servers became unavailable 40% of the thin-client users become unproductive because they cannot even utilise locally installed applications such as MS Office, Email (offline) etc. unlike fat-client users. Thin-client users should not have a significant

dependence on the computer system to be productive. If they do then they should be allocated a fat-client to mitigate risk of being unproductive users when systems go offline or the network becomes unavailable.

4.3.7 User's Acceptance of Working with the Computer System

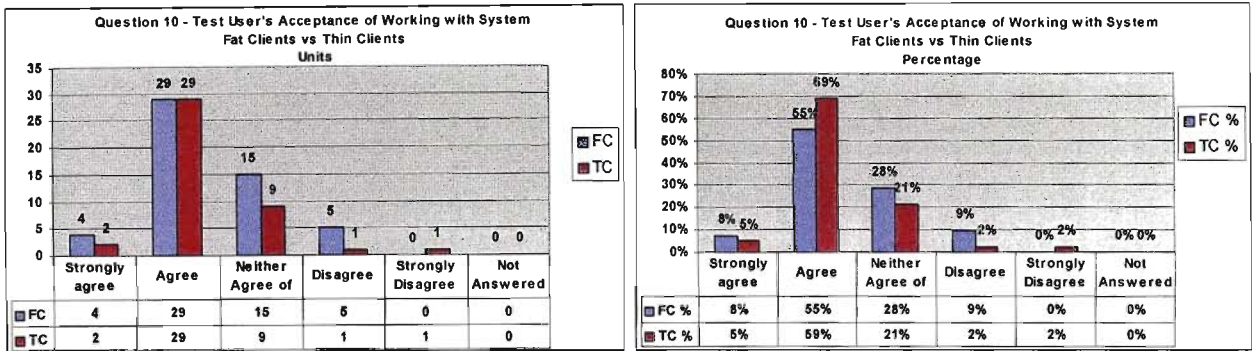


Figure 4.6: Question 10 – User's Acceptance of Computer System on Fat-clients & Thin-clients

Sixty-three percent of fat-client users are happy utilising their system and 74% of thin-client users are also happy utilising their system. This suggest an acceptable distribution based on user profile allocation of thin-clients and fat-clients, although Question 7 results suggested thin-client users that have 81-100% dependence on the system should be moved to a fat-client platform. As per Krikke (2004), if the network went down operations would halt. This important factor has to be taken into consideration.

4.3.8 Total Average Support Calls per Month of Thin-client vs. Fat-client

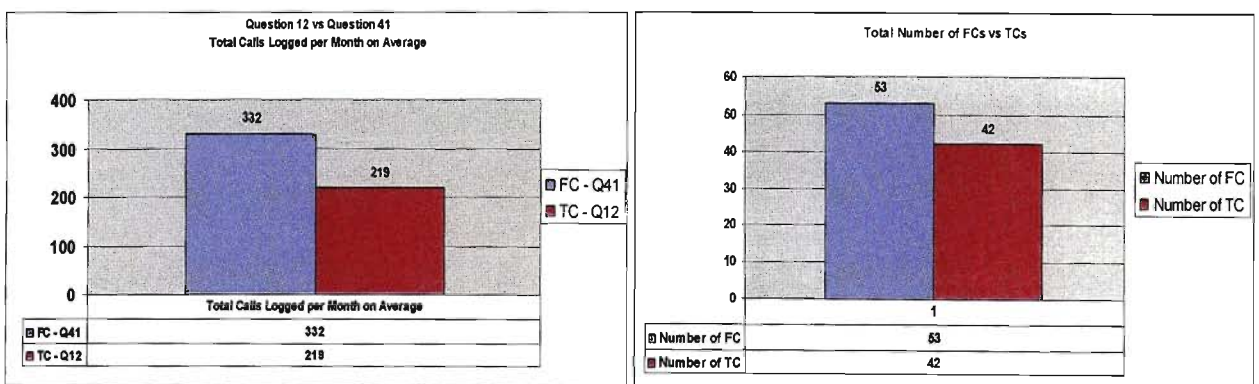


Figure 4.7: Question 12 & 41 – Total Average Support Calls per Month of Fat-clients vs. Thin-clients

The ratio of the number of thin-clients (42) to fat-clients (53) is 0.792, whilst the ratio of calls logged per month of thin-clients (219) and fat-clients (332) are 0.659. Proportionately if thin-clients logged 219 calls per month on average then fat-clients should log 277 calls on

average per month. Currently fat-clients log on average 55 more calls per month which approximates to 20% more calls on fat-clients than thin-clients on average per month. Calls to the helpdesk are charged on a per call basis. This attributes a 20% additional helpdesk cost for the fat-client environment when calculating the TCO.

4.3.9 Total Average Support Calls per Month per Region

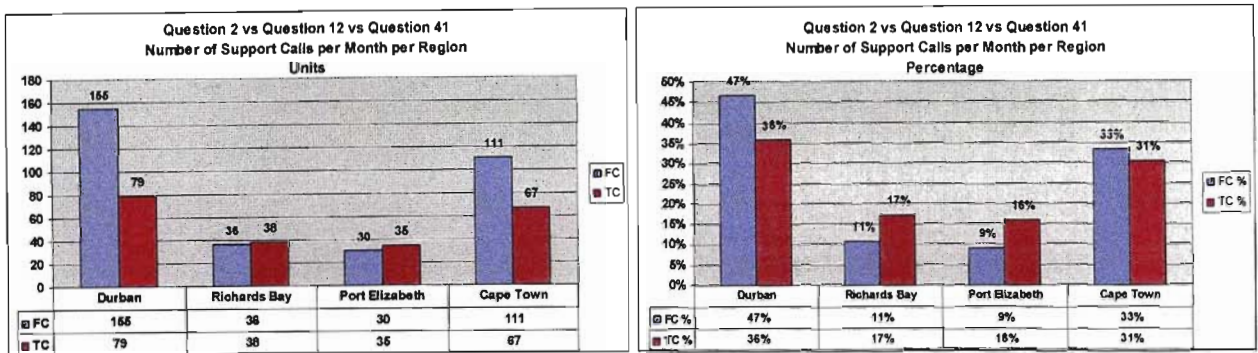


Figure 4.8: Question 2, 12 & 41 – Average Support Calls per Month per Region for Thin and Fat-clients

Durban logs 234 calls on average per month from both thin-client and fat-client users. Cape Town logs 178 calls on average per month for both thin-client and fat-client users. Durban has 47 desktops whilst Cape Town has 26 desktops. If Durban logs 234 calls on average per month then Cape should proportionately log 130 calls on average per month. Cape Town logs 48 calls more per month relative to Durban. This may be attributed to no local support staff in Cape Town. Remote support from Durban is also not as effective as local support.

There are more points of failure between Cape Town and Durban as the servers are situated in Durban and are local to all users. Greater remote support over the WAN link to Cape Town would suggest greater bandwidth so that support staff can undertake corrective changes remotely. Therefore these cost factors have a direct impact on the TCO calculation.

4.3.10 Thin-client User's Preference to Move Back to Fat-clients

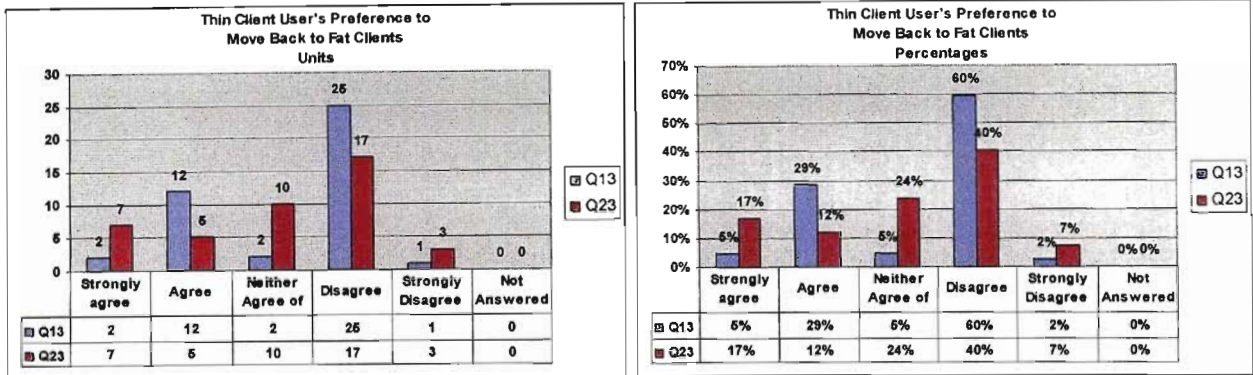


Figure 4.9: Question 13 & 23 – Thin-client User's Preference to Move Back to Fat-clients

Questions 13 and 23 are test, retest of thin-client user's preference for moving back to a fat-client. For Question 13, 34% prefer moving back as opposed to 62% who appear to be satisfied with their thin-clients. For Question 23, 29% opted to move back to fat-clients whilst 47% were satisfied with their thin-clients. Between questions 13 and 23, many questions were raised in the minds of the users as to the reliability of their devices and therefore a drop in percentage move of thin-client users from 62% to 47% was experienced.

This suggests that thin-client users have a moderate negative outlook to thin-clients due to the lack of IT support. This does not necessarily mean that the thin-client is a problematic technology but could also suggest that the problems may be application related. Application change, training and upgrade costs are taken into consideration when calculating the TCO.

4.3.11 Number of Support Calls Logged on Thin-clients Relative to Fat-clients

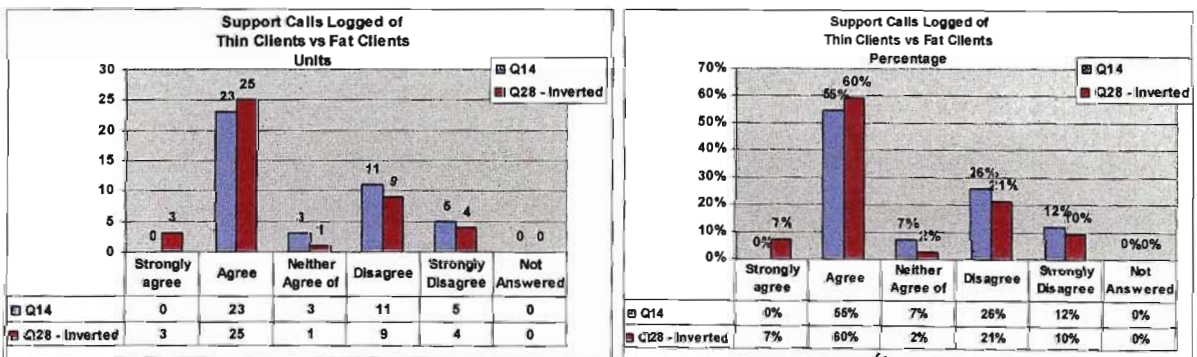


Figure 4.10: Question 14 & 28 (Inverted) – Support Calls Logged on Thin-clients Relative to Fat-clients

Question 28 responses are inverted to reflect the positive and are then graphed with Question 14 in Figure 4.10. On Question 14, 55% agreed to logging more support calls on fat-clients

than the thin-clients. For Question 28 which was inverted to reflect the positive, the respondents were at 67% agreement that they logged more support calls on fat-clients than thin-clients. This suggests that the majority of thin-client users are of the opinion that more support calls were logged on fat-clients than their now thin-clients. This further infers that the TCO calculation should yield lower on helpdesk support calls for thin-clients compared to fat-clients. According to Giga, TCC technology can reduce costs by 20 percent per terminal and calls to help desks by 30 to 60 percent (Volchkov, 2002).

4.3.12 Comparison of Training Requirements for Thin-clients vs. Fat-clients

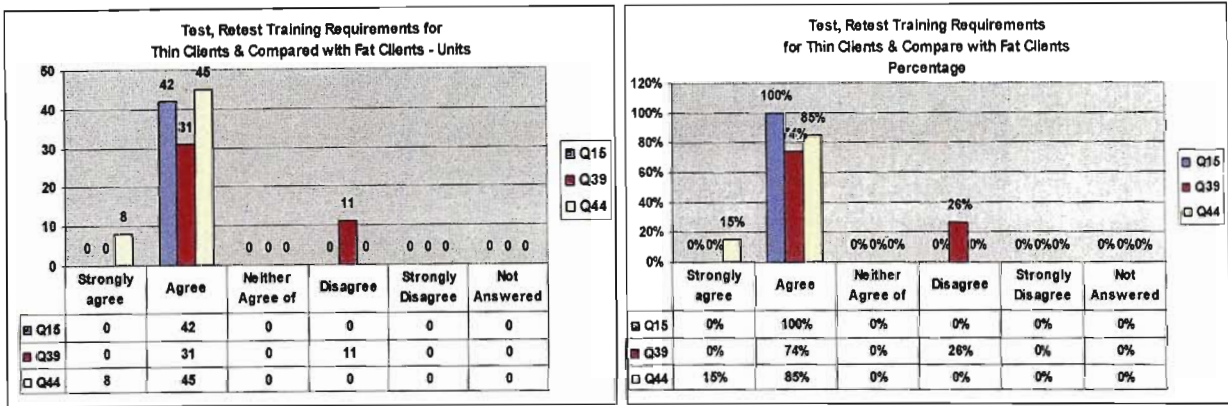


Figure 4.11: Question 15, 39 & 44 – Training Requirements for Thin-clients vs. Fat-clients

One-hundred percent of thin-client users agreed that they have received training and communication from management about the move from PCs to thin-clients. This question is retested in Question 39 with 74% validating their training responses on thin-client usage. Question 44 tested fat-client user access to system application training, where 100% validated that they did received training.

This suggests that adequate training and change-management measures were put into place for all users at National Ship Chandlers before the migration was undertaken. Training and change-management costs are significant and it is regarded as a norm to incorporate in calculating any TCO. Gartner’s (2001) TI² (“TI squared”) software, makes assumptions in calculation a TCO which includes training costs and is therefore a significant factor that has to be considered.

4.3.13 Data Availability and Uptime on Thin-clients

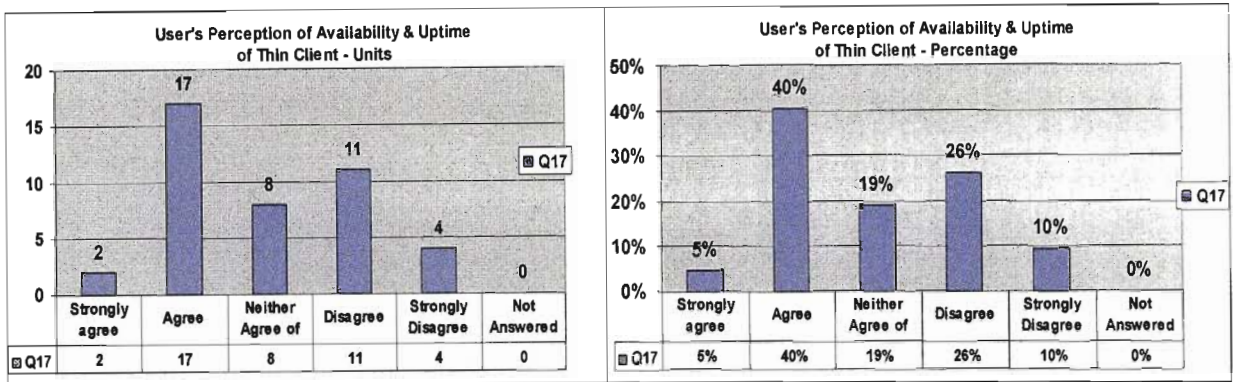


Figure 4.12: Question 17 – Data Availability and Uptime on Thin-clients

Forty-five percent of thin-client users felt their data was more secure and available compared to their previous fat-client platform, whilst 36% disagreed and 19% experienced no change. This data clearly suggests that more were satisfied than dissatisfied. This suggests that users have greater confidence and reliance on thin-clients and have accepted the technology. The 36% of thin-client users responses that disagreed have to be validated as it has to be understood whether their dissatisfaction may be attributed to network or server unavailability. According to Masding, (1991) almost impossible costs to measure in calculating a TCO include downtime, peer-to-peer support and time spent on user-solvable problems.

Factors for high availability servers and networks with antivirus protection have to be also included in the TCO calculations.

4.3.14 Productivity of Thin-client Users When System is Offline

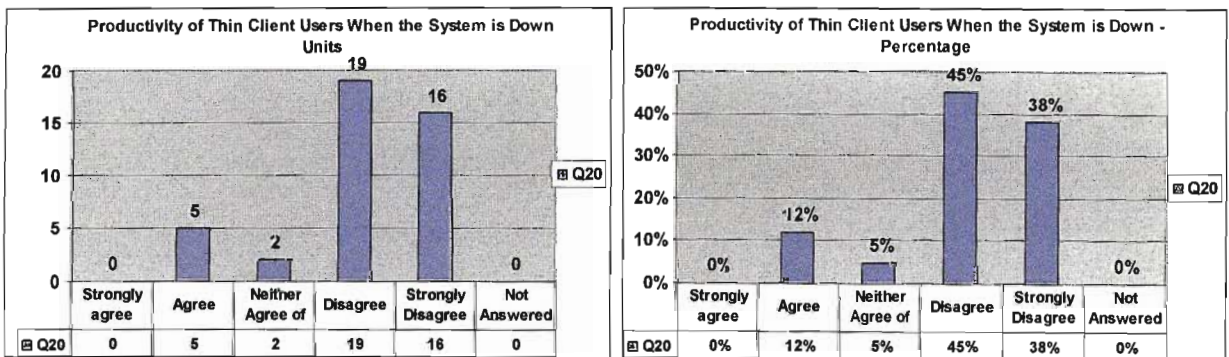


Figure 4.13: Question 20 – Productivity of Thin-client Users When System is Offline

Eighty-three percent of thin-client users agreed that they would be unproductive if their system was offline or unavailable. This suggests a great dependence on the systems

availability for maintained productivity. Therefore networks and server availability is of critical importance to National Ship Chandlers. Significant attention has to be attributed to implementing high availability networks and servers. Adding redundancy and resilience to servers and networks adds to the TCO in a thin-client environment.

4.3.15 Training Requirements and Impact on Productivity

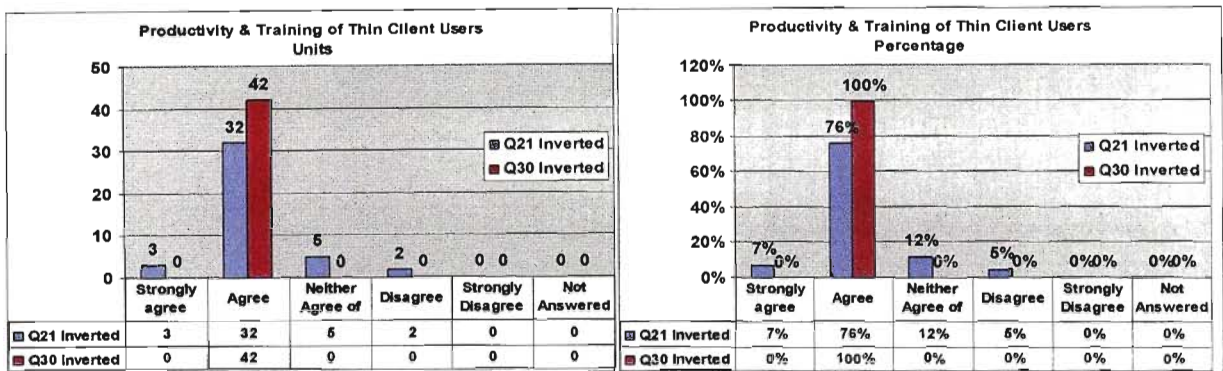


Figure 4.14: Question 21 & 30 – Training Requirements of Thin-client Users and Impact on Productivity

These questions were both inverted to reflect the positive. They also validated training requirements of thin-client users. Eighty-three percent and 100% of Questions 21 and 30 respectively agreed that additional training would not increase productivity. This also suggests that users have adequate experience and training with the thin-client environment and therefore no training costs may be attributed to the TCO costing.

4.3.16 Performance Requirements – Thin-clients

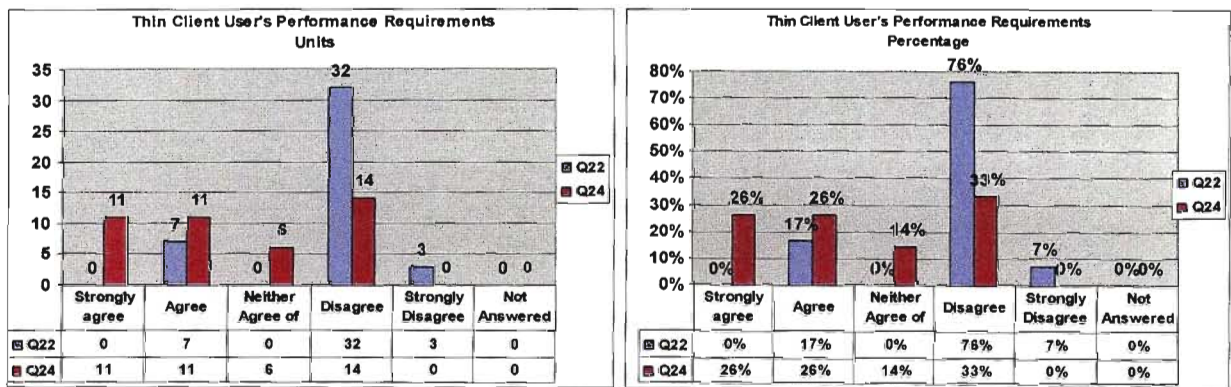


Figure 4.15: Question 22 & 24 – Thin-client User's Performance Requirements

Eighty-three percent disagreed to experiencing slow response on thin-clients for Question 22, whilst for Question 24, 52% agreed that they required greater performance on their thin-clients. Thin-client performance may be related to a slow server farm or network connection.

Network and server farms have to be designed and implemented with high performance and availability requirements, which is indicative of significantly greater costs to the thin-client environment. Good response time is the key to overall satisfaction with an interactive session (Tolia, Andersen and Satyanarayanan, 2006).

4.3.17 Thin-client User's CDROM/DVD/USB Usage

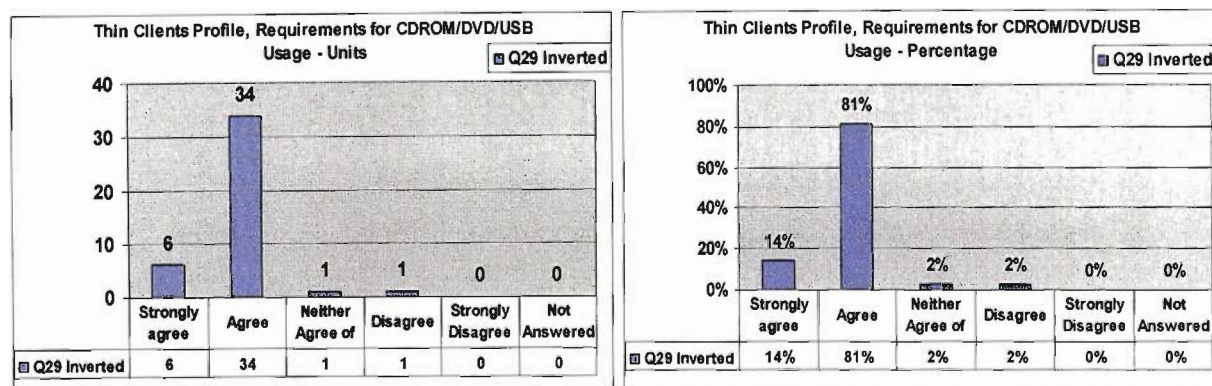


Figure 4.16: Question 29 – Thin-client User's CDROM/DVD/USB Usage

Question 29 is inverted to reflect the positive responses. Ninety-five percent of the thin-client users agree that their job function does not require them to utilise the functionality that a thin-client does not have. This suggests correctly profiled thin-client users based on job profile. If users are not correctly profiled, therefore given an appropriate device (thin-client or fat-client) to perform their job could lead to unhappy and therefore unproductive users who may ultimately resist using the system.

4.3.18 User's Preference: Thin-client over Fat-client

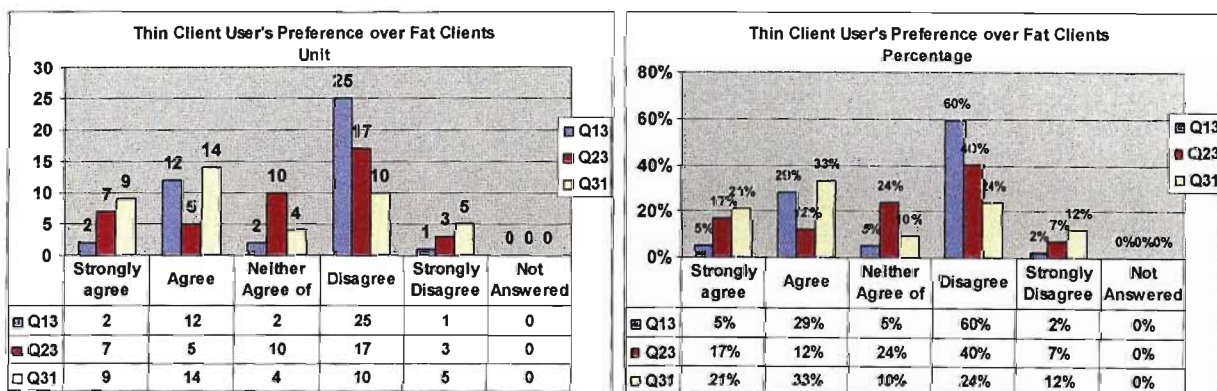


Figure 4.17: Question 13, 23 & 31 – Thin-client User's Preference over Fat-clients

On Question 13, 34% agreed to moving back to fat-clients whilst 62% were happy with their thin-clients. Question 23 retested Question 13, where 25% agreed to move back to thin-clients and 47% were satisfied with their thin-clients. Question 31 yielded 54% in agreement

that thin-clients are more reliable than fat-clients whilst 36% disagreed. This suggests that half the thin-client user-base prefer thin-clients over fat-clients. This may be attributed to the fact that thin-client users experience greater levels of reliability and ease of use. This translates to greater technology acceptance and user productivity.

4.3.19 User Training: Citrix System

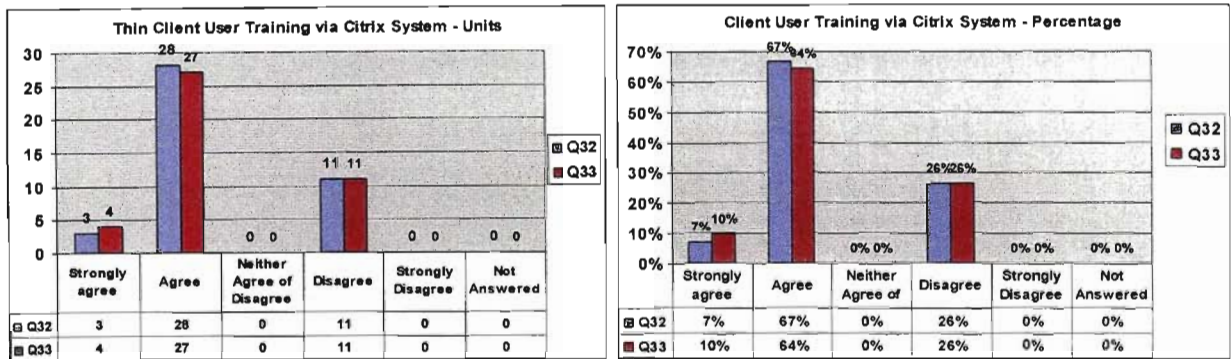


Figure 4.18: Question 32 & 33 – Thin-client User Training via Citrix System

Questions 32 and 33 test whether the thin-client Citrix system is used by IT support personnel as a medium to undertake training. Seventy-four percent agreed that is was indeed the case whilst 26% disagreed, for both questions. This suggests that thin-client users receive significant training via the Citrix system. This further implies that significant cost savings with respect to end-user training will ultimately impact the TCO calculation. This is consistent with the reliability test results of the Cronbach Alpha which yielded a 0.954 value which is greater than 0.8 and suggests a strong positive association.

4.3.20 Accessibility to Computer Games: Thin-client Users vs. Fat-client Users

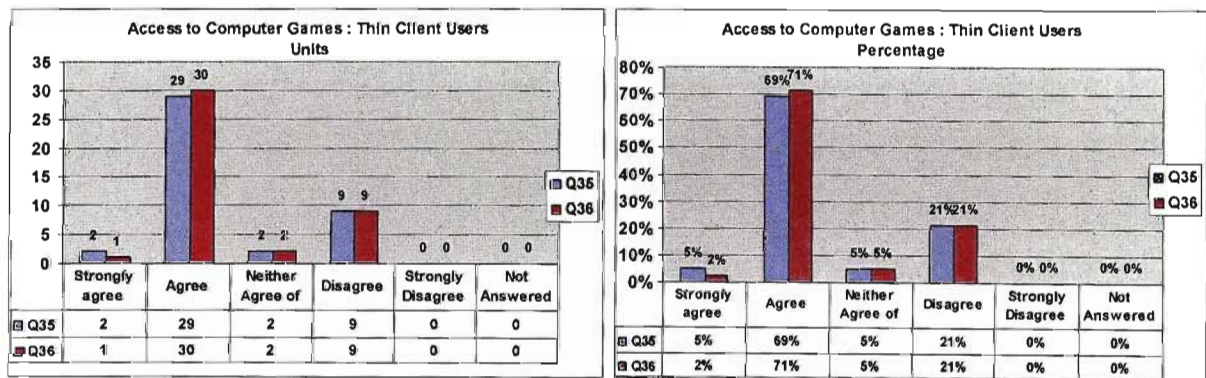


Figure 4.19: Question 35 & 36 – Thin-client User Access and Availability to Computer Games

For both Questions 35 and 36, 74% and 73% respectively, validated that computer games were available and thin-client users were allowed to play during lunch and tea breaks. This

implies that thin-client and fat-client users have equal accessibility to the system and there is no bias exercised between them.

Figure 4.20 in contrast, graphs fat-client user responses on the same questions to establish if there exists any form of bias between the different classes of users.

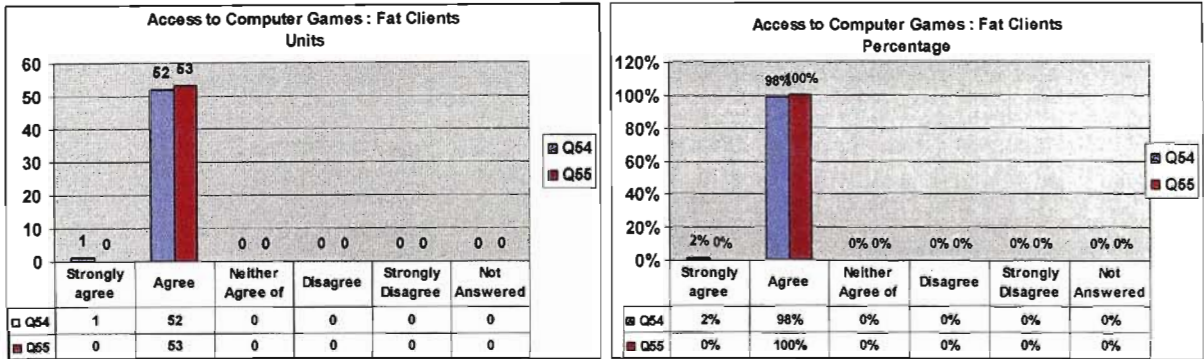


Figure 4.20: Question 54 & 55 – Fat-client User Access and Availability to Computer Games

For fat-client users, 100% agreed that they were allowed access to computer games during lunch and tea breaks. Unlike thin-client users, 21% of whom did not have authorisation to play computer games. Thin-client users appear to experience a 21% bias to playing computer games. This may contribute to thin-client user’s resistance in utilising thin-client devices. It could impact thin-client user’s motivation and lead to resistance to using the system and ultimately lower user productivity.

4.3.21 Virus Infections: Thin-clients vs. Fat-clients

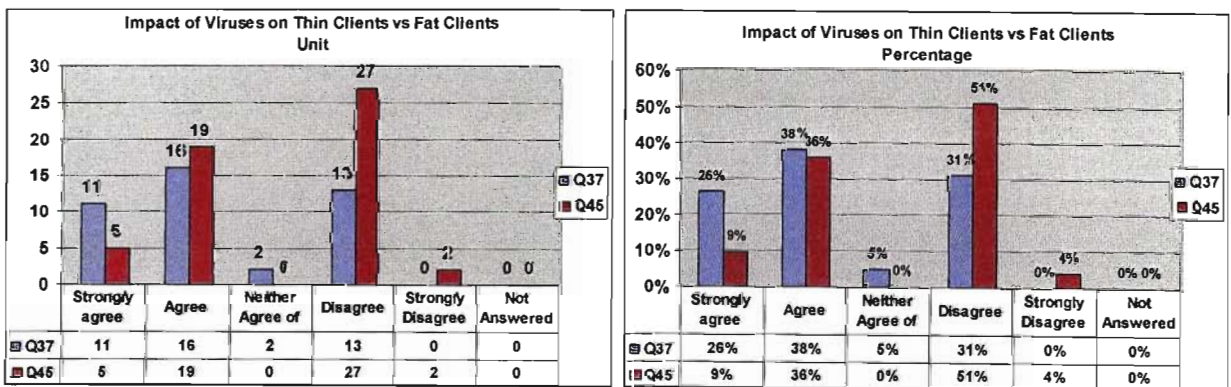


Figure 4.21: Question 37 & 45 – Impact of Viruses on Thin-clients vs. Fat-clients

Question 37 yielded thin-client user’s perception of virus infections within their environment relative to their prior experience with fat-clients. Sixty-four percent agreed to experience more virus attacks on fat-clients than their now thin-clients, whilst 31% disagreed. Question

45 yielded the fat-client user's impact of virus infections within a 12 month timeframe. Forty-five percent agreed that their fat-client were infected within the timeframe whilst 55% disagreed.

Viruses have a significant impact on organisations' productivity. Thin-client users are less prone to virus infections as compared to fat-clients. Antivirus license costs vary for each environment, that is, for the thin-client environment only the servers require antivirus licenses, whilst for the fat-client environment both servers and fat-clients require antivirus licenses. This has a significant cost different when calculating the TCO for each environment. Furthermore, virus eradication is a far easier task when only servers must be cleansed in comparison to the far more numerous PCs (Hankins, 1999).

4.3.22 Level of Satisfaction: Thin-client Users

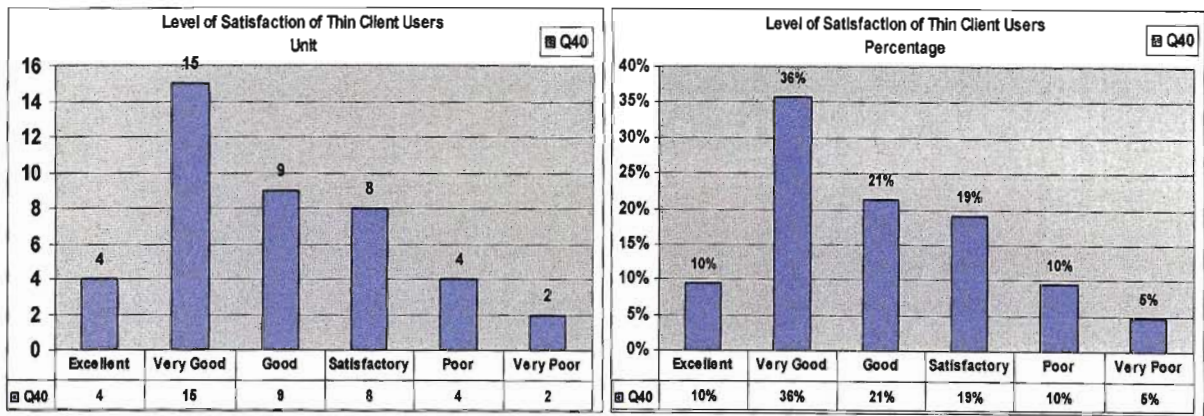


Figure 4.22: Question 40 – Level of Satisfaction of Thin-client Users

Eighty-six percent of thin-client users have expressed a minimum satisfactory level for utilising thin-clients whilst 10% rated poor levels and 5% very poor. This suggests that majority of the users are happy with thin-clients. This clearly indicates that desktop users are correctly profiled for utilising thin-client devices based on their job function and requirements. This suggests a high degree of technology acceptance and leads to greater user productivity. Studies undertaken by Guynes (1988), Martin and Corl (1986), Miller (1968), Rushinek and Rushinek (2002), and Shneiderman (1997) has suggested that for acceptable response times for trivial interactions user productivity is not impacted by response times below 150 milliseconds. This is therefore a good quantitative definition of crisp response and levels of satisfaction that maybe deduced by users.

4.3.23 Fat-client Users Preference over Thin-clients

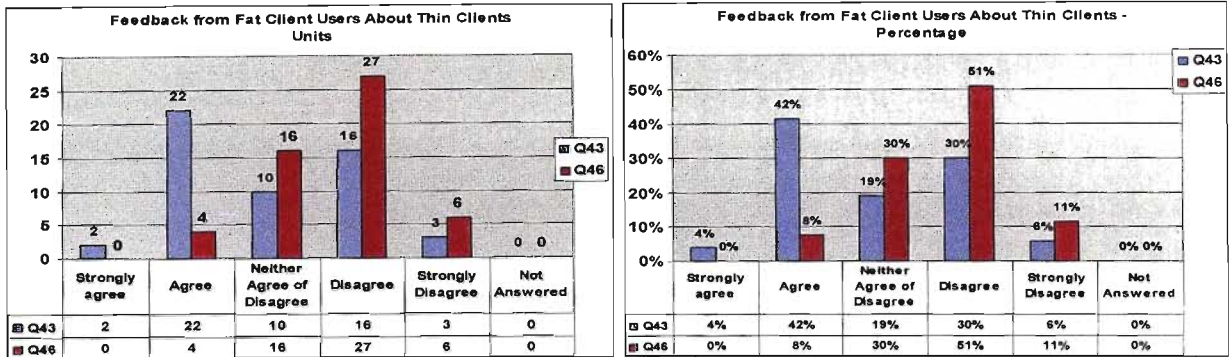


Figure 4.23: Question 43 & 46 – Fat-client User’s Preference over Thin-clients

Question 43 tested whether fat-client users got positive feedback from thin-client users. Forty-six percent agreed whilst 36% disagreed. The majority of the users agreed, confirming thin-client user’s levels of satisfaction. Question 46 tested whether fat-client users felt that thin-clients are more stable and available than fat-clients. Eight percent agreed whilst 62% disagreed. This suggests that fat-client users do not want to give-up their fat-clients for thin-clients and therefore influenced the response. It could also imply that additional change-management initiatives are required when migrating fat-clients to thin-clients. This impacts the TCO costing calculations for each of the environments.

4.3.24 Perceived Accessibility of Applications on Thin-clients

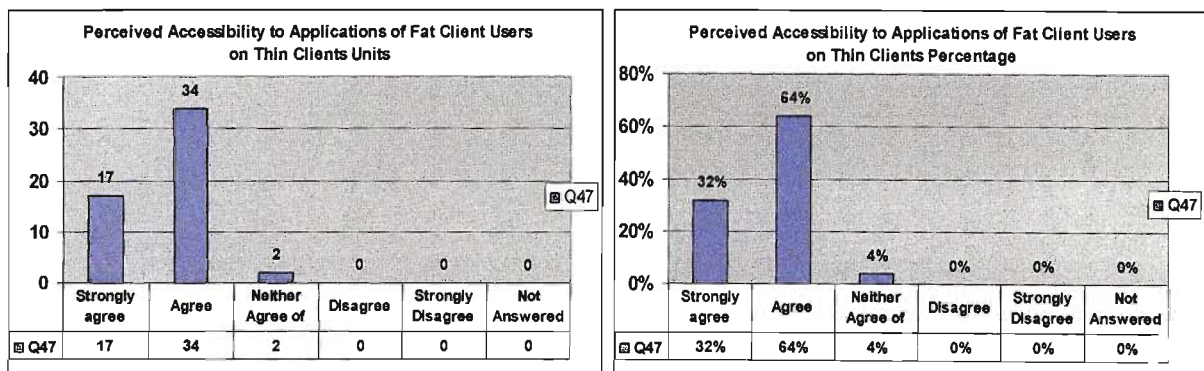


Figure 4.24: Question 47 – Perceived Accessibility of Applications on Thin-clients

Ninety-six percent of fat-client users agreed that their fat-clients have more accessibility to applications than thin-clients. This may be indicative as to why 62% of fat-client users are not willing to give-up their fat-clients for thin-clients. Fat-client users feel they will be restricted and lose their autonomy they have if they moved to a thin-client platform. This is

another motivation for change-management initiatives to facilitate the migration and also impacts the TCO calculation.

4.3.25 Comparative Analysis of Data Integrity on Fat-clients vs. Thin-clients

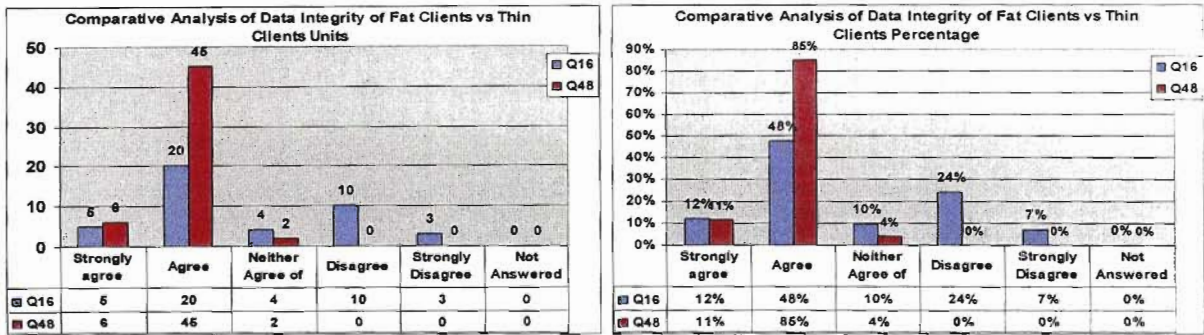


Figure 4.25: Question 16 & 48 – Comparative Analysis of Data Integrity on Fat-clients vs. Thin-clients

Question 16 and Question 48 test the thin-client and fat-client user perception of data integrity respectively. Sixty percent of the thin-client users agreed to have greater data integrity than fat-client users whilst 96% of the fat-client users felt they had greater data integrity than thin-clients. The results suggest that data integrity is greater in the fat-client environment, although data integrity includes system availability and vulnerability in relation to computer viruses. Fat-clients are more prone to virus infections than thin-clients as outlined in Section 4.3.21. Furthermore, according to O’Donnell (2004) central backup and control of data can help ensure that employees do not make common mistakes that can allow intrusions or cause data loss.

4.3.26 Fat-client Productivity: User Dependence on Fat-clients



Figure 4.26: Question 51 – Evaluation of Job Challenge landscape for thin-clients and fat-clients

One-hundred percent of fat-client users are convinced that they are more productive than thin-client users when the central servers or network is offline. This is also indicative as to

why fat-client users prefer fat-client devices over thin-client. Users that depend entirely on their computer system to function should have fat-clients allocated to them otherwise user productivity may be lost when systems become unavailable.

4.3.27 Performance: User Dependence on Fat-clients

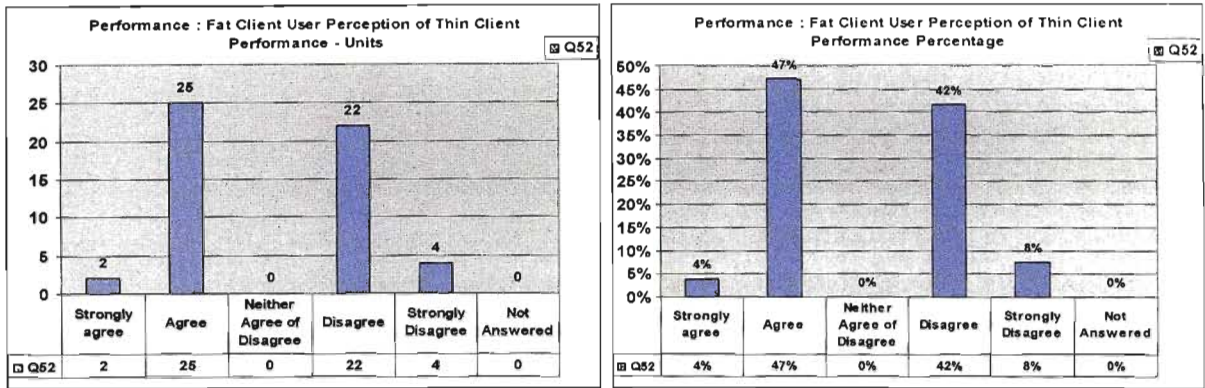


Figure 4.27: Question 52 – Performance: User Dependence on Fat-clients

At least 51% of fat-client users agreed that thin-clients operated faster than fat-clients whilst 49% disagreed. Fat-client users have significantly positive feedback from thin-client users on performance. This may be a key motivation for fat-client users to move to a thin-client platform. It would enable the transition and change-management.

4.3.28 Test Preference of Fat-client Users for Thin-client Device

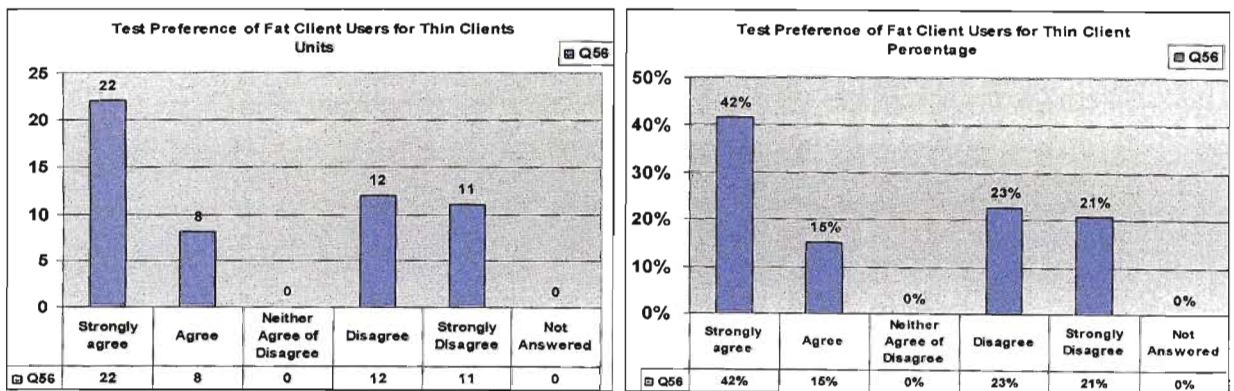


Figure 4.28: Question 56 – Test Preference of Fat-client Users for Thin-client Device

Fifty-seven percent of fat-client users agreed that if given adequate training they could move to a thin-client platform whilst 43% disagreed. Over 50% of the fat-client population are willing to move to a thin-client platform. This could be effortlessly achieved if users were appropriately transitioned through change-management and communication. This would ease

change-management initiatives and imply cost savings on the TCO calculation for the thin-client environment.

4.4 Factors and Cost Implications of an Outsource of Thin-clients vs. Fat-clients

According to IBM DMS (2005) a managed desktop service offers an effective and easy approach, assuring the reduction of the Total Cost of Ownership (TCO) of the desktop infrastructure deployed within an organisation. This offering also allows National Ship Chandlers to receive the best possible price for the hardware from IBM, and is backed by an efficient support infrastructure that contains tools and processes that will provide the desktop environment in the most cost efficient manner.

Managing and supporting a desktop infrastructure is becoming more costly and more complex for most organisations. Frequent hardware updates, the proliferation of software applications and an increasingly distributed working environment have caused the total cost of ownership (TCO) to spiral upward.

Industry analysts Gartner estimate that as much as 60% of the average company's desktop infrastructure costs can be attributed to indirect costs such as service desk problem management, virus detection and repair, backup and restore and user management. IBM defined four TCO categories with over 40 cost drivers, depicted in Figure 4.29.

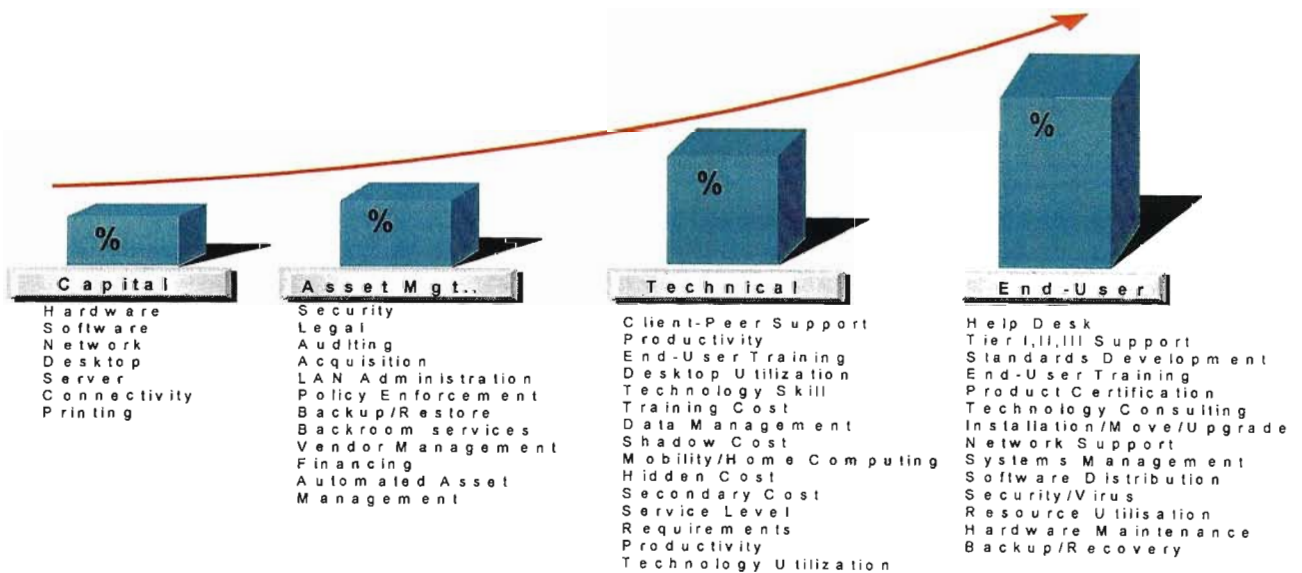


Figure 4.29: IBM's Four TCO Categories with over 40 cost drivers – Source: IBM DMS, 2005

To address these challenges, IBM introduced its Desktop Management offering, using best of breed tools, technologies and Intellectual Capital from across the IBM organization, including PCD ThinkVantage Technologies®, BlueBase® Intellectual Capital from IGS (IBM Global Service), EMEA (Europe and Middle East Africa) Wintel Development team and IBM Watson Research laboratories who have filed over 40 patents for IBM Desktop Management Services (IBM DMS, 2005).

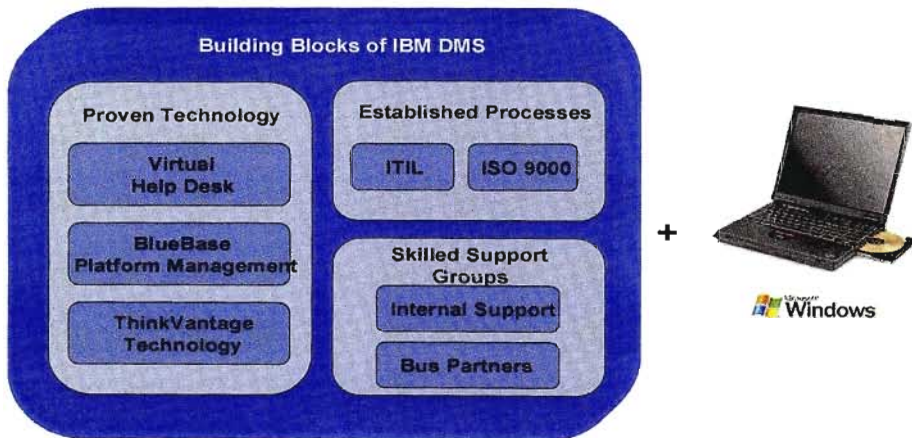


Figure 4.30: Building Blocks of IBM DMS – Source: IBM DMS, 2005

The aim of the offering is to

- Lower the total cost of ownership of the desktop environment
- Improve end user support
- Reduce the complexity in managing the desktop infrastructure
- Improve security of data and infrastructure
- Provide more predictable budgetary forecasting

The offering is designed to provide a cost effective end to end desktop management service. It combines the best elements of IBM ThinkVantage Technologies and Intellectual Capital and experience from IBM.

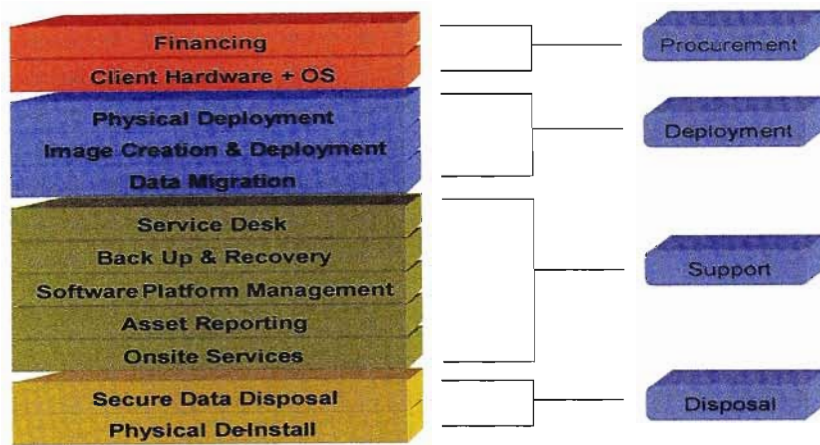


Figure 4.31: IBM DMS Offering Breakdown – Source: IBM DMS, 2005

IBM's offering on the Managed Desktop Framework identifies the range of services that will be required to comprehensively support the desktop environment as depicted in Figure 4.31.

The IBM model is aligned with the infrastructure management, service support and service delivery frameworks as defined by the best practices approach advocated by ITIL (IT Infrastructure Library) and Microsoft's Operating Framework® (MOF). Alignment with these approaches ensures that the desktop service provided is compliant to the COBIT (Control Objectives for Information and related Technology) best practice framework. COBIT provides best practices for the management of IT processes in a manageable and logical structure, meeting the multiple needs of enterprise management by bridging the gaps between business risks, technical issues, control needs and performance measurement requirements.

IBM DMS (2005) utilise the COBIT management framework for the management of the of desktop information technology infrastructure and is regarded by both Gartner and IDC as a best practice framework. COBIT (Control Objectives for Information and related Technology) is a framework that suggests an approach to Information Technology management with the objective of ensuring that the technology delivers the information that meet the business needs of the entity. COBIT intends to provide management with answers to the following traditional questions:

- What is the issue/problem?
- What is the solution?
- What does it consist of?
- Will it work?
- How do I do it?

COBIT is a business orientated framework that identifies 34 information technology processes, grouped in 4 domains, and is supported by 318 detailed control objectives. Each one of the 34 processes references IT resources, and the quality, fiduciary and security requirements for information. Figure 4.32 depicts the COBIT Framework.

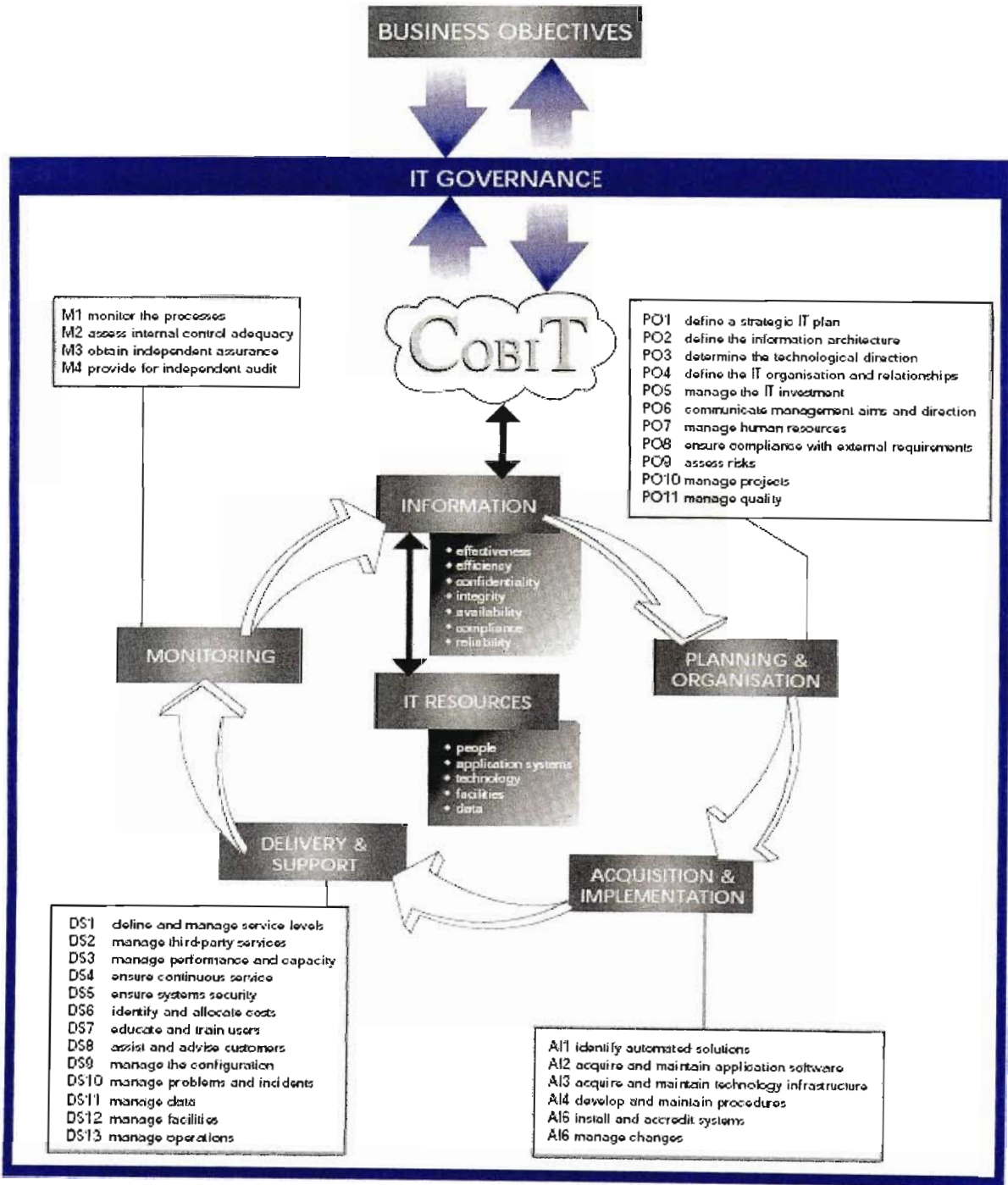


Figure 4.32: COBIT Information Technology Governance Framework – Source: IBM DMS, 2005

CobiT provides a generally applicable and accepted standard for good IT security and control practices to support management's needs in determining and monitoring the appropriate level of IT security and control for their organisations.

Further, the COBIT Management Guidelines are generic and action orientated for the purpose of addressing the following types of management concerns:

- Performance measurement - What are indicators of good performance?
- IT control profiling - What's important? What are critical success factors for control?
- Awareness - What are the risks of not achieving our objectives?
- Benchmarking - What do others do? How do we measure and compare?

Figure 4.33 (IBM DMS, 2005) depicts the elements that will be applied as a managed outsourced service to National Ship Chandlers for their desktop environment. Each of the elements are interconnected to provide a well managed environment with best practices, minimal risk and least cost to company.

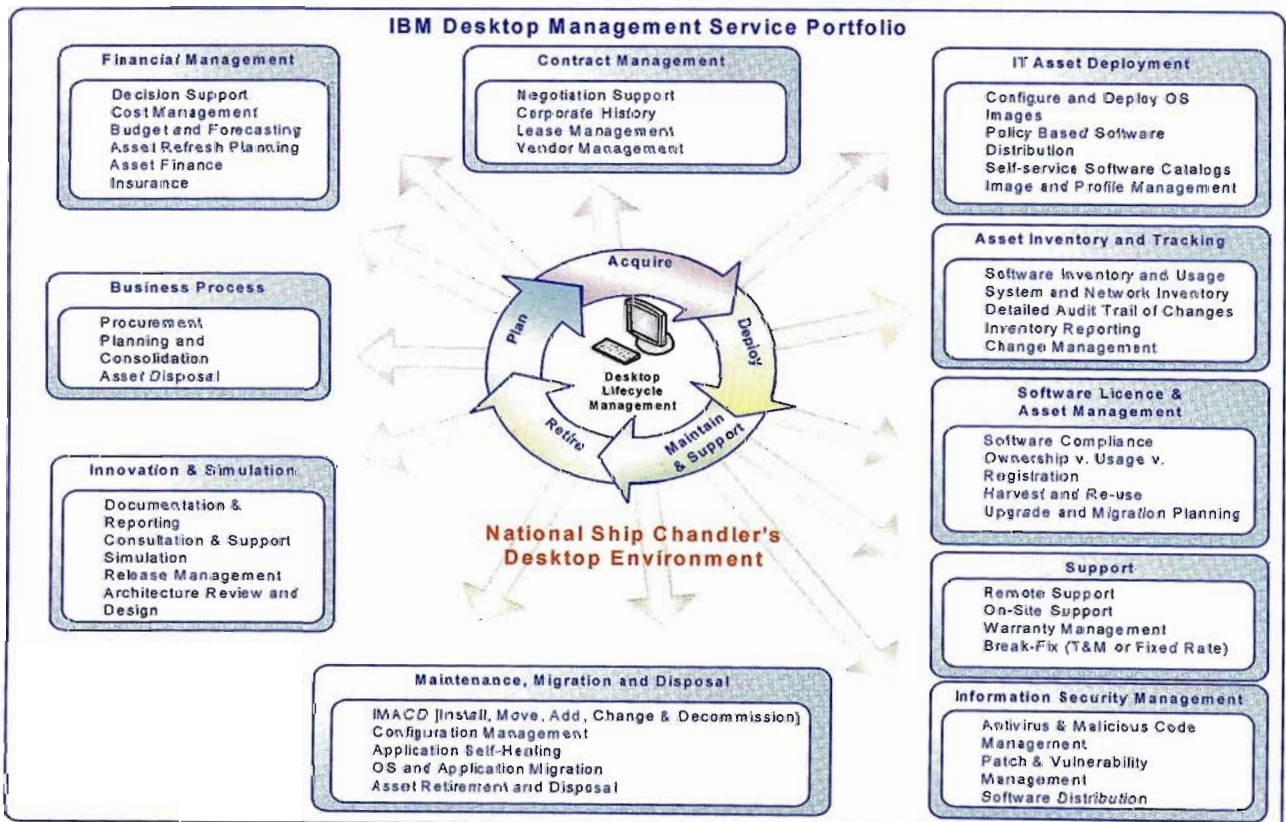


Figure 4.33: IBM Desktop Managed Service Portfolio – Source: IBM DMS, 2005

These combined frameworks of ITIL, MOF and COBIT will assist to provide a pragmatic rollout for the desktop outsource for both thin-clients and fat-clients. It is also imperative to

outline all the risks and costs associated, which is paramount in concluding the TCO between them.

4.5 Total Cost of Ownership Calculation of Thin-clients versus Fat-clients – Outsourced Desktop Environment

Reducing Total Cost of Ownership (TCO) alone is a compelling reason to move to thin-clients for nearly all organisations. For a study group of 2500 clients and 35 servers, Gartner Research (2002) reports a thin-client TCO of at least 25% less than unmanaged or poorly managed PCs. The payback period for rolling out the sample set of 2500 thin-clients, even taking into account the cost for new servers and server-side software licenses, is approximately three months.

Gartner Research (2002) also reports, however, that the TCO differential between thin-clients and extremely well managed PCs may be negligible. Well-managed PCs, according to Gartner, are ones that are locked down to prevent software installation or changes by users and are managed with a set of tools that allow central administration. In a real sense, “well-managed PCs” by their definition, are little more than elaborating thin-clients. It is important to realise, however, that Gartner’s well managed PCs still contain moving parts and, despite best efforts, may not be locked-down as securely as network administrators would like them to be.

4.5.1 Protecting the Assets of the Organisation

To a growing extent, all organisations are driven by the information contained within their computer systems. Consequently, they are placing increasing emphasis on securing it, while at the same time, making it accessible whenever and wherever it is needed.

The elimination of floppy disk drives on the desktop through the implementation of thin-clients has significant benefits. It eliminates the carrying virus infections and ensures that data on the servers is always current. Standard data centre backup procedures also assure complete backups.

4.5.2 Remote Management and Administration

One of the key benefits of thin-clients is that all maintenance and control functions are centralised. While this requires a greater investment at the central site for redundancy, fail-

over and staffing, the near-zero costs of remote maintenance afforded by thin-clients makes the case quite compelling, especially as the number of remote locations containing client devices increases. Figure 4.34 illustrates the relative cost advantage of thin-clients as the number of locations increases (from left to right in the illustration).

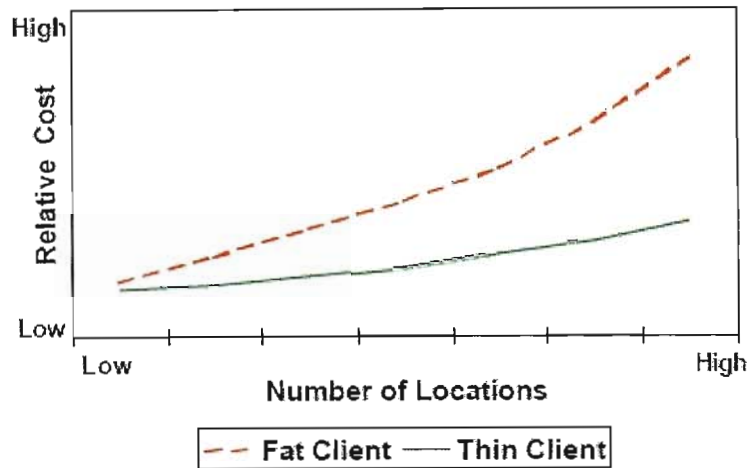


Figure 4.34: Cost against Number of Fat-clients versus Thin-clients – Source: Harvard Computing, 2002

An example of tangible annual savings from deploying thin-clients, a California university research lab has reduced their annual maintenance budget since converting to thin-clients. In the past, they allocated an amount equal to 10% of their annual PC purchase budget for maintenance. Now, their annual thin-client maintenance budget is 2% of their expenditures on new systems (Harvard Computing, 2002).

While the mean time between failures (MTBF) for current generation PCs may be quite good, the MTBF for thin-clients is five to 10 times higher. Most of the added reliability stems from two primary hardware and software factors:

- Elimination of moving parts (which are the most likely to fail)
- Elimination of complex operating system and application software.

Most organisations keep a small stock of replacement thin-clients on hand for those very rare cases when one fails. Petronet, a division of Transnet maintains an inventory equal to about 4% of their thin-client population for this purpose.

The Mean Time to Repair (MTTR) for thin-clients is also superior to that for PCs for most types of failures. In the worst-case scenario, when the entire device must be replaced, a new

thin-client can be plugged in and running in less than five minutes. Installing the hardware and configuring the software for a replacement PC could take hours.

	Thin-Clients	Fat-Clients
	Time - Minutes	Time - Minutes
Hardware Installation	10	10
Install & Configure Operating System - Windows XP	0	45
Install Applications & User Profiles - MS Office	0	30
Test	5	5
Total	15	90

Table 4.17: Estimated Average Time for deploying a thin-client versus fat-client – Source: Interview with IBM Engineers, 2006

This is made more evident in Table 4.17 which qualifies this point. It depicts an estimated average comparative time for deploying a thin-client versus a fat-client. The times included installing and configuring Windows XP will relevant drivers, installing the users profile onto the network, installing Microsoft Office 2003 and testing. It takes 6 times as long to deploy a fat-client as it takes to deploy a thin-client, that is, 15 minutes to deploy a thin-client and 90 minutes to deploy a fat-client.

4.5.3 Application Lifecycle Management

The process by which organisations develop, test and deploy new applications can be extremely time consuming and labour intensive. In a traditional fat-client environment, the problem is exacerbated by the sheer variety of PC configurations and operating systems that must be tested to ensure that applications function properly on every desktop configuration.

In addition, every new or revised software version, and there may be many in the development cycle for a major application may require an IT staff person to visit each desktop. Even if an organisation uses software management tools that allow them to push changes out to desktop computers, variations in desktop PCs may force IT staff to visit a considerable number of machines for every software update.

A final challenge in the traditional fat-client environment is that software upgrades in large, distributed environments often need to be scheduled over an extended period to ensure sufficient IT staff time to accomplish the upgrades. As a result, users throughout the organisation may end up running different software versions for some period of time. During

this time, there may be a loss in productivity because of the questions or problems that arise from the software differences.

In addition, this can put an added burden on the support department, further slowing the deployment throughout the organisation. While thin-clients don't eliminate all of these problems, they certainly contribute to a vastly smoother and easier application deployment. First, new versions of applications only need to be installed once on the server. Second, assuming an application does not need to take advantage of specialised hardware features on specific thin-client models, if the application works on one thin-client, it will work on all of them. Finally, because software installed on the server is automatically running on every thin-client, the organisation does not have to deal with multiple software versions in use at one time.

4.5.4 Information Security Management on Thin-clients

A key benefit of thin-clients is the ease of securing a centralised environment. Rather than relying on end users to update their security settings, IT personnel can maintain all security software, making sure it is consistent and up-to-date across all thin client users (Wyse, 2003).

Furthermore, most thin clients do not have hard drives. Thin-client users are also restricted from inserting a USB (Universal Serial Bus) memory stick into the device and thereby moving information into or out the computer environment. This means that they cannot act as a haven for viruses or as a means of losing important intellectual property, as often happens when notebook computers are stolen. Because thin clients do not function without a centralised server, they are less of a target for thieves.

Furthermore, modern thin-clients today support a range of security features such as smart cards, biometric devices, multiple user accounts and access levels, multi-level security, auto-connect, and auto-failover to backup devices.

Information security for National Ship Chandlers is an absolute and uncompromising element. If their information is compromised a single order from a ship averages \$100, 000 US dollars is at risk, including ongoing business thereof which could translate into millions of dollars. By utilising thin-clients no information can be moved electronically and therefore securing the organisation.

4.5.5 The Cost Calculation Model

The choice of desktop allocated is based on the business profile of each user. The job-function and requirements of the user dictate whether users are power-users and require the additional functionality required by their desktop and deem them an allocation of a fat-client, whether laptop or PC. Based on consultation with the management of National Ship Chandlers the following minimum mandatory requirements were defined across the regional offices of National Ship Chandlers. Management and supervisors who require PCs or laptops are defined by the CEO. They are all defined by default as power-users or super-users. Table 4.18 defines the minimum desktop requirements landscape for National Ship Chandlers across the country.

Minimum Mandatories of Desktop Allocation

	Number of FC - Laptops	Number of FC - PCs	Total
Durban	4	5	9
Richards Bay	0	2	2
Port Elizabeth	0	2	2
Cape Town	0	5	5
Total Minimum Fat Client Requirements			18

Table 4.18: Mandatory Number of Fat-clients required at National Ship Chandlers – Source: Interview with CIO, 2006

Therefore the common denominator for an outsource costing for both fat and thin-clients will always be 18 fat-clients as per minimum requirements defined by the business. These 18 fat-clients will remain a constant irrespective of thin or fat-client desktop platform. Therefore the costing exercise below will draw a comparative analysis between the balances of desktop users, that is, 77 thin-clients versus 77 fat-clients. Table 4.19 provides a breakdown of this rationale.

Common Denominator for Fat Clients vs Thin Client TCO Analysis

	Number of Thin Clients	Number of Fat Clients
Mandatory Fat Clients Constant	18	18
Outsource Comparison Analysis	77	77
Total Desktops	95	95

Table 4.19: Common Denominator Constant for Fat-clients – Source: Interview with CIO, 2006

Table 4.20 is a detailed comparative analysis of the Total Cost of Ownership (TCO) of thin-clients versus fat-clients in an outsourced desktop environment. All detail calculations are attached as Appendix 6.

The costs derived are confined to the following limitations:

- Management defined the number of super-users for each region that will be allocated fat-client devices, that is, 18 in total.
- File servers are priced for each of the environments because they have a direct impact on the TCO calculation.
- WAN link tariffs are also priced as a result of the different bandwidth requirements by thin-clients versus fat-clients, and directly impacts the TCO calculation.
- Fifteen percent margin is applied to cost prices obtained from distributors on hardware and software
- Pricing calculated at 18% interest rate including bank charges.
- All prices are South African Rand value, calculated: August 2006 – November 2006 and exclude Value Added Tax (VAT).
- The service provider that will be servicing National Ship Chandlers has service centres at each of the regional sites.
- Any dollar prices are calculated at fixed exchange rate of \$1.00 = R7.00
- Monitors are a constant cost factor and therefore NOT factored. This includes end-user licenses for Microsoft Exchange[®] and Active Directory[®] access.
- The outsourced costing is based on IBM's Desktop Management Service (DMS) offering as defined in Section 4.4.

Mean-Time-To-Failure (MTTF) for both fat-client and thin-client environments are calculated on actual values obtained from National Ship Chandler's IT Manager on current fat-client and thin-client quantities. Based on 77 fat-clients and 77 thin-clients, the MTTF values were then proportioned accordingly to yield a projected MTTF for each environment. Microsoft Exchange Servers were also priced into TCO calculations for both environments due to impact of number of Exchange Servers required and therefore further software licensing cost implications.

Total Cost Of Ownership(TCO) Analysis for National Ship Chandlers of Thin Clients vs Fat Clients

* This analysis endeavours to assist in making a business decision on technologies of choice

* This analysis does not constitute a fixed methodology to the TCO calculation for generic environments

MBA Dissertation Research
2006



Contributing Cost Factors		Quantity for TCs	77 Citrix Thin Clients (TC)	Quantity for FCs	77 Fat Client (FC) - PCs	Assumptions
1	Mean Time to Failure & Mean Time to Repair - average per month	1	R 288.31	7	R 1,729.86	All devices are located at designated sites i.e. Durban, Richards Bay, Port Elizabeth & Cape Town. Actuals over 12 month average on hardware failures : 12 Thin Clients failed & 84 FCs failed as per proportionate calculations per annum. Travel is calculated on average distance i.e. 33km return + 1 hour labour per device with separate call out charges. This excludes costs of repair or swap outs as all hardware will be under a separate maintenance contract. Costs calculated as at August 2006 - October 2006 - CALLS ARE HARDWARE FAILURES ONLY. NO application related calls were taken into account
2	Hardware Costs of Workstations of Thin Clients vs Fat Clients financed over 3 years	77	R 7,388.37	77	R 17,488.39	PCs include operating system with 3 year onsite warranty 1GB RAM, 40 GB HDD @ R6,262.35. Thin Clients configured with 256MB RAM with Windows CE @ R2,654.12. No Monitors included in both scenarios. 36 month financed hardware for both TCs & FCs.
3	WAN Costs for each Totalled per month	-	R 12,821.25	-	R 9,505.770	TCs use 8kbps bandwidth each, FCs bandwidth utilisation is erratic as it is client server based. FCs save data on home directories on file servers.
4	Desktop Management for Remote Control & Software Deployment	77	R 0.00	77	R 8,457.32	Server Hardware to run Desktop Management and Software Distribution requires rack mount cabinet, and are single processor boxes. 36 month finance on hardware, software and installation - Infrastructure required : running Microsoft SMS Server - 3 servers + all running Windows 2003 Adv Server, 1 X SQL Server License, 1 X SMS Server
5	Citrix Licensing vs XP Licensing on Desktops	77	R 6,884.83	77	R 0.00	R2164.70 per user per month for licenses and R308.53 per user for 2 year maintenance for on licenses to yield 3 year software maintenance. For Fat Clients cost of OS is included in hardware purchase
6	Server Hardware Farm for Citrix Servers vs Distributed Servers and Backup Distribution	77 TCs	R 12,668.22	77 PCs	R 11,493.70	3 X x336 IBM Citrix Servers. Storage for Thin Clients on File Server located at HQ. For FC Environment : 1 X File Server for Head Office (Cape Town) - Same config as file server with single processor with 3 X 73GB HDD, 40/80GB DLT Tape Backup Drive & 1 X Exchange Server, 1 X File Server with Exchange Server installed for each site i.e. Port Elizabeth, Richards Bay & Cape Town on single server.
7	Server Admin and Management - Monthly and sanity checks	-	R 11,400.00	-	R 15,200.00	TCs : 60 hours Citrix Support per month versus; FCs : 80 hours for 1 additional file server at HQ, 3 Additional Exchange and file servers at remote sites + Administration of SMS Services
8	Antivirus for Client PCs and Servers vs Antivirus on Citrix Server Farm	77 TCs	R 142.62	77 PCs	R 1,128.06	TCs & FCs : Trend Neatsuite from Secure Data, includes entire suite from email server scanning to web security etc. for 77 clients on Citrix Financed over 36 months. Costs per user - Server-side is free
9	Software Upgrades : Contingency for 2 software upgrades per annum for software applications - visit all workstations	77 TCs	R 0.00	77 PCs	R 1,411.66	Fat Clients: 30 Minutes per PC twice per annum => 77 hours labour at R220.00/hour = R1694/year => R1411.66/month; Thin Clients: Application upgraded on single instance on server and instantly all users are upgraded
10	Training Implications : Hands-on	77 TCs	R 178.75	77 PCs	R 715.00	For FC Users : Training for end-users 30 per fat client user hands-on 77 users per annum = 39 hours @ R220/hour = R8580 per annum => R715 per month. For TC Users: Training for end-users is on Citrix Server training 20 users at once by taking control of screens 25% the cost => R178.75 per month
11	Help Desk Calls Logged on Average per Month as per Questionnaire Survey	219	R 3,394.50	332	R 5,146.00	Fat Clients: 332 call per month on average R15.50 per call = R5,146; Thin Clients: 219 calls per month on average @ R15.50 per call = R3,394.50
12	Security of Data - PCs vs Centrally stored and control via Citrix	-	-	-	-	The security of company information is very difficult to attribute monetary value to, but is the most expensive if compromised
Outsource including WAN Costs per Month			R 55,166.85		R 72,275.77	
SAVING PER MONTH INCLUDING WAN COSTS				R 17,108.91		
Outsource Excluding WAN Costs per Month			R 42,345.60		R 62,770.00	
SAVING PER MONTH EXCLUDING WAN COSTS				R 20,424.39		

This analysis is confined to:

* The dynamics of the National Ship Chandlers environment as at August 2006

* Calculated with finance over 36 months explicitly

* Exclusively hardware calls made to helpdesk relating to Thin Clients

* Call rates do NOT reflect those that maybe experienced in an outsourced environment

* Does NOT include costs associated with the SAN in either Thin Client or Fat Client scenarios

* For 95 desktop user environment with 18 fat client users as a constant.

* WAN costing as supplied by Telkom Telematic Tariffs Software

* Does NOT include application level calls and support

* New Hardware Infrastructure to be Costed for both Environments

Table 4.20: Total Cost Ownership Analysis of Thin-clients versus Fat-clients in Outsourced Desktop Environment

4.6 Hypothesis Testing and Results

The hypothesis H_1 and null-hypothesis H_0 and other extraneous variables defined in Section 2.7.1 were evaluated through the questionnaires and interviews at National Ship Changers. H_1 is the Hypothesis and H_0 the Null-Hypothesis.

Hypothesis H_1 : The Total Cost of Ownership (TCO) of a Thin-client (TC) **IS** **lower/less than** the Total Cost of Ownership (TCO) of a Fat-client (FC) in an outsourced desktop environment.

$$TCO_{TC} < TCO_{FC}$$

THIN-CLIENTS: $TCO_{TC} = R\ 55,166.85$ per month for 36 months

FAT-CLIENTS: $TCO_{FC} = R\ 72,275.77$ per month for 36 months

$$R\ 55,166.85 < R\ 72,275.77$$

Resulting in a monthly saving of R17,108.91

Therefore: $TCO_{TC} < TCO_{FC}$

AND H_1 IS TRUE

WHILST NULL HYPOTHESIS

Null-Hypothesis H_0 : The Total Cost of Ownership (TCO) of a Thin-client (TC) **IS GREATER** **than** the Total Cost of Ownership (TCO) of a Fat-client (FC) in an outsourced desktop environment.

$$TCO_{TC} > TCO_{FC}$$

H_0 IS FALSE

Independent Variables: Thin-clients and Fat-clients in an outsourced desktop environment

Dependent Variables: Lower Total Cost of Ownership

Extraneous Variables:

- Purchase price of all hardware and software
- Training costs of new owner of device
- Software application cost change to maintain compatibility

- Maintenance and support costs for keeping the desktop hardware device operational
- Environmental changes required to permit connectivity on the computer network
- Technical support contract(s), personnel and procedure(s) in place for the desktop device
- Information Security
- System Availability and business productivity loss due to unavailability thereof.

4.7 Conclusion

Based on both qualitative and quantitative research methodologies and the specified dynamics of the National Ship Chandlers desktop computing environment, the hypothesis held true. Some of these key dynamics are:

- the number of desktop users,
- nature of job function of users,
- IT support staff,
- training, management of IT services to the desktop environment, hardware costs,
- software costs,
- information security,
- end-user commitment through change-management,
- management commitment

Mulders, (2002) expressions that organisations are continually searching for better ways to manage their information technology investments and to ensure that they remain relevant and affordable into the future is evident in National Ship Chandlers quest the same. Mulders, (2002) further elaborates that since thin-client technology offers a promising enhancement to vast, distributed, divergent and costly computer systems, organisations should adopt a thin-client model to improve the performance, security, and efficiency of its information technology architecture. A managed desktop environment within the context of an outsource realises these benefits because it contributes to the significant aspect of the management of the environment. Without proper management, savings may not be realised.

Tolia, Andersen and Satyanarayan's (2006) outlined distinct factors that motivate interest in thin-clients, the concentration of personal computing into central server farms due to the physical dispersion of personal computing hardware which complicates system administration. For example, isolating an infected machine, forcing certain security upgrades, or restarting a crashed machine are examples of actions that typically require physical access to the hardware. Concentrating all computing in centralised server farms simplifies this physical access. Rather than walking from machine to machine, access is available at the system administrator's fingertips in a server room. National Ship Chandlers' endeavors to reduce administration costs and increase operational efficiencies may be realized through their thin-client computing efforts.

Volchkov, (2002) expressed that the principal advantages of thin-client implementations are reduced maintenance and support for client terminals, a standardised corporate client terminal, and centralised resources management. All of these in turn make it easier to support increased employee mobility and the deployment of heavy client-server applications at remote locations or subsidiaries because of less bandwidth usage.

There are many other soft people-issues that need to be taken into consideration when undertaking such an exercise such as equality of personnel in using the computer system and motivation thereof. These can significantly skew the result because ultimately the end-users are the owners of any computer system and can realise the success or failure of it. World-class computer systems and applications that are developed and deployed without end-user buy-in often result in complete failure due to lack of end-user commitment. Badly developed systems and applications with support from end-users yield significant success. It is therefore of paramount importance to ensure significant effort is placed on change-management initiatives to realise the successful implementation of a thin-client environment.

CHAPTER 5: RECOMMENDATIONS AND CONCLUSION

5.1 Introduction

It is imperative for National Ship Chandlers that conclusive findings are made, as it will have a direct impact on the strategic future of the desktop environment and the financials of the organisation through realisable cost savings. However the research proves these savings to be realised is of significant value to other organisations in a similar industry in South Africa and elsewhere in the world. The conclusion of the study would also reflect the user's acceptance of the current thin-client environment since their migration in 2002 from fat-clients.

The primary objective of this study is to establish whether thin-clients do indeed deliver a lower Total Cost of Ownership (TCO) than fat-clients. The conclusion of this study will allow National Ship Chandlers to understand whether they indeed did realise a lower TCO from migrating from fat-clients to thin-clients 3 years ago. This study is paramount to National Ship Chandlers business as it complements their consolidation, cost reduction and refocus of core business deliverables (ship chandling) strategies. It will also assist the industry by contextualising the feud of the Total Cost of Ownership between thin-clients and fat-clients.

5.2 Evaluation of Objectives of Research

In Section 1.8 the objectives of this research were outlined. These objectives will now be cross-reference with our findings to understand whether any were met. The following objectives were set and findings drawn:

- **Objective:** To determine all extraneous variables not already identified that will contribute to costing a TCO for a desktop environment

Findings: Variables identified were:

- nature of job function of users,
- end-user commitment through change-management,
- management commitment

- **Objective:** To outline in detail all extraneous variables.

Findings: A number of variables were identified and used in calculation the TCO costing model of which they are:

- the number of desktop users,
- nature of job function of users,
- IT support staff,
- Training costs,
- management of IT services to the desktop environment,
- hardware costs,
- software costs,
- information security,
- end-user commitment through change-management,
- management commitment

- **Objective:** To evaluate end-user acceptability of thin-client usage.

Findings: From the statistical analysis the majority of the thin-client users were satisfied with their thin-clients. Eighty-six percent of thin-client users expressed a minimum 'satisfactory' level of utilising thin-clients. The 86% comprised of the following categories of levels of satisfaction:

- 10% 'excellent'
- 36% 'very good'
- 21% 'good' and
- 19% 'satisfactory'

This clearly suggests that over 80% of the users that had been migrated from fat-clients to thin-clients have accepted their thin-clients and are happy with operations thereof. Furthermore, based on questionnaire surveys 62% of the thin-client users opted not to move back to a fat-client environment. This concludes that the majority of thin-client users have accepted and are satisfied with their thin-clients.

- **Objective:** To identify the impact of training and change-management in migrating from PCs to thin-clients.

Findings: One-hundred percent of thin-client users responded that they were both communicated with and trained on thin-clients before the migration was undertaken. Thus training and change-management initiatives were put in place and executed to the satisfaction of the thin-client users which yielded a positive thin-client acceptance result.

- **Objective:** To construct a cost model for the TCO for both a thin-client and fat-client environment within National Ship Chandlers, based on an outsourced desktop solution.

Findings: Based on qualitative research methods of mapping the IBM DMS (Desktop Management Service) offering to National Ship Chandlers and quantitative research methods of questionnaire surveys on thin-client users, a costing model was developed using the significant cost factors as outlined in Section 4.6.5. Significant cost factors attributed to both thin-client and fat-client environments included:

- Mean-Time-To-Repair (MTTR)
- Hardware Costs
- WAN Costs
- Desktop Management for Remote Control and Software Deployment
- Citrix Licensing vs. XP Licensing on Desktops
- Server Hardware Farm for Citrix Servers vs. Distributed Servers
- Server Admin and Management for each of the environments
- Antivirus for fat-clients vs. Server-side for thin-clients
- Software Upgrades per Annum. Based on number of fat-client workstation visits
- Training implications for each environment
- Number of helpdesk calls for each environment based on questionnaire survey
- Security of Data – Costs to this cannot be easily quantified.

There are other soft, people-issues that also contribute to user acceptance and ultimately the TCO for each of the environments which cannot be measured but management have to take cognisance of. Motivation, change-management, open communication between users and management and the impact of morale with respect to utilising the system with flexibility, without compromising security (access to computer games) are some of the soft, people-issues identified.

- **Objective:** To evaluate and contrast the cost structures against each other.

Findings: To facilitate this evaluation a hypothesis (H_1) was defined together with a null-hypothesis (H_0) and tested against the results of the data analysis. Costs were calculated with projections over a 36 month period.

Hypothesis H_1 : The Total Cost of Ownership (TCO) of a Thin-client (TC) **IS lower/less than** the Total Cost of Ownership (TCO) of a Fat-client (FC) in an outsourced desktop environment.

$$TCO_{TC} < TCO_{FC}$$

THIN-CLIENTS: $TCO_{TC} = R\ 55,166.85$ per month for 36 months

FAT-CLIENTS: $TCO_{FC} = R\ 72,275.77$ per month for 36 months

$$R\ 55,166.85 < R\ 72,275.77$$

Conclusions were that a monthly saving of R17,108.91 could be realised through implementation of thin-client technologies over fat-client technologies at the defined research environment.

Therefore: $TCO_{TC} < TCO_{FC}$

AND H_1 IS TRUE

- **Objective:** To provide recommendations for strategic direction into the future for National Ship Chandler's desktop environment.

Findings: It is recommended that National Ship Changers outsourced their thin-client desktop environment on a thin-client platform as the hypothesis H_0 proves true i.e., the Total Cost of Ownership (TCO) of thin-clients is less than the Total Cost of Ownership (TCO) of fat-clients in an outsourced desktop environment.

The organisation can envisage an approximate saving of 23% per annum by implementing a thin-client desktop platform over a fat-client platform.

It is an imperative to note that thin-clients are NOT a panacea for the desktop platform in organisations today but yield a lower Total Cost of Ownership (TCO) depending on the organisational dynamics, management and users of the technology.

5.3 Recommendations

According to a survey of executives in North America by market research firm International Data Corporation (2004), the top concern that is keeping information technology executives awake at night is security. It's deemed more important than even cost containment and cost reduction. And no wonder. Enterprises today face an increasing diversity of threats to their information infrastructure, at a time when business success directly hinges on the resilience of that infrastructure. Malware such as viruses, worms and Trojan horses can cause devastating financial consequences. In June 2004, mi2G (Intelligence Unit) raised its estimate of the probability of a catastrophic global malware attack with damage surpassing \$100 billion from 2.5 percent to 30 percent. Computer and data theft also pose serious threats. According to the 2003 BSI Computer Theft Survey, nearly half of respondents experienced computer theft or worked for an organisation that had. Thieves were rarely caught and the value of the stolen data averaged more than \$690,000 per system (International Data Corporation, 2004).

Government regulations, such as the Sarbanes-Oxley Act in the United States and the ECT ACT in South Africa, add a new dimension to managing risk. Now corporations can incur steep fines or even criminal prosecution for failing to secure customer data and other information needed for financial audits or lawsuits.

IDC projects that spending on security and business continuity will grow twice as fast as total IT spending over the next several years, reaching more than \$116 billion by 2007 (International Data Corporation, 2004).

Most of this money will go toward securing what is the collective Achilles heel of most organisations which will be unprotected desktop, telecommuter and road warrior PCs and notebooks.

Information security has always involved protecting the network's gateway to the Internet, but today's attacks often proliferate via unprotected PCs. Unless all network endpoints which include uncooperative users are kept current with the latest anti-virus, spyware and operating system patches, the enterprise is at risk. Even if all systems were somehow kept up-to-date, application-level attacks for which patches have yet to be released could infect networks in a matter of hours or even minutes.

For many enterprises, especially those with sensitive security profiles, desktop and notebook security management can be overwhelming. Add to this the management and support burden inherent in the PC life cycle, and often organisations have a costly and risky problem that will only worsen as access devices proliferate.

Thin-clients redefine the landscape depicted above as can be seen from this study where the Total Cost of Ownership (TCO) yield lower for thin-clients than fat-clients. Businesses today are able to realise return on investments IT infrastructure and it has become an enabler rather than a burden to protect and maintain.

National Ship Chandlers will realise a cost saving of **R 17,108.91** per month for **36 months** if a thin-client solution is implemented as opposed to a fat-client solution. Cost savings per annum amounts to **R 205,306.92**, this is a relative **saving of 23.67% per annum** to fat-clients.

It is therefore recommended that National Ship Chandlers together with a preferred IT services provider plan and implement a thin-client desktop outsource over a fat-client desktop outsource with estimated savings of 23% per annum.

5.4 Areas of Future Research

Both Gartner Research (2002) and IBM DMS (2005) predict that the traditional PC (Personal Computer) and Laptop will become less pervasive between 2006 and 2010. This is due to the rapid development and penetration of cellular technology and cellular phones. With the integration of cellular phone functionality with limited laptop technology and entertainment devices like MP3 players, an enormous chunk of the desktop market will become depleted by mobile users. Cellphones like the i-Mate and Nokia 9300 and 9600 to mention a few provide the user the full experience of a laptop, MP3 Player, camera and cellular device in the palm of your hand. These devices are equipped with operating systems such and Microsoft

Windows Mobile 5.0, Symbian OS and Linux, providing the mobility and versatility of the 'office on the move'. With these technologies becoming more pervasive and compatible with MS Windows based applications, users today can run thin-client software on their cellular phones and via GPRS (General Packet Radio Service) technology connecting into servers farms and perform all office functions from literally anywhere in the world. They would have only otherwise able to perform this whilst sitting at their office or via broadband internet connection. Significant research can be undertaken to look at performance implications on utilising thin-client technologies on cellular data carrier networks. Furthermore, the total cost of ownership for mobile users utilising these technologies, versus being office bound with respect to user productivity can be researched.

Research into thin-client platform offerings for utilising Open Source technologies like Linux and Linux Terminal Services can be comparatively costed against Microsoft and Citrix to analyse which would yield a lower total cost of ownership. Thin-client connectivity is becoming more and more available to all users connected to any data line that can provide an 8kbps link, which is the minimum required for operation of a thin-client.

5.5 Conclusion

Ease of use, security and reliability make thin-clients practical for occasional users who don't have their own computers. In factories and warehouses, and in any business with multiple shifts or high turnover, thin-clients are ideal for occasional or shared use. By logging onto any shared workstation, workers can check their human resource benefits, surf the Web or send and receive e-mail. With no moving parts such as fans and disk drives to break down, thin-clients are more reliable than PCs and well suited to harsh industrial environments such as factories, warehouses and loading docks. Furthermore the thin-client operating environment is easy to use compared with the typical PC, so even occasional users require little training. Multiple users can share the same thin-clients by logging-on using their unique security identifications, and wireless mobility allows deployment wherever the wireless network reaches.

Organisations looking to implement thin-client technology have many options from which to choose. Options include Windows-based, web-based, ASPs, and Java applets-based solutions. One of the most important items that should be addressed when embarking on a thin-client desktop strategy is planning. The server-side should be carefully planned for

scalability, which is the key to fast server performance. In addition, the overall performance also depends on the number and types of applications being served. Another factor that should be considered is the overall cost of the implementation.

Thin-clients offer significant business benefits in an era when IT has to deliver more with less. To achieve these benefits, an organisation's management has to be focused and committed since thin-client technology involves considerable change. Management of organisations should realise that the key business benefits offered thin-clients come through good project strategy, design and roll out. The issues that need to be resolved before reaching a key benefit are often subtle and require detailed expertise. IT management should work with their organisation to choose a limited set of business deliverables rather than adopt a scatter-gun approach.

Many organisations today are struggling to reconcile key challenges of how to secure the IT infrastructure and information assets while creating an agile, effective enterprise by providing access to applications and data at the point of sale/point of service. Thin-client computing addresses these challenges by delivering reliable, secure access in a centralised, cost-effective architecture that is easier to secure and manage than PC-based, fat-client computing. Every IT business executive should explore its potential to improve their business and technology operations.

James Burke noted once that, "Never have so many understood so little about so much." A case in point when IT directors are faced with the difficult task of delivering technology-dependent services whose value is difficult to quantify and hard to measure. With the acceleration of information technology, we find ourselves faced with the constant challenge of balancing services, costs, and outcome. The gap between budgets and the cost of acquiring and maintaining IT is widening year after year. IT managers are puzzled by the falling prices in the home PC market and the IT department's continuing requests for additional larger budgets. We must create new alternatives to the upward spiralling costs of desktops. Thin-clients are by no means a panacea, and they pose a host of new problems not unique to network centric computing but certainly more pronounced there. These include the risks associated with single points of network failure, the need for highly trained, technically competent IT staff to manage a server based environment, the high costs of "thick" servers and redundant systems, and finally, the inevitable political problems associated with re-centralising control of computing resources in the workplace. However, that there are

workable solutions to these issues and that they do not present significant obstacles to thin-client computing. The management and cost benefits offered by these technologies are compelling, as is the case made by the fact that technology environments are evolving towards platform independent, network-centric models. Organisations and IT outsource service providers should start pay attention to thin-client computing.

This study found that for the National Ship Chandler's desktop computing environment, an approximate 23% savings can be realised over a fat-client platform. This excludes the benefits that can be realised from aspects of information security, ease of operational platform and system availability. Thin-client technology has proved to give CEOs and CIOs compelling reasons to deploy as a desktop computing architecture and will continue to grow its' market-share into the future.

REFERENCES

- Aasted, E. (2001) The Journal: *Thin Client Focus*. [Internet]. Available from: <http://www.thejournal.com/the/printarticle/?id=15494>, [Accessed: 18 August 2006].
- Alasuutari, P. (1995) *Researching culture: Qualitative method and cultural studies*. London, Sage.
- Anderson, C. (2000) Windows 2000 Magazine: *How Motorola Deployed an RDP-Only Thin Client*. [Internet]. Available from: <http://www.thinclient.net/success/motorola-rdp.htm>, [Accessed: 2 August 2006].
- Axel, (2006) White Paper: *How to Test the Performance of a Thin Client*. [Internet]. Available from: http://www.axel.com/articles/wp0001_e.html, [Accessed: 2 August 2006].
- Bernier, D. (2001), DDCEI 3, Mulders, (2002) telephone interview, 6 Feb 2001.
- Bird, D. (2003) Intranet Journal: *Is It Time to Get Thin?* [Internet]. Available from: http://www.intranetjournal.com/articles/200310/pij_10_29_03a.html, [Accessed: 2 August 2006].
- Caceres, R. (2005) "Reincarnating PCs with Portable Soul-Pads," Proc. 3rd Int'l Conf. Mobile Systems, Applications, and Services (MobiSys 2005), ACM Press, 65-78.
- Carr, D. (1999) "Thin Clients for a Fat Web," Internet World, 1 Nov 1999, 84.
- Castonguay, M.F. CFCSC J6, Mulders (2002) personal interview, 6 Mar 2001
- Chia-Chen Kuo, Ping Ting, Ming-Syan Chen and Jeng-Chun Chen, (2002) "Design and implementation of a network application architecture for thin clients," Computer Software and Applications Conference, COMPSAC 2002 Proceedings. 26th Annual International 26-29 Aug., 193-198.

Christiansen, B.O., Schauser, K.E. and Munke, M. (2004) “*Streaming thin client compression*” High performance Distributed Computing, Proceedings, 13th IEEE International Symposium, 4-6 June, 214-224.

Coleman, T.A. (1998) *Lowering the Total Cost of Ownership for the Desktop*. Proc. Conf. Educause 1998, University of Tennessee, 21 October 1998, 2-14.

Computer Desktop Encyclopedias (1998), The Computer Language Corporation Inc. [Internet]. Available from:
http://www.pcmag.com/encyclopedia_term/fat+client&i=43017,00.asp, [Accessed 28 July 2006].

Cooper, R.D. and Schindler, S.P. (2001) *Business Research Methods*, 7th Edition, McGraw-Hill Companies, Inc. New York.

Cronbach, L.J. (1951) Coefficient alpha and the structure of psychometric tests, *Psychometrika*, 31, 93-96.

Cruz, T. and Simoes, P. (2005) “*Enabling preOS desktop management*” *Systems Engineering*, 2005. ICSEng 2005. 18th International Conference, 16-18 Aug., 370-375.

Chen, J., Hou, G. and Ming-Syan, C. (2004) “*Multimedia over IP for thin clients : building a collaborative resource-sharing prototype*” *Advanced Communication Technology*, 2004. The 6th International Conference, 2(6), 1072-1077.

Das, T.H (1983) “*Qualitative research in organisational behaviour*”, *Journal of Management Studies*, 20(3), 311.

David, B. (2002) “*Thin Client Benefits*” White Paper, Newburn Consulting, 27 March 2002, 6.

de Camargo, V.V. and Penteadó, R.D. (1998) “*An alternative object oriented reengineering for thin-client environments*” *Intelligent Network Workshop*, IN '98. Proceedings., 7th IEEE, 10-13 May 1998, 303-313.

Friedlander, D. (2002) "*Market Overview: Thin-Client Server-Based Computing,*" Giga Information Group, Cambridge, 19.

Gartner Research (2002) "*Thin-client vs. Fat-client TCO*" Decision Framework, Document Number: DF-14-2800, 2-3.

Goldsborough, R. (2002) "Personal computing: Is the PC Dead?" Link-Up, p 9.

Goldstein, L. (2005) Campus Technology: Making the Case for TCO [Internet]. Available from: <http://www.campustechnology.com/print.asp?ID=10565>, [Accessed: 18 August 2006].

Gulfas, V.M., Abalde, C., Castro, L.M. and Varela, C. (2001) "*A new risk management approach deployed over a client/server distributed functional architecture*" Data Compression Conference, 2001. Proceedings. DCC 2001. 27-29 March, 223-232.

Gupta, A., Lin, B. and Dinda, P.A. (2002) "*Measuring and understanding user comfort with resource borrowing*" Software Maintenance and Reengineering, 2002. Proceedings. Sixth European Conference, 11-13 March 2002, 211–216.

Gutwin, C. (2001) "*The Effects of Network Delays on Group Work in Real-Time Groupware,*" Proc. 7th European Conf. Computer-Supported Cooperative Workshop, Kluwer, 299-318.

Guynes, J.L. (1988) "*Impact of System Response Time on State Anxiety,*" Comm. ACM, IEEE Press, 31(3), 342-347.

Handley, T. (2004) "*Thin Client Components,*" VIA Technologies [Internet]. Available from: <http://ftp.cyberscrub.com/articles/via.html> , [Accessed 24 August 2006].

Harvard Computing, (2002) "*Security and Desktop Architectures – The Road Ahead,*" Whitepaper, Harvard Computing Group Report.

IBM DMS, (2005) "*Desktop Management Services (DMS),*" Managed Service Offerings IBM Global Services Division, IBM Corporation.

IT World CIO Report 2005, Total Cost of Ownership: *One Step Forward, One Step Back*. [Internet]. Available from: <http://www.itworld.com/Man/2837/ITW3487/pfindex.html>, [Accessed 18 August 2006].

International Data Corporation Report (2004), "*Thin Clients: A Cost-Effective Way to Improve Security*," Executive Brief, IDC 25050-001, 1.

Jain, V. (1999) "*Code restructuring for improving execution efficiency, code size and power consumption for embedded DSPs*", 12th International Workshop on Languages and Compilers for Parallel Computing. [Internet]. Available from: <http://citeseer.ist.psu.edu/jain99code.html> , [Accessed 24 August 2006].

Kahneman, D. (2003) "*Maps of Bounded Rationality: A Perspective on Intuitive Judgment and Choice*," Nobel Prizes, 2002, Almqvist & Wiksell Int'l.

Kleaveland, B. (2000) "*Thin Client and Internet Computing*," Health Management Technology, Nov 2000, 20.

Kozuch, M. and Satyanarayanan, M. (2002) "*Internet Suspend/Resume*," Proc. 4th IEEE Workshop Mobile Computing Systems and Applications, IEEE Press, 40-46.

Krikke, J. (2005) "*Thin-clients Get Second Chance in Emerging Markets*," Pervasive Computing. IEEE Journal, 4(3), 7-10.

Lai, A. and Nieh, J. (2002) "*Limits of Wide-Area Thin-Client Computing*," IEEE AFRICON. 6th, 1(1), 31-36.

Lampson, B.W. (1983) "*Hints for Computer System Design*," Proc. 9th ACM Symp. Operating Systems Principles, ACM Press, 33-48.

Lee, T. W. (1999) "*Using qualitative methods in organizational research*," Thousand Oaks, CA: Sage

- Lenander, J. and Andersson, L. (2002) "*Thin clients and distributed servers for service management*" Africon Conference in Africa, 2002. IEEE AFRICON. 6th, 1(6), 431-436.
- Likert, R. (1932) "A Technique for the Measurement of Attitudes," Archives of Psychology, New York.
- Lowber, P. (2001) "*Thin Client Predictions for 2002*," Gartner Research, Note Number: COM-15-0003, 6-9.
- Martin, G.L. and Corl, K.G. (1986) "*System Response Time Effects on User Productivity*," Behaviour and Information Technology 5(1), 3-13.
- Masding, D. (1991) "*Can we save costs and improve*," National Computing Centre, CIO Magazine, Issue: 15 November 2000, 5.
- McDougall, P. (2000) "*Thin Clients: Best Way to Keep Viruses at Bay?*", Information Week, 6 Dec 2000, 194.
- McIver, J.P. and Carmines, E.G. (1981) "*Unidimensional scaling*," Thousand Oaks, CA: Sage.
- Miles, M.B. and Huberman, A.M. (1994) *Qualitative Data Analysis: An Expanded Sourcebook*. Sage Publications.
- Miller, R.B. (1968) "*Response Time in Man-Computer Conversational Transactions*," Proc. AFIPS Fall Joint Computer Conf., AFIPS Press, 267-277.
- Morgan, L. (2001) "*Be Afraid...Be Very Afraid*," Internet Week, 9 Jan 2001, 37.
- Mulders, D. (2002) Thin Client Architecture: "*A New Way for the Department to Compute*", NORAD Operations Centre Modernisation Project, 3(2), 136-142.
- Neoware, 2002. Case Study: *Kids Peace Web*. [Internet]. Available from: <http://www.neoware.com/solutions/kidspeace.html>, [Accessed: 2 August 2006].

Nieh, J., Yang, S.J. and Novik, N. (2003) “*Measuring Thin-Client Performance Using Slow-Motion Benchmarking*,” ACM Trans. Computer Systems, 21(1), 87-115.

Nixon, K.J. and Dwolatzky, B., (2003) “*Computer laboratory infrastructure in engineering education*” Integrated Network Management, 2003. IFIP/IEEE Eighth International Symposium, 24-28 March, 321-334.

O’Donnell, B. (2002) International Data Corporation Executive Brief: “*The Rise of Thin Machines*” 1-4.

Plebani, E. (2002) Case Study: *Haverty Furniture Companies, Inc.* [Internet]. Available from: <http://www.thinplanet.com/sites/generic.asp?f=SInumber&k=s&v=SP>, [Accessed: 2 August 2006].

Preble, G. (2000) White Paper: *Common Sense about Thin Clients*. [Internet]. Available from: <http://www.thinplanet.com/tech/generic?f=TDnumber&k=s&v=T>, [Accessed: 2 August 2006].

Rahman, A.K.M.A. (2003) “*Thin clients via shadow objects*” Chilean Computer Science Society,. SCCC 2003. Proceedings. 23rd International Conference, 6-7 Nov. 2003, 137-144

Richardson, T. (1998) “*Virtual Network Computing*,” IEEE Internet Computing, 2(1), 33-38.

Robinson B. (2004) Thin-client Desktops: *Not Defunct Yet*. [Internet]. Available from: <http://www.fcw.com/article83853-08-23-04>, [Accessed: 2 August 2006].

Romm, D. (2006) Library Journal: *It Pays to be Thin*. [Internet]. Available from: <http://www.libraryjournal.com/index.asp?layout=articlePrint&article>, [Accessed: 18 August 2006].

Rubin, Herbert and Rubin, Irene (1995) “*Qualitative interviewing: The art of hearing data*,” Thousand Oaks, CA: Sage.

Rushinek A. and Rushinek S.F. (2002) “*What Makes Users Happy?*” Comm. ACM, 29(7), 594-598.

Sandklef, H. (2004) “*Testing Applications with Xnee,*” Linux Journal 2004, January, 5.

Sapuntzakis, C. (2002) “*Optimising the Migration of Virtual Computers,*” Proc. 5th Symp. Operating Systems Design and Implementation, Usenix, 377-390.

Saunders, M., Lewis, P. and Thornhill, A. (2003), *Research Methods for Business Students*, 3rd Edition, Pearson Education Limited, England.

Schneiderman, B. (1997): *Designing the User Interface: Strategies for Effective Human-Computer Interaction*, 3rd edition, New York: Addison-Wesley

Spector, P. (1992) “*Summated rating scale construction,*” Thousand Oaks, CA: Sage.

Stone, A. (2004) *Thin Is In: Thin Clients Save Time & Money.* [Internet]. Available from: <http://www.smallbusinesscomputing.com/testdrive/article.php/3430721>, [Accessed: 2 August 2006]

Sudman, S. and Blair E. (1998) *Marketing research: A problem Solving Approach*, 1st Edition, Mc Graw Hill, Singapore.

Sun Microsystems Inc, (1999) “*Bank of Nova Scotia Pilot Project, SunRay 1 Enterprise Appliance,*” Aug 1999, 1-3.

Techencyclopedia (2001) “*Thin client,*” definition, 3 Mar 2001 [Internet], <http://www.techweb.com/encyclopedia>, p 1 [Accessed: 5 August 2006].

Tolia, N., Andersen, D.G., Satyanarayanan, M., (2006) “*Quantifying interactive user experience on thin clients*”, IEEE Computer Journal, 39(3), 46-52.

Udell, J. (2004) InfoWorld: *Thin Clients & Rich Data*. [Internet]. Available from: <http://www.infoworld.com/archives/emailPrint.jsp?R=printThis&A=/art>, [Accessed: 2 August 2006].

Volchkov, A. (2002) “*Server-based computing opportunities*”, IEEE Computer Journal, 4(2), 18-23.

Williams, A.M. (2001) “*Thin Clients: Fundamental, Not a Fad,*” Information Week, 26 Jun 2001, 196.

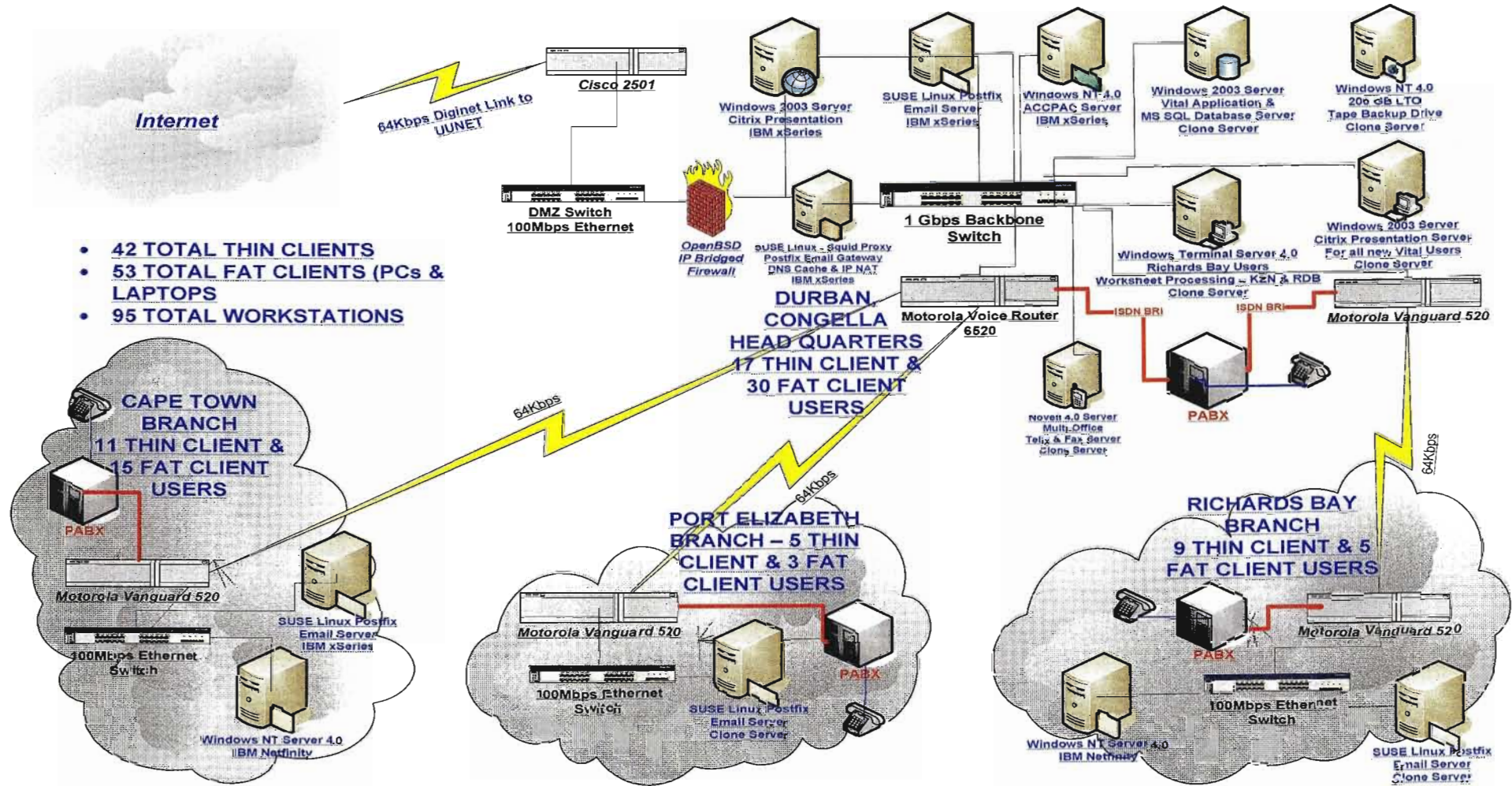
Wyse, (2003) “*Demystifying the Thin Client Operating System: Which Thin-Client is Right for Your Business?*” Executive Brief, Ziff Davis Media, Custom Publishing.

Yu, W. (2004) Desktop Guerilla Tactics: *A Portable Thin Client Approach*. [Internet]. Available from: <http://www.linuxjournal.com/article/7109.html>, [Access: 2 August 2006].

Zurovitch, K (2000) “*Redefining Thick and Thin,*” Enterprise Systems Journal, 32.

APPENDICES

Appendix 1: National Ship Chandlers WAN



Appendix 2: Questionnaire

Survey Cover Sheet

Determining User Productivity on Thin-clients and Fat-clients

You are invited to participate in a research project conducted by Navin Radhalal. I am a student enrolled for a Masters in Business Administration degree at the University of KwaZulu-Natal. If you would like to contact me, you may reach me at 0823039529 or email radhalal@gmail.com

I estimate that it will take you approximately 10 minutes to complete this questionnaire related to your views on the above topic.

All responses will be kept confidential. You may find benefits from the opportunity to reflect upon your existing environment and what you would like to change to increase your productivity and effectiveness within your job-function in your department whilst utilising a personal computer, thin-client or laptop.

Please answer questions 1 to 40 if you are a thin-client user. For users with either laptops or PCs please answer questions 1 to 11 and 41 to 57.

To help in assuring your anonymity, please do not include any personal contact information on the questionnaire. Your completion and submission of this questionnaire will be considered your voluntary agreement to participate and an indication of your consent that it may use the data that you provide for research purposes.

Thank you for your participation.

Please mark the appropriate box that corresponds with your answer with a tick.

1. What is your age group?
 - 19 – 25 years
 - 26 –30 years
 - 31- 40 years
 - 41 –50 years
 - more than 50 years

2. What is your geographically location of employment at National Ship Chandlers?
 - Durban
 - Richards Bay
 - Port Elizabeth
 - Cape Town

3. What is your length of employment at National Ship Chandlers?
 - 0-1 year
 - 1- 5 years
 - 5-10 years
 - more than 10 years

4. What is your highest level of education?
 - Matric
 - Diploma
 - Degree
 - Post-Graduate Degree
 - Other

5. What is your job function?
 - Clerical
 - Admin / Finance
 - Supervisor
 - Manager
 - Director

6. Tick all software applications you utilise at National Ship Chandlers.
 - Microsoft Office (Word, Excel, PowerPoint)
 - Email (Outlook / Outlook Express)
 - Accpac
 - Worksheeting
 - Customs / SARS Application
 - Internet

7. What percentage of your job-time requires you to spend on your thin-client, personal computer or laptop?
 - None
 - 1-20%
 - 21-40%
 - 41-60%
 - 61-80%
 - 81-100%

8. You find your job enjoyable.
 - Strongly agree
 - Agree
 - Neither Agree or Disagree
 - Disagree
 - Strongly Disagree
 - I do not want to answer this question

9. You find your job challenging.
- Strongly agree
 - Agree
 - Neither Agree or Disagree
 - Disagree
 - Strongly Disagree
 - I do not want to answer this question
10. You enjoy working with the computer system, irrespective of whether you are using a thin-client, personal computer or laptop.
- Strongly agree
 - Agree
 - Neither Agree or Disagree
 - Disagree
 - Strongly Disagree
 - I do not want to answer this question
11. What do you utilise for accessing the computer systems at National Ship Chandlers?
- Personal Computer (PC)
 - Thin-client (Wyse Terminal)
 - Laptop
 - None - Don't access the computer system.

If you are using a **thin-client** then please answer questions 12 – 40 only.

If you are using a **personal computer or laptop** please answer questions 41 – 57 only.

Thin-client Users Only: Questions 12 - 40

12. Please indicate an estimated number of IT support calls you place per month to the IT support helpdesk: ____ support calls.
13. You prefer moving back to a personal computer.
- Strongly agree
 - Agree
 - Neither Agree or Disagree
 - Disagree
 - Strongly Disagree
 - I do not want to answer this question
14. You place more IT support calls when you used a PC than the now thin-client.
- Strongly agree
 - Agree
 - Neither Agree or Disagree
 - Disagree
 - Strongly Disagree
 - I do not want to answer this question
15. You were trained and communicated to by management about the move from a PC to a thin-client.
- Strongly agree

- Agree
 - Neither Agree or Disagree
 - Disagree
 - Strongly Disagree
 - I do not want to answer this question
16. You feel that your data is more secure and accurate using a thin-client than when you used a PC.
- Strongly agree
 - Agree
 - Neither Agree or Disagree
 - Disagree
 - Strongly Disagree
 - I do not want to answer this question
17. You feel that your data is more available using a thin-client than when you used a PC.
- Strongly agree
 - Agree
 - Neither Agree or Disagree
 - Disagree
 - Strongly Disagree
 - I do not want to answer this question
18. You are comfortable without the ability to move data via USB memory, Stiffy Diskette or CDROM from your thin-client.
- Strongly agree
 - Agree
 - Neither Agree or Disagree
 - Disagree
 - Strongly Disagree
 - I do not want to answer this question
19. You feel that you have greater access to the computer system on the thin-client than you previously had on the PC.
- Strongly agree
 - Agree
 - Neither Agree or Disagree
 - Disagree
 - Strongly Disagree
 - I do not want to answer this question
20. When Citrix or the network is unavailable, you are still productive by doing manual work as opposed to requiring the computer system all the time.
- Strongly agree
 - Agree
 - Neither Agree or Disagree
 - Disagree
 - Strongly Disagree
 - I do not want to answer this question

21. You feel that thin-client training will increase your productivity at work.
- Strongly agree
 - Agree
 - Neither Agree or Disagree
 - Disagree
 - Strongly Disagree
 - I do not want to answer this question
22. Your thin-client is significantly slow i.e. you have to wait seconds or even minutes for screen and mouse activity on the screen.
- Strongly agree
 - Agree
 - Neither Agree or Disagree
 - Disagree
 - Strongly Disagree
 - I do not want to answer this question
23. Given the opportunity, you would exchange your thin-client for your old PC.
- Strongly agree
 - Agree
 - Neither Agree or Disagree
 - Disagree
 - Strongly Disagree
 - I do not want to answer this question
24. Based on your current experience of using a thin-client, you require your thin-client's performance to be faster.
- Strongly agree
 - Agree
 - Neither Agree or Disagree
 - Disagree
 - Strongly Disagree
 - I do not want to answer this question
25. You listen to CDs or MP3s on your PC before moving onto a thin-client.
- Strongly agree
 - Agree
 - Neither Agree or Disagree
 - Disagree
 - Strongly Disagree
 - I do not want to answer this question
26. You like to listen to MP3s and CDs on your current thin-client if it were possible.
- Strongly agree
 - Agree
 - Neither Agree or Disagree
 - Disagree
 - Strongly Disagree
 - I do not want to answer this question

27. Prior to using a thin-client, you took data home to work with and now cannot because you have a thin-client.
- Strongly agree
 - Agree
 - Neither Agree or Disagree
 - Disagree
 - Strongly Disagree
 - I do not want to answer this question
28. Within a 12 month window, you logged more support calls using the thin-client than you did when you had a personal computer.
- Strongly agree
 - Agree
 - Neither Agree or Disagree
 - Disagree
 - Strongly Disagree
 - I do not want to answer this question
29. Your job require you to utilise the functions of a personal computer that your now thin-client does not have i.e. CDROM/DVD, USB memory slot, stiffy drive access etc.
- Strongly agree
 - Agree
 - Neither Agree or Disagree
 - Disagree
 - Strongly Disagree
 - I do not want to answer this question
30. You feel that you require thin-client usage training.
- Strongly agree
 - Agree
 - Neither Agree or Disagree
 - Disagree
 - Strongly Disagree
 - I do not want to answer this question
31. You feel that a thin-client is more reliable than a personal computer.
- Strongly agree
 - Agree
 - Neither Agree or Disagree
 - Disagree
 - Strongly Disagree
 - I do not want to answer this question
32. When experiencing application issues on Citrix the IT support staff take control of your system screen and guide you in rectifying the problem so that in the future you could do it yourself.
- Strongly agree
 - Agree
 - Neither Agree or Disagree

- Disagree
 - Strongly Disagree
 - I do not want to answer this question
33. The IT support staff or management use Citrix as a medium to conduct online training.
- Strongly agree
 - Agree
 - Neither Agree or Disagree
 - Disagree
 - Strongly Disagree
 - I do not want to answer this question
34. You are aware that all your online Citrix activity may be monitored from the server by management and IT staff.
- Strongly agree
 - Agree
 - Neither Agree or Disagree
 - Disagree
 - Strongly Disagree
 - I do not want to answer this question
35. Computer games are available for your access on your thin-client Citrix system.
- Strongly agree
 - Agree
 - Neither Agree or Disagree
 - Disagree
 - Strongly Disagree
 - I do not want to answer this question
36. Management allows you to play computer games during lunch and tea breaks.
- Strongly agree
 - Agree
 - Neither Agree or Disagree
 - Disagree
 - Strongly Disagree
 - I do not want to answer this question
37. You experienced more virus attacks when you had a personal computer than on the now thin-client Citrix system.
- Strongly agree
 - Agree
 - Neither Agree or Disagree
 - Disagree
 - Strongly Disagree
 - I do not want to answer this question
38. You are satisfied with the level of responsiveness from IT support in resolving your support call requests
- Strongly agree
 - Agree

- Neither Agree or Disagree
- Disagree
- Strongly Disagree
- I do not want to answer this question

39. You were previously trained on thin-client usage.

- Strongly agree
- Agree
- Neither Agree or Disagree
- Disagree
- Strongly Disagree
- I do not want to answer this question

40. Rate your level of satisfaction using a thin-client in comparison to when you used a PC.

- Excellent
- Very Good
- Good
- Satisfactory
- Poor
- Very Poor

If you are using a Laptop or Personal Computer (PC) please answer Questions 41 – 57 only.

Laptop and Personal Computer (PC) Users Only: Questions 41 - 57

41. Please indicate an estimated number of IT support calls you place per month to the IT support helpdesk: ____ support calls.

42. You have a laptop or PC because your job function requires the additional functionality or mobility.

- Strongly agree
- Agree
- Neither Agree or Disagree
- Disagree
- Strongly Disagree
- I do not want to answer this question

43. You get positive feedback from your colleagues that use thin-clients.

- Strongly agree
- Agree
- Neither Agree or Disagree
- Disagree
- Strongly Disagree
- I do not want to answer this question

44. You were given formal or informal training on utilising your computer system.

- Strongly agree
 - Agree
 - Neither Agree or Disagree
 - Disagree
 - Strongly Disagree
 - I do not want to answer this question
45. Within a 12 month timeframe your laptop or PC is often been infected with viruses.
- Strongly agree
 - Agree
 - Neither Agree or Disagree
 - Disagree
 - Strongly Disagree
 - I do not want to answer this question
46. You feel that if you had a thin-client you would have a more stable and available system as opposed to your current PC or laptop.
- Strongly agree
 - Agree
 - Neither Agree or Disagree
 - Disagree
 - Strongly Disagree
 - Unable to comment
47. You feel that applications are more accessible to your PC or laptop than to the thin-client users.
- Strongly agree
 - Agree
 - Neither Agree or Disagree
 - Disagree
 - Strongly Disagree
 - I do not want to answer this question
48. You feel that your data on the server is more secure and accurate than with thin-client users.
- Strongly agree
 - Agree
 - Neither Agree or Disagree
 - Disagree
 - Strongly Disagree
 - Unable to comment
49. You use your CDROM/DVD, floppy drive or USB port on your laptop or PC.
- Strongly agree
 - Agree
 - Neither Agree or Disagree
 - Disagree
 - Strongly Disagree
 - I do not want to answer this question

50. You are aware that by accessing data from a CD/DVD, stiffy disk or USB drive, you could infect your computer and the server with viruses.
- Strongly agree
 - Agree
 - Neither Agree or Disagree
 - Disagree
 - Strongly Disagree
 - I do not want to answer this question
51. When the network or servers are unavailable, you feel that you are more productive than the thin-client users, because you could work on local applications running on your PC or laptop (Word, Excel, offline emails etc), unlike the thin-client users that would not be able to.
- Strongly agree
 - Agree
 - Neither Agree or Disagree
 - Disagree
 - Strongly Disagree
 - Unable to comment
52. You feel that thin-clients operate faster than your current PC or laptop.
- Strongly agree
 - Agree
 - Neither Agree or Disagree
 - Disagree
 - Strongly Disagree
 - Unable to comment
53. You use your CD/DVD or the USB drive to listen to MP3s.
- Strongly agree
 - Agree
 - Neither Agree or Disagree
 - Disagree
 - Strongly Disagree
 - I do not want to answer this question
54. Computer games are available for your access on your PC or laptop.
- Strongly agree
 - Agree
 - Neither Agree or Disagree
 - Disagree
 - Strongly Disagree
 - I do not want to answer this question
55. Management allows you to play computer games during lunch and tea breaks.
- Strongly agree
 - Agree
 - Neither Agree or Disagree
 - Disagree
 - Strongly Disagree

- I do not want to answer this question

56. Given the opportunity with adequate training, you would exchange your PC or laptop for a thin-client.

- Strongly agree
- Agree
- Neither Agree or Disagree
- Disagree
- Strongly Disagree
- I do not want to answer this question

57. You are satisfied with the level of responsiveness from IT support in resolving your support call requests.

- Strongly agree
- Agree
- Neither Agree or Disagree
- Disagree
- Strongly Disagree
- I do not want to answer this question

Thank you for your assistance!

Appendix 3: Comments on Questionnaire for the Reader

This was NOT distributed to sample but is a simply a guide and motivation for the reader as to why questions were posed and correlation, association or comparison with relative questions for data modelling purposes.

Please mark the appropriate box that corresponds with your answer with a tick.

1. What is your age group?

- 19 – 25 years
- 26 –30 years
- 31- 40 years
- 41 –50 years
- more than 50 years

Comment: Age will assist in determining user acceptance of modern technology. Research has shown that older generations are very resistant to newer technologies.

2. What is your geographically location of employment at National Ship Chandlers?

- Durban
- Richards Bay
- Port Elizabeth
- Cape Town

Comment: Geographical location for modelling of data will assist in identifying if user's issues or challenges are unique to a geographic and further attention maybe required.

3. What is your length of employment at National Ship Chandlers?

- 0-1 year
- 1- 5 years
- 5-10 years
- more than 10 years

Comment: Years of employment will assist in understanding the users acquaintance with the job and their understanding of the environment. It will also assist in defining the type of device the user should have i.e. thin client, PC or laptop.

4. What is your highest level of education?

- Matric
- Diploma
- Degree
- Post-Graduate Degree
- Other

Comment: Level of education will assist in understanding requirements of end-user training and the degree of training required. It will also assist in understanding the profile of the job function allocated.

5. What is your job function?

- Clerical
- Admin / Finance
- Supervisor
- Manager
- Director

Comment: The user's job function assists in determining whether the has a motivation to either have a thin client, PC or laptop as workstation.

6. Tick all software applications you utilise at National Ship Chandlers.

- Microsoft Office (Word, Excel, PowerPoint)
- Email (Outlook / Outlook Express)
- Accpac
- Worksheeting
- Customs / SARS Application
- Internet

Comment: Understanding the job requirements of the user and degree of dependence on server based applications vs PC based applications i.e. Office is PC based, others are server based.

7. What percentage of your job-time requires you to spend on your thin-client, personal computer or laptop?

- None
- 1-20%
- 21-40%
- 41-60%
- 61-80%
- 81-100%

Comment: This will assist in determining degree of dependence and availability of systems. Based on the job profile of the user an appropriate device – i.e. thin client, PC or laptop can be allocated to the user.

This question can be graphed against Q20 and Q51.

8. You find your job enjoyable.

- Strongly agree
- Agree
- Neither Agree or Disagree
- Disagree
- Strongly Disagree
- I do not want to answer this question

Comment: Determining the users satisfaction within their job function will assist in concluding whether the workstation used by that user is correct, i.e. thin client/PC/Laptop.

This question can be graphed against Q11.

9. You find your job challenging.

- Strongly agree
- Agree
- Neither Agree or Disagree
- Disagree
- Strongly Disagree
- I do not want to answer this question

Comment: Testing users outlook towards job function.

This question can be graphed against Q11.

10. You enjoy working with the computer system, irrespective of whether you are using a thin-client, personal computer or laptop.

- Strongly agree
- Agree
- Neither Agree or Disagree
- Disagree
- Strongly Disagree
- I do not want to answer this question

Comment: Testing users acceptance of working on computer systems, irrespective of type of workstation.

This question can be graphed against Q11, Q12 & Q41

11. What do you utilise for accessing the computer systems at National Ship Changers?

- Personal Computer (PC)
- Thin-client (Wyse Terminal)
- Laptop
- None - Don't access the computer system.

Comment: Validate number of thin client, PC and laptop users.

This question can be graphed against Q9, Q7 & Q5 to test appropriateness of workstation based on job profile of user.

If you are using a **thin-client** then please answer questions 12 – 40 only.

If you are using a **personal computer or laptop** please answer questions 41 – 57 only.

Thin-client Users Only: Questions 12 - 40

12. Please indicate an estimated number of IT support calls you place per month to the IT support helpdesk: ___ support calls.

Comment: Number of support calls per month has an impact on direct costs for supporting the environment. It will also assist in comparing support calls of each environment.

This question can be graphed against Q41 to compare support call request of Thin Clients vs Fat Clients.

13. You prefer moving back to a personal computer.

- Strongly agree
- Agree
- Neither Agree or Disagree
- Disagree
- Strongly Disagree
- I do not want to answer this question

Comment: Determine users acceptance of using a thin client or level of satisfaction from using it.

This question can be graphed against Q22 for confirming user's preference based on performance issues. Q23 for retesting.

14. You place more IT support calls when you used a PC than the now thin-client.

- Strongly agree
- Agree
- Neither Agree or Disagree
- Disagree
- Strongly Disagree
- I do not want to answer this question

Comment: Test whether more support calls were placed on fat client environment than the now thin client environment.

This question can be graphed against Q28 for retesting

15. You were trained and communicated to by management about the move from a PC to a thin-client.

- Strongly agree
- Agree
- Neither Agree or Disagree
- Disagree
- Strongly Disagree
- I do not want to answer this question

Comment: Test whether change-management and training was undertaken before migrating users from fat clients to thin clients.

This question can be graphed against Q39 for retesting and Q44 to validate that all users including fat client users were privy to training.

16. You feel that your data is more secure and accurate using a thin-client than when you used a PC.

- Strongly agree
- Agree
- Neither Agree or Disagree
- Disagree
- Strongly Disagree
- I do not want to answer this question

Comment: Test users perception of data integrity.

This question can be graphed against Q48 to compare fat client users perception of data integrity.

17. You feel that your data is more available using a thin-client than when you used a PC.

- Strongly agree
- Agree
- Neither Agree or Disagree
- Disagree
- Strongly Disagree
- I do not want to answer this question

Comment: Test users perception of availability or uptime of thin client environment.

18. You are comfortable without the ability to move data via USB memory, Stiffy Diskette or CDROM from your thin-client.

- Strongly agree
- Agree
- Neither Agree or Disagree
- Disagree
- Strongly Disagree
- I do not want to answer this question

Comment: Test whether users were correctly profiled to use thin clients based on their job function requirements. Also test users needs to move data around.

19. You feel that you have greater access to the computer system on the thin-client than you previously had on the PC.

- Strongly agree
- Agree
- Neither Agree or Disagree
- Disagree
- Strongly Disagree
- I do not want to answer this question

Comment: Test users perception on accessibility of applications and ability to be versatile using the different systems on the network. If users feels otherwise it maybe indicative of a unproductive user that is restricted to function. Test whether application restrictions are imposed including games etc.

This question can be graphed against Q47 to compare fat client user's perception of accessibility of the system.

20. When Citrix or the network is unavailable, you are still productive by doing manual work as opposed to requiring the computer system all the time.

- Strongly agree
- Agree
- Neither Agree or Disagree
- Disagree
- Strongly Disagree
- I do not want to answer this question

Comment: Re-test Question 7 i.e. user dependence on the availability of the system, specifically testing whether thin client users are productive in the thin client, network or Citrix system was unavailable.

21. You feel that thin-client training will increase your productivity at work.

- Strongly agree
- Agree
- Neither Agree or Disagree
- Disagree
- Strongly Disagree
- I do not want to answer this question

Comment: Test users requirement for training.

This question can be graphed against Q30 for retesting.

22. Your thin-client is significantly slow i.e. you have to wait seconds or even minutes for screen and mouse activity on the screen.

- Strongly agree
- Agree
- Neither Agree or Disagree
- Disagree
- Strongly Disagree
- I do not want to answer this question

Comment: Test performance and responsiveness of the thin client – this may attribute to users level of satisfaction using the thin client and job ultimately.

This question can be graphed against Q13 for evaluating users choice due to performance issues. Also with Q24 to validate this.

23. Given the opportunity, you would exchange your thin-client for your old PC.

- Strongly agree
- Agree
- Neither Agree or Disagree
- Disagree
- Strongly Disagree

Comment: Test users level of satisfaction for using thin clients and whether fat client was better for their job.

This question can be graphed against Q13 for retesting, Q31 for evaluating users perception of reliability of thin client.

- I do not want to answer this question

24. Based on your current experience of using a thin-client, you require your thin-client's performance to be faster.

- Strongly agree
- Agree
- Neither Agree or Disagree
- Disagree
- Strongly Disagree
- I do not want to answer this question

Comment: Test, re-test Question 22 on performance of thin client. Also test users satisfaction based on thin client performance.

25. You listen to CDs or MP3s on your PC before moving onto a thin-client.

- Strongly agree
- Agree
- Neither Agree or Disagree
- Disagree
- Strongly Disagree
- I do not want to answer this question

Comment: Test whether users maybe dissatisfied without the facility to listen to their own custom music in their previous fat client environment. This maybe indicative by resistance to using thin clients and reduced levels of productivity due to lack of motivation. It will also be a motive for users to tried and justify a move back to fat clients if listening to their custom music was important to them as individuals. T

26. You like to listen to MP3s and CDs on your current thin-client if it were possible.

- Strongly agree
- Agree
- Neither Agree or Disagree
- Disagree
- Strongly Disagree
- I do not want to answer this question

This question can be graphed against Q53 to evaluate if fat client users have greater privileges over thin client users.

Comment: Test, re-test Question 25 on users level of need to listen to music that they cannot now do on the thin clients.

27. Prior to using a thin-client, you took data home to work with and now cannot because you have a thin-client.

- Strongly agree
- Agree
- Neither Agree or Disagree
- Disagree
- Strongly Disagree
- I do not want to answer this question

Comment: Test whether users were profiled appropriately based on job function to use thin clients. PC users can only move data.

28. Within a 12 month window, you logged more support calls using the thin-client than you did when you had a personal computer.

- Strongly agree
- Agree
- Neither Agree or Disagree
- Disagree
- Strongly Disagree
- I do not want to answer this question

Comment: Determine the users perception of whether more support calls logged when they used fat clients or their now thin clients. This assists in understanding whether users were profiled before thin clients were given to them and whether there are more support costs that can be attributed to either the thin client for fat client environments.

This question can be graphed against Q14 for retesting.

29. Your job require you to utilise the functions of a personal computer that your now thin-client does not have i.e. CDROM/DVD, USB memory slot, stiffer drive access etc.

- Strongly agree
- Agree
- Neither Agree or Disagree

Comment: Has the user been profiled to use a thin client and does the users productivity affect the lack of functions thereof from the thin client.

- Disagree
- Strongly Disagree
- I do not want to answer this question

30. You feel that you require thin-client usage training.

- Strongly agree
- Agree
- Neither Agree or Disagree
- Disagree
- Strongly Disagree
- I do not want to answer this question

Comment: Test, re-test Question 21 on training requirements for thin client user.

31. You feel that a thin-client is more reliable than a personal computer.

- Strongly agree
- Agree
- Neither Agree or Disagree
- Disagree
- Strongly Disagree
- I do not want to answer this question

Comment: Test the personal experience on the acceptance of the thin client user on overall reliability of the thin client.

This question can be graphed against Q13 & Q23 for retesting.

32. When experiencing application issues on Citrix the IT support staff take control of your system screen and guide you in rectifying the problem so that in the future you could do it yourself.

- Strongly agree
- Agree
- Neither Agree or Disagree
- Disagree
- Strongly Disagree
- I do not want to answer this question

Comment: Test whether IT support is utilising the Citrix software functionality to resolve support issues and undertake user training.

33. The IT support staff or management use Citrix as a medium to conduct online training.

- Strongly agree
- Agree
- Neither Agree or Disagree
- Disagree
- Strongly Disagree
- I do not want to answer this question

Comment: Test, re-test Question 32 to confirm that any form of user training is undertaken through the Citrix software system.

34. You are aware that all your online Citrix activity may be monitored from the server by management and IT staff.

- Strongly agree
- Agree
- Neither Agree or Disagree
- Disagree
- Strongly Disagree
- I do not want to answer this question

Comment: Test whether users are aware of monitoring of their user activity and may therefore reserved on their opinions and not willing to comment. This may lead to de-motivated employees and under-productivity. It also tests levels of communication between IT support and end-users.

35. Computer games are available for your access on your thin-client Citrix system.

- Strongly agree
- Agree
- Neither Agree or Disagree
- Disagree
- Strongly Disagree
- I do not want to answer this question

Comment: Test whether the organisation has restricted users from using games. Total restriction of games may lead to unproductive employees with lack of motivation.

36. Management allows you to play computer games during lunch and tea breaks.

- Strongly agree
- Agree
- Neither Agree or Disagree
- Disagree
- Strongly Disagree
- I do not want to answer this question

Comment: Test, re-test Question 35, specifically do the management allow games played during lunch and tea breaks.

This question can be graphed against (Q35 & Q36) vs (Q54 & Q55) to qualify and discrimination of users of thin client and fat clients for access to computer games.

37. You experienced more virus attacks when you had a personal computer than on the now thin-client Citrix system.

- Strongly agree
- Agree
- Neither Agree or Disagree
- Disagree
- Strongly Disagree
- I do not want to answer this question

Comment: Test the users perception of virus attacks and threats within the thin client environment – this leads directly to productivity. It also outlines how often each is more susceptible to viruses.

This question can be graphed against Q45 to compare vulnerability of virus to fat client versus thin client environments.

38. You are satisfied with the level of responsiveness from IT support in resolving your support call requests.

- Strongly agree
- Agree
- Neither Agree or Disagree
- Disagree
- Strongly Disagree
- I do not want to answer this question

Comment: Test users satisfaction of IT support. If IT support is not responsive enough to thin client users this may have direct impact on user productivity. It may also lead to the users perception of a availability of the thin client system.

This question can be graphed against Q12 to draw any comparison between number of support calls versus level of responsiveness.

39. You were previously trained on thin-client usage.

- Strongly agree
- Agree
- Neither Agree or Disagree
- Disagree
- Strongly Disagree
- I do not want to answer this question

Comment: Test whether in the past the users were privy to any form of thin client training.

This question can be graphed against Q15 for retesting. Q44 for evaluating whether all users fat and thin were privy to training.

40. Rate your level of satisfaction using a thin-client in comparison to when you used a PC.

- Excellent
- Very Good
- Good
- Satisfactory
- Poor
- Very Poor

Comment: Test overall users perception and acceptance of thin client, deduce user productivity from this.

This question can be graphed against Q13, Q23 & Q31 to validate users experience on thin clients.

- I do not want to answer this question

If you are using a **Laptop or Personal Computer (PC)** please answer **Questions 41 – 57** only.

Laptop and Personal Computer (PC) Users Only: Questions 41 - 57

41. Please indicate an estimated number of IT support calls you place per month to the IT support helpdesk: ____ support calls.

Comment: Number of support calls per month has an impact on direct costs for supporting the environment. It will also assist in comparing support calls of each environment.

42. You have a laptop or PC because your job function requires the additional functionality or mobility.

This question can be graphed against Q12 for comparative analysis of support calls within thin client versus fat client environments.

- Strongly agree
- Agree
- Neither Agree or Disagree
- Disagree
- Strongly Disagree
- I do not want to answer this question

Comment: Testing validity or justification of workstation based on job function.

43. You get positive feedback from your colleagues that use thin-clients.

This question can be graphed against Q5 to validity of job function and profile.

- Strongly agree
- Agree
- Neither Agree or Disagree
- Disagree
- Strongly Disagree
- I do not want to answer this question

Comment: Test the perception thin client users leave with fat client users.

44. You were given formal or informal training on utilising your computer system.

This question can be graphed against Q46 for validating fat client users feedback from thin client users. Also with Q52 to test validity for performance reasons.

- Strongly agree
- Agree
- Neither Agree or Disagree
- Disagree
- Strongly Disagree
- I do not want to answer this question

Comment: Test whether any form of training, for fat or thin client was undertaken.

45. Within a 12 month timeframe your laptop or PC is often been infected with viruses.

This question can be graphed against Q15 & Q39 to establish that all users were privy to training.

- Strongly agree
- Agree
- Neither Agree or Disagree
- Disagree
- Strongly Disagree
- I do not want to answer this question

Comment: Test susceptibility of fat client environment to viruses and influence with the environment.

46. You feel that if you had a thin-client you would have a more stable and available system as opposed to your current PC or laptop.

This question can be graphed against Q37 to compare environments susceptibility to viruses.

- Strongly agree
- Agree
- Neither Agree or Disagree
- Disagree
- Strongly Disagree

Comment: Test perception of fat client users of thin clients and if they favour thin clients.

This question can be graphed against Q43 validate feedback from thin client users.

- Unable to comment

47. You feel that applications are more accessible to your PC or laptop than to the thin-client users.

- Strongly agree
- Agree
- Neither Agree or Disagree
- Disagree
- Strongly Disagree
- I do not want to answer this question

Comment: Test users perception of relative versatility and access to systems to thin clients, if any.

This question can be graphed against Q19 to compare perceptions of users with respect to accessibility.

48. You feel that your data on the server is more secure and accurate than with thin-client users.

- Strongly agree
- Agree
- Neither Agree or Disagree
- Disagree
- Strongly Disagree
- Unable to comment

Comment: Test users perception of thin clients and its reliability and integrity, if any.

This question can be graphed against Q16 to compare perceptions of users with respect to integrity of data.

49. You use your CDROM/DVD, stiffer drive or USB port on your laptop or PC.

- Strongly agree
- Agree
- Neither Agree or Disagree
- Disagree
- Strongly Disagree
- I do not want to answer this question

Comment: Test if user utilises fat client due to job profile and therefore additionally functionality required by users that fat clients offer.

50. You are aware that by accessing data from a CD/DVD, stiffer disk or USB drive, you could infect your computer and the server with viruses.

- Strongly agree
- Agree
- Neither Agree or Disagree
- Disagree
- Strongly Disagree
- I do not want to answer this question

Comment: Test knowledge of fat client users susceptibility to security and virus infection. Test awareness on risk exposure of fat clients.

51. When the network or servers are unavailable, you feel that you are more productive than the thin-client users, because you could work on local applications running on your PC or laptop (Word, Excel, offline emails etc), unlike the thin-client users that would not be able to.

- Strongly agree
- Agree
- Neither Agree or Disagree
- Disagree
- Strongly Disagree
- Unable to comment

Comment: Test fat client users perspective of versatility and awareness of functionality differences between thin client and fat clients. Also test the value to fat client users.

This question can be graphed against Q7 to test correct profiling of user in relation to dependence on computer system for productivity.

Comment: Evaluate perception from fat client users of thin clients in terms of performance.

52. You feel that thin-clients operate faster than your current PC or laptop.

- Strongly agree

This question can be graphed against Q43 trying to relate feedback from thin client users.

- Agree
- Neither Agree or Disagree
- Disagree
- Strongly Disagree
- Unable to comment

53. You use your CD/DVD or the USB drive to listen to MP3s.

- Strongly agree
- Agree
- Neither Agree or Disagree
- Disagree
- Strongly Disagree
- I do not want to answer this question

Comment: Test whether fat client and thin client users have same levels of authorisation to listen to music.

This question can be graphed against Q25 test whether fat client users are privy to thin client users.

54. Computer games are available for your access on your PC or laptop.

- Strongly agree
- Agree
- Neither Agree or Disagree
- Disagree
- Strongly Disagree
- I do not want to answer this question

Comment: Test accessibility to games on fat clients relative to thin clients. Games can be removed or restricted on fat clients using profiles.

(Q54 & Q55) vs (Q35 & Q36) to verify that both thin & fat client have equal privileges.

55. Management allows you to play computer games during lunch and tea breaks.

- Strongly agree
- Agree
- Neither Agree or Disagree
- Disagree
- Strongly Disagree
- I do not want to answer this question

Comment: Does management allow the playing of games during lunch or tea breaks. Test relative to thin client users. This may increase motivation of staff to be more productive.

56. Given the opportunity with adequate training, you would exchange your PC or laptop for a thin-client.

- Strongly agree
- Agree
- Neither Agree or Disagree
- Disagree
- Strongly Disagree
- I do not want to answer this question

Comment: Test whether the overall perception of thin clients is so good that fat client users are willing to substitute theirs for thin clients.

57. You are satisfied with the level of responsiveness from IT support in resolving your support call requests.

- Strongly agree
- Agree
- Neither Agree or Disagree
- Disagree
- Strongly Disagree
- I do not want to answer this question

Comment: Test IT support responsiveness and relate to responsive of thin client users.

This question can be graphed against Q41 to check for correlation if any of number of support calls and responsiveness on calls placed.

Thank you for your assistance!

Fat-clients

Questions	Q1 - Age group	Q2 - Location	Q3 - Years of Service	Q4 - Education	Q5 - Job Function	Q6 - Applications used; Office; Email; Worksheeting; Accpac; Customs/SARS	MO-E-W-A-C-	Q7 - Percentage Computer Dependence for Job Function	Q8 - Enjoyable Job 6-Strongly Agree 2-Strongly disagree 1-Do not want to answer	Q9 - Challenging Job	Q10 - Enjoy working with Computer System	Q11 - PC, Laptop or Thin Client user	Q41 - no. of support calls per month	Q42	Q43	Q44	Q45	Q46	Q47	Q48	Q49	Q50	Q51	Q52	Q53	Q54	Q55	Q56	Q57	1 - No Answer Total Q13-Q39	2 - Strongly Disagree Total Q13-Q39	3 - Disagree Total Q13-Q39	4 - Neither Or Total Q13-Q39	5 - Agree Total Q13-Q39	6 - Strongly Agree Total Q13-Q39	
1	50+	DBN	10+	Degree	Director	MO/E/W/I		81-100%	6	6	6	PC	1	5	4	5	3	3	5	5	5	6	6	6	3	5	5	6	5	0	0	3	1	8	4	
2	50+	DBN	10+	Diploma	Supervisor	MO/E/W/I		81-100%	5	6	5	PC	0	5	4	6	3	4	5	6	6	6	6	3	5	5	6	5	0	0	2	2	5	7		
3	50+	DBN	5-10	Matric	Supervisor	MO/E/I		1-20%	4	4	5	PC	5	6	4	5	5	3	6	5	6	5	6	5	2	5	5	6	5	0	1	1	1	8	5	
4	41-50	DBN	1-5	Matric	Supervisor	MO/E/I		1-20%	5	6	5	PC	8	5	5	5	3	3	5	5	5	5	5	5	3	5	5	6	4	0	0	3	1	11	1	
5	41-50	DBN	1-5	Matric	Supervisor	MO/E/I		41-60%	4	4	4	PC	10	5	5	6	3	4	6	5	5	6	5	5	2	5	5	6	3	0	1	2	1	8	4	
6	31-40	DBN	10+	Degree	Manager	MO/E/W/I/A		81-100%	6	6	5	PC	8	5	5	6	5	4	4	5	6	5	6	3	3	5	5	6	5	0	0	2	2	8	4	
7	50+	DBN	10+	Matric	Admin/Finance	MO/E/W/A		61-80%	5	5	4	PC	5	6	4	5	5	4	6	4	5	5	6	5	2	5	5	6	4	0	1	0	4	7	4	
8	50+	DBN	10+	Matric	Admin/Finance	MO/E/W/A		81-100%	2	2	4	PC	8	5	5	6	3	3	5	5	6	6	6	5	3	5	5	5	3	0	0	4	0	8	4	
9	31-40	DBN	10+	Matric	Admin/Finance	MO/E/W/C		81-100%	5	5	5	PC	5	6	4	5	5	3	6	5	5	5	5	5	3	5	5	5	5	0	0	2	1	11	2	
10	41-50	DBN	5-10	Matric	Admin/Finance	MO/E/W/I/A		81-100%	4	4	5	PC	5	5	5	5	5	4	5	5	5	5	6	3	3	5	5	6	5	0	0	2	1	11	2	
11	41-50	DBN	5-10	Matric	Admin/Finance	W		21-40%	3	3	4	PC	4	6	3	5	3	4	6	4	6	5	5	5	3	5	5	6	5	0	0	3	2	7	4	
12	31-40	DBN	1-5	Matric	Admin/Finance	MO/E/W/A		61-80%	5	3	4	PC	7	5	4	5	6	4	6	5	6	5	6	5	3	5	5	6	5	0	0	1	2	8	5	
13	19-25	DBN	1-5	Matric	Admin/Finance	MO/E/W/C		81-100%	5	5	4	PC	8	5	5	5	5	5	5	5	6	5	5	6	3	5	5	6	4	0	0	2	1	11	2	
14	31-40	DBN	10+	Matric	Admin/Finance	MO/E/W/C		81-100%	3	3	5	PC	5	5	5	5	3	3	5	5	5	5	6	5	3	5	5	5	3	0	0	4	0	11	1	
15	41-50	DBN	10+	Matric	Admin/Finance	MO/E/W/I		21-40%	3	6	5	PC	5	5	4	5	3	3	6	6	5	6	5	5	3	5	5	5	5	0	0	3	1	9	3	
16	41-50	DBN	10+	Degree	Manager	MO/E/W		21-40%	6	6	5	PC	7	5	4	6	3	3	6	5	6	5	6	3	3	5	5	6	5	0	0	4	1	6	5	
17	41-50	DBN	5-10	Matric	Admin/Finance	MO/E/W		21-40%	5	5	4	PC	8	5	5	5	5	5	6	5	5	5	6	5	3	5	5	6	3	0	0	2	0	11	3	
18	41-50	DBN	1-5	Degree	Admin/Finance	MO/E/W		81-100%	6	6	5	PC	5	5	5	5	4	5	5	6	5	6	5	2	5	5	6	5	0	0	1	0	1	11	3	
19	31-40	DBN	5-10	Matric	Admin/Finance	MO/E/W/I		41-60%	5	5	5	PC	8	5	5	5	3	4	5	5	6	5	6	5	3	5	5	5	6	0	0	2	1	10	3	
20	31-40	DBN	1-5	Diploma	Admin/Finance	MO/E/W/I		41-60%	5	5	4	PC	5	5	3	5	3	4	5	5	6	6	5	3	3	5	5	6	3	0	0	5	1	7	3	
21	41-50	DBN	1-5	Matric	Admin/Finance	MO/E/W/I		61-100%	5	6	4	PC	5	4	5	5	3	3	5	6	6	5	5	3	3	5	5	6	5	0	0	4	1	8	3	
22	31-40	DBN	5-10	Matric	Admin/Finance	MO/E/W/I		1-20%	4	5	5	PC	3	5	3	6	3	4	4	5	6	6	6	3	3	5	5	5	5	0	0	4	2	6	4	
23	19-25	DBN	1-5	Matric	Director	MO/E/W/I		81-100%	6	6	6	PC	2	6	5	5	2	4	5	5	5	6	5	5	3	5	5	6	5	0	0	1	1	1	10	3
24	50+	DBN	5-10	Matric	Admin/Finance	MO/E/W/I		81-100%	5	5	5	PC	2	5	5	5	3	4	6	5	5	5	5	3	5	5	6	5	0	0	2	1	11	2		
25	31-40	DBN	5-10	Matric	Supervisor	MO/E/W/I		81-100%	5	6	6	PC	4	5	5	5	3	5	5	6	6	5	5	5	3	5	5	5	5	0	0	2	0	12	2	
26	26-30	DBN	0-1	Matric	Admin/Finance	MO/E/W/I		1-20%	4	6	5	PC	5	6	6	5	3	4	6	5	5	6	6	5	2	5	5	5	5	0	1	1	1	8	5	
27	26-30	DBN	1-5	Diploma	Admin/Finance	MO/E/W/I/A		81-100%	5	5	5	Laptop	5	6	4	6	3	3	5	5	5	5	6	5	2	5	5	6	5	0	1	2	1	8	4	
28	31-40	DBN	10+	Degree	Manager	MO/E/W/I		81-100%	5	5	6	Laptop	5	5	5	5	3	3	5	5	6	5	6	5	3	5	5	6	5	0	0	3	0	9	4	
29	50+	DBN	10+	Matric	Director	MO/E/W/I		81-100%	6	6	4	Laptop	2	6	5	5	3	4	5	5	6	6	5	5	2	6	5	6	5	0	1	1	1	8	5	
30	19-25	DBN	1-5	Degree	Admin/Finance	MO/E/W/A		81-100%	5	6	4	Laptop	5	6	6	6	2	4	5	5	6	5	6	5	3	5	5	6	5	0	1	1	1	7	6	
31	50+	RDB	10+	Matric	Manager	MO/E/W/I		81-100%	6	6	5	PC	10	5	3	5	6	3	5	5	6	5	5	3	3	5	5	2	5	0	1	4	0	9	2	
32	50+	RDB	10+	Matric	Supervisor	MO/E/W/C		61-80%	5	5	4	PC	5	6	4	5	5	2	6	5	5	4	6	3	3	5	5	3	5	0	1	3	2	7	3	
33	41-50	RDB	10+	Matric	Supervisor	MO/E/W/C		81-100%	5	6	5	PC	8	5	3	5	5	3	5	5	5	3	5	2	3	5	5	2	3	0	2	5	0	9	0	
34	41-50	RDB	1-5	Matric	Supervisor	MO/E/I		41-60%	4	4	4	PC	8	5	5	5	5	2	5	5	6	5	5	3	3	5	5	2	6	0	2	2	0	10	2	
35	41-50	RDB	1-5	Matric	Supervisor	MO/E/I		1-20%	5	6	5	PC	5	6	3	5	5	2	5	5	6	5	5	3	3	5	5	2	5	0	2	3	0	9	2	
36	41-50	PE	10+	Matric	Manager	MO/E/W/I		81-100%	5	6	5	PC	10	5	2	5	6	2	6	8	6	5	6	2	3	5	5	2	3	0	4	2	0	5	5	
37	41-50	PE	1-5	Matric	Supervisor	MO/E/W/C		81-100%	5	6	5	PC	12	6	2	5	6	2	6	6	6	6	6	2	3	5	5	2	2	0	5	1	0	3	7	
38	50+	PE	10+	Matric	Supervisor	MO/E/W/C		81-100%	5	6	4	PC	8	6	2	5	6	2	6	5	6	6	6	2	3	5	5	2	3	0	4	2	0	4	6	
39	26-30	CPT	1-5	Matric	Admin/Finance	MO/E/W/C		81-100%	4	6	4	PC	8	3	3	5	5	3	5	5	5	5	5	3	5	5	2	3	0	1	5	0	10	0		
40	41-50	CPT	5-10	Matric	Admin/Finance	MO/E/W/C		41-60%	3	5	5	PC	6	3	5	5	3	3	5	5	5	5	5	3	3	5	5	3	4	0	0	6	1	9	0	
41	41-50	CPT	5-10	Matric	Supervisor	MO/E/W/I/A		81-100%	5	6	5	PC	8	3	3	5	5	3	5	5	5	5	5	3	3	5	5	3	3	0	0	7	0	9	0	
42	50+	CPT	5-10	Matric	Admin/Finance	MO/E/W/C		61-80%	4	6	3	PC	5	3	3	5	5	3	5	5	5	5	5	3	5	5	2	3	0	1	5	0	10	0		
43	50+	CPT	5-10	Matric	Admin/Finance	MO/E/W/C		81-100%	4	5	5	PC	10	3	3	5	3	3	5	5	5	5	5	3	3	5	5	3	3	0	0	8	0	8	0	
44	50+	CPT	5-10	Matric	Admin/Finance	MO/E/W/C		61-80%	5	5	3	PC	8	3	3	5	3	5	5	5	5	5	5	5	3	5	5	3	3	0	0	6	0	10	0	
45	50+	CPT	10+	Matric	Manager	MO/E/W/I		81-100%	5	6	5	PC	4	3	3	5	3	3	5	5	5	5	5	3	3	5	5	3	4	0	0	7	1	8	0	
46	50+	CPT	10+	Matric	Director	MO/E/W/I		81-100%	5	6	5	PC	5	3	5	5	3	3	5	5	5	6	5	3	3	5	5	3	3	0	0	7	0	8	1	
47	41-50	CPT	10+	Matric	Admin/Finance	W		61-80%	4	5	3	PC	8	3	3	5	5	3	6	5	5	5	5	3	3	5	5	2	3	0	1	6	0	8	1	
48	31-40	CPT	10+	Matric	Supervisor	MO/E/W/C		81-100%	3	6	5	PC	3	3	5	5	3	3	5	5	5	5	5	3	3	5	5	3	3	0	0	7	0	9	0	
49	41-50	CPT	5-10	Matric	Admin/Finance	MO/E/W/C		61-80%	4	5	5	PC	12	3	3	5	5	3	5	5	5	5	5	3	5	5	2	2	0	2	4	0	10	0		
50	31-40	CPT	5-10	Matric	Admin/Finance	MO/E/W/C		41-60%	3	5	3	PC	8	3	3	5	5	3	5	5	5	6	5	3	3	5	5	3	3	0	0	7	0	8	1	
51	41-50	CPT	5-10	Matric	Admin/Finance	MO/E/W/C		61-80%	3	5	5	PC</																								

Appendix 5: Academic Rigor - Reliability Testing

Reliability and validity checking of responses of fat and thin computer network users

1. Questionnaire layout

Each of 95 users of a computer network was requested to complete a questionnaire consisting of 57 questions. The users consisted of 42 thin-clients (accessing the network via a terminal connected to a central server) and 53 fat-clients (PC and laptop users). The purpose of the analysis is to check the reliability (repeatability of scores) and validity (extent to which a question measures what it is supposed to measure) of certain questions.

Note : All calculation below are with the following assumption confined to these calculation and the hypothesis is NOT the same as defined in section 2.6, which is defined for the dissertation as a whole.

a. Hypothesis – Assumption of association

b. Null Hypothesis – Hypothesis of NO association

Cronbach's Alpha has ability to calculate associations for 2 or more variables whilst the Somers'd and Kendall's tau-b only calculate possible association for 2 variables at a time. All three will be utilised for analysis of the data.

Cronbach's Alpha

Cronbach's alpha measures how well a set of items (or variables) measures a single unidimensional latent construct. When data have a multidimensional structure, Cronbach's alpha will usually be low. Technically speaking, Cronbach's alpha is not a statistical test - it is a coefficient of reliability (or consistency).

Cronbach's alpha can be written as a function of the number of test items AND the average inter-correlation among the items.

Below, for conceptual purposes, we show the formula for the standardised Cronbach's alpha:

$$\alpha = \frac{N}{N-1} \left(\frac{\sigma_X^2 - \sum_{i=1}^N \sigma_{Y_i}^2}{\sigma_X^2} \right)$$

Here N is equal to the number of items and \bar{r} is the average inter-item correlation among the items.

Somers'd

Somers' d is gamma modified to penalise for pairs tied on x only, in directional (asymmetric) hypotheses in which x causes or predicts y; and to penalise for pairs tied on y only, in hypotheses in which y causes or predicts x. Somers' d, $d_{yx} = (P - Q)/(P + Q + Y_0)$ for the hypothesis that x causes or predicts y. For the hypothesis that y causes or predicts x, the formula is: $d_{xy} = (P - Q)/(P + Q + X_0)$. As explained in the section on gamma, P is concordant pairs, Q is discordant pairs, Y_0 is pairs tied on Y, and X_0 is pairs tied on X. Computation of the variance of gamma is given in Liebetrau (1983: 80-82).

Kendall's tau-b

Kendall's Tau-b is a measure of association often used with but not limited to 2-by-2 tables. Since tau-b has a known sampling distribution it is possible to compute its standard error and significance. SPSS and other major packages report the significance level of the computed tau-b value. The formula for the variance of tau-b is given in Liebetrau (1983: 70).

It is computed as the excess of concordant over discordant pairs (C - D), divided by a term representing the geometric mean between the number of pairs not tied on X (X_0) and the number not tied on Y (Y_0):

$$\text{Tau-b} = (C - D) / \text{SQRT} [(C + D + Y_0)(C + D + X_0)]$$

There is no well-defined intuitive meaning for Tau -b, which is the surplus of concordant over discordant pairs as a percentage of concordant, discordant, and

approximately one-half of tied pairs. The rationale for this is that if the direction of causation is unknown, then the surplus of concordant over discordant pairs should be compared with the total of all relevant pairs, where those relevant are the concordant pairs, the discordant pairs, plus either the X-ties or Y-ties but not both, and since direction is not known, the geometric mean is used as an estimate of relevant tied pairs.

Tau-b requires binary or ordinal data. It reaches 1.0 (or -1.0 for negative relationships) only for square tables when all entries are on one diagonal. Tau-b equals 0 under statistical independence for both square and non-square tables. Tau-c is used for non-square tables.

Mann-Whitney

Mann-Whitney U test is a non-parametric test for assessing whether the medians between two samples of observations are the same. The null hypothesis is that the two samples are drawn from a single population, and therefore that the medians are equal. It requires the two samples to be independent, and the observations to be ordinal or continuous measurements, i.e. one can at least say, of any two observations, which is the greater. In order to apply the Mann-Whitney test, the raw data from samples A and B must first be combined into a set of $N=n_a+n_b$ elements, which are then ranked from lowest to highest, including tied rank values where appropriate. These rankings are then re-sorted into the two separate samples.

The value of U reported in this analysis is the one based on sample A, calculated as

$$U_A = n_a n_b + \frac{n_a(n_a+1)}{2} - T_A$$

where T_A = the observed sum of ranks for sample A, and

$$n_a n_b + \frac{n_a(n_a+1)}{2} = \text{the maximum possible value of } T_A$$

2. Percentage of job time versus productivity when network is unavailable

Percentage versus productivity

Question 7 * Question 20a Cross-Tabulation
Question 20a is Inverse on Question 20 to reflect the positive

		q20a				Total
Count		Agree	neither agree/disagree	disagree	strongly disagree	
q7	1-20%	2	0	0	0	2
	41-60%	3	1	5	2	11
	61-80%	0	1	9	2	12
	81-100%	0	0	5	12	17
Total		5	2	19	16	42

Directional Measures - Somers'd

			Test Value	Standard Error	T - Value	P Value / Significance
Ordinal by Ordinal	Somers' d	Symmetric	.583	.106	4.989	.000
		q7 Dependent	.606	.106	4.989	.000
		q20a Dependent	.562	.109	4.989	.000

- Not assuming the null hypothesis.
- Using the asymptotic standard error assuming the null hypothesis.

Symmetric Measures - Kendall's tau-b

		Value	Asymp. Std. Error(a)	Approx. T(b)	Approx. Sig.
Ordinal by Ordinal	Kendall's tau-b	.584	.106	4.989	.000
N of Valid Cases		42			

- Not assuming the null hypothesis.
- Using the asymptotic standard error assuming the null hypothesis.

Since the test value yields 0.583 for Somers'd which is greater than 0 the possibility of association does exist, however the P Value yields a much greater valued than 0.1 which suggests little association. A P-Value less than 0.1 suggests that a strong association. The same inferences can be drawn on the Kendall's tau-b calculation.

Reliability Statistics - Cronbach's Alpha

Cronbach's Alpha	N of Items
.118	2

There is a small positive association between q7 and q20a i.e. the higher the percentage of time spent on the thin-client, the more the thin-client respondents disagree that they are productive by doing manual work when the computer system is down.

3. Speed of performance of thin-client

Question 22 * Question 24 Cross Tabulation

Count	q24				Total
	3	4	5	6	
q22 2	3	0	0	0	3
3	7	5	11	9	32
5	4	1	0	2	7
Total	14	6	11	11	42

Directional Measures - Somers' d

			Test Value	Standard Error	T Value	P Value / Significance
Ordinal by Ordinal	Somers' d	Symmetric	.034	.162	.213	.831
		q22 Dependent	.026	.124	.213	.831
		q24 Dependent	.050	.233	.213	.831

- a. Not assuming the null hypothesis.
- b. Using the asymptotic standard error assuming the null hypothesis.

Symmetric Measures - Kendall's tau-b

		Value	Asymp. Std. Error(a)	Approx. T(b)	Approx. Sig.
Ordinal by Ordinal	Kendall's tau-b	.036	.170	.213	.831
N of Valid Cases		42			

- a. Not assuming the null hypothesis.
- b. Using the asymptotic standard error assuming the null hypothesis.

Reliability Statistics - Cronbach's Alpha

Cronbach's Alpha(a)	N of Items
-.093	2

a. The value is negative due to a negative average covariance among items. This violates reliability model assumptions.

No association between q22 and q24.

4. Listening to CD's and MP3's

Question 25 * Question 26 Cross tabulation

Count	q26			Total
	4	5	6	
q25 3	4	24	14	42
Total	4	24	14	42

Directional Measures - Somers'd

Ordinal by Ordinal	Somers' d	Symmetric	.(a)
--------------------	-----------	-----------	------

a. No statistics are computed because q25 is a constant.

Symmetric Measures - Kendall's tau-b

		Value
Ordinal by Ordinal	Kendall's tau-b	.(a)
N of Valid Cases		42

a. No statistics are computed because q25 is a constant.

Reliability Statistics - Cronbach's Alpha

Cronbach's Alpha	N of Items
7.64E-014	2

Answer to question 25 is the same for all thin-clients therefore cannot calculate a measure of association.

5. Training

Question 21 * Question 30 Cross-Tabulation

Count	q30		Total
	3		
Q21 2	3		3
3	32		32
4	5		5
5	2		2
Total	42		42

Directional Measures - Somers'd

Ordinal by Ordinal	Somers' d	Symmetric	.(a)
--------------------	-----------	-----------	------

a. No statistics are computed because question 30 is a constant.

Symmetric Measures - Kendall's tau-b

		Value
Ordinal by Ordinal	Kendall's tau-b	.(a)
N of Valid Cases		42

a. No statistics are computed because question 30 is a constant.

Reliability Statistics Cronbach's Alpha

Cronbach's Alpha	N of Items
3.37E-014	2

Answer to question 30 is the same for all thin-clients and cannot therefore calculate a measure of association.

6. Support staff (Citrix)

Question 32 * Question 33 Cross- Tabulation

Count	q33			Total
	3	5	6	
Q32 3	11	0	0	11
5	0	24	4	28
6	0	3	0	3
Total	11	27	4	42

Directional Measures - Somers' d

			Test Value	Standard Error	T Value	P Value/ Significance
Ordinal by Ordinal	Somers' d	Symmetric	.753	.095	5.507	.000
		q32 Dependent	.733	.109	5.507	.000
		q33 Dependent	.774	.110	5.507	.000

- a. Not assuming the null hypothesis.
- b. Using the asymptotic standard error assuming the null hypothesis.

Symmetric Measures - Kendall's tau-b

	Value	Asymp. Std. Error(a)	Approx. T(b)	Approx. Sig.
Ordinal by Ordinal Kendall's tau-b	.753	.095	5.507	.000
N of Valid Cases	42			

- a. Not assuming the null hypothesis.
- b. Using the asymptotic standard error assuming the null hypothesis.

Reliability Statistics - Cronbach's Alpha

Cronbach's Alpha	N of Items
.954	2

Since the Cronbach's Alpha is greater than 0.8 a high positive association exists between question 32 and question 33.

7. Computer Games – Thin-clients

Question 35 * Question 36 Cross-Tabulation

Count		q36				Total
		3	4	5	6	
q35	3	9	0	0	0	9
	4	0	2	0	0	2
	5	0	0	29	0	29
	6	0	0	1	1	2
Total		9	2	30	1	42

Directional Measures - Somers'd

		Symetric				
Ordinal by Ordinal	Somers' d		.963	.035	5.745	.000
	q35 Dependent		.997	.003	5.745	.000
	q36 Dependent		.930	.066	5.745	.000

- Not assuming the null hypothesis.
- Using the asymptotic standard error assuming the null hypothesis.

Symmetric Measures – Kendall's tau-b

		Value	Asymp. Std. Error(a)	Approx. T(b)	Approx. Sig.
Ordinal by Ordinal	Kendall's tau-b	.963	.035	5.745	.000
N of Valid Cases		42			

- Not assuming the null hypothesis.
- Using the asymptotic standard error assuming the null hypothesis.

Reliability Statistics Cronbach's Alpha

Cronbach's Alpha	N of Items
.992	2

Since the Cronbach's Alpha is greater than 0.8 a high positive association exists between question 35 and question 36.

8. Computer Games – Fat-clients

Question 54 * Question 55 Cross-Tabulation

Count		q55	
		5	Total
q54	5	52	52
	6	1	1
Total		53	53

Directional Measures – Somers'd

Ordinal by Ordinal	Somers' d	Symmetric	.(a)
--------------------	-----------	-----------	------

a. No statistics are computed because q55 is a constant.

Symmetric Measures – Kendall's tau-b

		Value
Ordinal by Ordinal	Kendall's tau-b	.(a)
N of Valid Cases		53

a. No statistics are computed because q55 is a constant.

Reliability Statistics – Cronbach's Alpha

Cronbach's Alpha	N of Items
1.57E-012	2

Answer to question 55 is the same for all thin-clients and therefore cannot calculate a measure of association.

9. Support Calls – Thin-clients versus Fat-clients

Frequency distribution – Support calls for Thin-clients

Question 12

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	1	1.1	2.2	2.2
	2	10	10.5	22.2	24.4
	3	1	1.1	2.2	26.7
	4	5	5.3	11.1	37.8
	5	11	12.6	26.7	64.4
	6	2	2.1	4.4	68.9
	8	6	7.4	15.6	84.4
	10	6	7.4	15.6	100.0
	Total	42	47.4	100.0	
	Missing	System	53	52.6	
Total		95	100.0		

Frequency distribution – Support calls for fat-clients

Question 41

		Frequency	Percent	Valid Percent	Cumulative Percent	
Valid	0	1	1.1	1.9	1.9	
	1	1	1.1	1.9	3.8	
	2	3	3.2	5.7	9.4	
	3	2	2.1	3.8	13.2	
	4	3	3.2	5.7	18.9	
	5	17	17.9	32.1	50.9	
	6	1	1.1	1.9	52.8	
	7	2	2.1	3.8	56.6	
	8	16	16.8	30.2	86.8	
	10	5	5.3	9.4	96.2	
	12	2	2.1	3.8	100.0	
	Total		53	55.8	100.0	
	Missing	System	42	44.2		
Total		95	100.0			

Mann-Whitney test for equality of means

Ranks

support	thin	42	42.04	1765.50
	fat	53	52.73	2794.50
	Total	95		

Test Statistics (a)

	support
Mann-Whitney U	862.500
Wilcoxon W	1765.500
Z	-1.919
Asymp. Sig. (2-tailed)	.055

a. Grouping Variable: client

The number of calls for support is higher for the fat-clients than for the thin-clients.

10. Satisfaction of thin-client users and feedback of thin-clients to fat-clients

Frequency distribution of satisfaction Thin-clients

Question 40

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	2	2.1	4.8	4.8
	2	4	4.2	9.5	14.3
	3	8	8.4	19.0	33.3
	4	9	9.5	21.4	54.8
	5	15	15.8	35.7	90.5
	6	4	4.2	9.5	100.0
	Total	42	44.2	100.0	
Missing	System	53	55.8		
Total		95	100.0		

Frequency distribution of feedback (thin to fat-clients)

Question 43

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	3	3.2	5.7	5.7
	3	16	16.8	30.2	35.8
	4	10	10.5	18.9	54.7
	5	22	23.2	41.5	96.2
	6	2	2.1	3.8	100.0
	Total	53	55.8	100.0	
Missing	System	42	44.2		
Total		95	100.0		

11. Job versus type of system

Question 5 * Question 11 Cross-Tabulation

Count		q11			Total
		Laptop	PC	Thin-clients	
q5	Admin/Finance	2	28	22	52
	Clerical	0	0	20	20
	Director	1	3	0	4
	Manager	1	5	0	6
	Supervisor	0	13	0	13
Total		4	49	42	95

12. Viruses Thin-client versus Fat-client

Frequency distribution – thin-clients

Question 37

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3	13	13.7	31.0	31.0
	4	2	2.1	4.8	35.7
	5	16	16.8	38.1	73.8
	6	11	11.6	26.2	100.0
	Total	42	44.2	100.0	
Missing	System	53	55.8		
Total		95	100.0		

Frequency distribution – fat-clients

Question 45

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	2	2.1	3.8	3.8
	3	27	28.4	50.9	54.7
	5	19	20.0	35.8	90.6
	6	5	5.3	9.4	100.0
	Total	53	55.8	100.0	
Missing	System	42	44.2		
Total		95	100.0		

There suggests a divided opinion with both thin and fat users. For question 37 opinions slightly in favour of agree, while for question 45 the opinion slightly is in favour of disagree.

13. Positive feedback and change from fat to thin-clients

Question 43 * Question 56 Cross-Tabulation

Count		q56				Total
		2	3	5	6	
q43	2	3	0	0	0	3
	3	7	6	1	2	16
	4	0	1	2	7	10
	5	1	5	4	12	22
	6	0	0	1	1	2
Total		11	12	8	22	53

Directional Measures – Somers'd

			Test Value	Standard Error	T Value	P Value/ Significance
Ordinal by Ordinal	Somers' d	Symmetric	.462	.099	4.488	.000
		q43 Dependent	.457	.099	4.488	.000
		q56 Dependent	.466	.100	4.488	.000

- a. Not assuming the null hypothesis.
- b. Using the asymptotic standard error assuming the null hypothesis.

Symmetric Measures – Kendall's tau-b

		Value	Asymp. Std. Error(a)	Approx. T(b)	Approx. Sig.
Ordinal by Ordinal	Kendall's tau-b	.462	.099	4.488	.000
N of Valid Cases		53			

- a. Not assuming the null hypothesis.
- b. Using the asymptotic standard error assuming the null hypothesis.

Reliability Statistics – Cronbach's Alpha

Cronbach's Alpha	N of Items
.682	2

There exists a moderate positive association between question 43 and question 56.

14. IT support

Frequency distribution of satisfaction with IT support on thin-clients

Question 38

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	2	2.1	4.8	4.8
	3	8	8.4	19.0	23.8
	4	4	4.2	9.5	33.3
	5	25	26.3	59.5	92.9
	6	3	3.2	7.1	100.0
	Total	42	44.2	100.0	
Missing	System	53	55.8		
Total		95	100.0		

Frequency distribution of satisfaction with IT support on fat-clients

Question 57

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	3	3.2	5.7	5.7
	3	19	20.0	35.8	41.5
	4	5	5.3	9.4	50.9
	5	23	24.2	43.4	94.3
	6	3	3.2	5.7	100.0
	Total	53	55.8	100.0	
Missing	System	42	44.2		
Total		95	100.0		

Ranks

		user	N	Mean Rank	Sum of Ranks
Satisfied	1		42	46.26	1943.00
	2		53	49.38	2617.00
	Total		95		

Test Statistics (a)

	Satisfied
Mann-Whitney U	1040.000
Wilcoxon W	1943.000
Z	-.568
Asymp. Sig. (2-tailed)	.570

a. Grouping Variable: user

Results suggest no difference between level of satisfaction with IT support for thin and fat-clients

15. Training and Change-Management

Question 15

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	5	42	44.2	100.0	100.0

Question 21

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	3	3.2	7.1	7.1
	3	32	33.7	76.2	83.3
	4	5	5.3	11.9	95.2
	5	2	2.1	4.8	100.0
	Total	42	44.2	100.0	
Missing	System	53	55.8		
Total		95	100.0		

Question 30

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3	42	44.2	100.0	100.0

Single responses to question 15 (all agree) and question 30 (all disagree). In response to question 21 the majority (32 out of 42) disagree. Thin-clients do not have any intelligence and merely act as windows based “dumb terminals”. Therefore no training is required for thin-client devices.

Appendix 6: Pricing Case Calculations

Calculations for Mean Time To Repair (MTTR) and Failure

Rand value- cost to IBM / Service Provider	Quantity	Thin Clients average per month to maintain HW including travel	Quantity	Fat Clients average per month to maintain HW including travel		Assumptions
	1	R 288.31	7	R 1,729.86		All devices are located at designated sites ie. Durban, Richards Bay, Port Elizabeth & Cape Town. Actuals over 12 month average on hardware failures : 12 Thin Clients failed & 84 FCs failed as per proportionate calculations per annum. Travel is calculated on average distance i.e. 33km return + 1 hour labour per device with separate call out charges. This excludes costs of repair or swap outs as all hardware will be under a separate maintenance contract.Costs
	Number of Thin Clients	Number of failures			Labour Rate - Desktop Engineers	Per Kilometer Costs
Thin Clients		6			Unit Costs Prices to Service Provider Organisation	R 2.07
					R 220.00	
Current HW Failures	Number of Clients	Number of HW Failures per annum				
Thin Clients	42	6				
Fat Clients	53	48				
Proportioned HW Failures						
Thin Clients	77	11				
Fat Clients	77	70				
Thin Client HW Failures per month	0.92	~1				
Fat Client HW Failures per month	5.83	~6				
	Durban	Richards Bay	Port Elizabeth	Cape Town	Total	Average kilometers return to be travelled between service provider office to National Ship Chandlers regional office
Distance Between Support Service Regional Office & National Ship Chandlers Regional Office - Return Trip in kilometers	38	52	14	28	132	33

WAN Cost Calculations for Thin-clients and Fat-clients

WAN COST DIFFERENCES	Durban to Richards Bay	Durban to Port Elizabeth	Durban to Cape Town	Total Per Month	Durban Number	031-2054221
Thin Clients RDB-128K; PE-64K; CPT-192K	R 3,662.91	R 3,268.00	R 5,890.34	R 12,821.25	Richards Bay Number	035-7973511
Fat Clients all 64 kbps Links from Durban	R 2,676.27	R 3,268.00	R 3,561.50	R 9,505.77	Port Elizabeth Number	041-4847633
All prices excluding VAT					Cape Town Number	021-5118922

All prices calculated via Telkom's Tariffs program for up-to-date prices, attached in Appendix 7

Desktop Management, Remote Control and Software Distribution

Desktop Management, Remote Control and Software Distribution	Thin Clients	Fat Clients		Description	Quantity	Unit Price	Total Price	Customer Price - 16% Margin
	Functionality built into Citrix for Management							
		Hardware						
		> IBM Hardware		Server x336 Express, Intel Xeon 3.2GHz, 2MB L2 Cache, 2x612MB PC2-3200 DDR2 SDRAM, O/Bay 3.6" HS SCSI, 1 x 585W p/s, integrated dual Gigabit Ethernet, 3 yr On-Site Warranty	3	R 13,326.00	R 39,978.00	
				IBM ServeRAID 6i+ Controller	3	R 2,616.00	R 7,846.00	
				IBM 73GB 16K U320 SCSI HS HDD	9	R 3,361.00	R 30,159.00	
				IBM 1GB (2 x 612MB) PC2-3200 CL3 ECC DDR SDRAM NonChipkill	3	R 1,909.00	R 5,727.00	
				> TOTAL IBM HW			R 83,709.00	R 98,481.18
		Software						
				> Windows 2003 Ent. Server	3	R 14,633.00	R 43,699.00	
				> SQL Server	1	R 35,722.00	R 35,722.00	
				> SMS Server	1	R 3,666.00	R 3,666.00	
							R 82,887.00	R 97,514.12
		Installation Costs		Configure 77 clients @ R220 / device for 1 hour				R 16,940.00
				Server-side installation costs - 2 weeks installation, configuration and testing i.e. 60 hours * R350 / hour				R 21,000.00
						Total to National Ship Chandlers		R 233,936.29
						Financed over 36 months at 18% interest charges to yield per month charges		R 8,457.32

Hardware Costs for Fat-clients and Thin-clients

PCs includes Windows XP operating system with 3 year onsite warranty 1GB RAM, 40 GB HDD @ R6,282.35. Thin Clients configured with 256MB RAM with Windows CE @ R2,654.12. No Monitors included in both scenarios, 36 month financed hardware for both TCs & FCs.	Unit Price	Quantity	Total	Financed over 36 months @ 18%
Wyse V30 Thin Client Hardware Costs with 3 year onsite warranty - Windows CE	R 2,654.12	77	R 204,367.24	R 7,388.37
IBM E50 ThinkCentre Fat Client Hardware Costs with 3 year onsite warranty - Windows XP operating system with 1GB RAM, 40 GB HDD	R 6,282.35	77	R 483,740.95	R 17,488.39

Licensing Costs - Citrix Licensing and Client Operation System

	Citrix Server Licensing		Thin Clients	15% Margin		Fat Clients
Citrix License Costs per Users	77	R 1,840.00	R 141,680.00	R 166,682.35	400 Users Cost \$15000 for 2 years software subscription (R7.00 = \$1)	Windows XP Professional Costs included in Cost of Hardware
				R 23,756.76	0	0
				R 190,439.12	0	0
			Financed at 18% over 36 months, per month cost	R 6,884.83	R 2,164.71	0
				Total	R 308.53	0
Software Subscription for 2 additional years	77	R 262.25	R 20,193.25	-	-	0

Server Hardware Farm versus

Server Hardware required for distributed fat client environment Versus Central File Server and Citrix server farm for thin client environment										
		Distributed Servers			Fat Clients		Thin Clients - Citrix Server Farm			
Quantity	Fat Clients Hardware	Unit Price	Total Price	15% Margin	Quantity	Thin Client HW	Unit Price	Total Price	15% Margin	
Hardware Costs										
2	1 X File Server for Head Office (Congoella) - Same config as file server with single processor with 3 X 73GB HDD, 4096GB DLT Tape Backup Drive & 1 X Exchange Server	R 37,846.00	R 75,692.00	R 86,045.41	3	Server x336 Express, Intel Xeon 3.2GHz, 2MB L2 Cache, 2x512MB PC2-3200 DDR2 SDRAM, 0x5Bay 3.5" HS SCSI, 1 x 365W ps, Integrated dual Gigabit Ethernet, 3 yr On-Site Warranty, ServerRAID 6M Controller, 4 GB Additional Memory, 2nd Xeon Processor, 2 X 73GB HDD.	R 39,836.00	R 119,508.00	R 140,597.69	
1	1 X File Server with Exchange Server installed for Richards Bay - Same config as file server with single processor with 3 X 73GB HDD, 4096GB DLT Tape Backup Drive	R 37,846.00	R 37,846.00	R 44,524.71	0	Server Raid Adapters - IBM ServerRAID 6M Controller	R 5,260.00	R 0.00	R 0.00	
1	1 X File Server with Exchange Server installed for Port Elizabeth - Same config as file server with single processor with 3 X 73GB HDD, 4096GB DLT Tape Backup Drive	R 37,846.00	R 37,846.00	R 44,524.71	0	IBM 1GB (2 x 512MB) PC2-3200 CL3 ECC DDR SDRAM NonCrashall	R 1,909.00	R 0.00	R 0.00	
1	1 X File Server with Exchange Server installed for Port Elizabeth - Same config as file server with single processor with 3 X 73GB HDD, 4096GB DLT Tape Backup Drive	R 37,846.00	R 37,846.00	R 44,524.71	0	IBM 1GB (2 x 512MB) PC2-3200 CL3 ECC DDR SDRAM NonCrashall	R 1,909.00	R 0.00	R 0.00	
					0	IBM 2GB (2 x 1GB) PC2-3200 CL3 ECC DDR2 SDRAM RDIMM Kit	R 5,861.00	R 0.00	R 0.00	
Software										
5	Windows 2003 Server Standard	R 4,473.00	R 22,365.00	R 25,311.76	0	Second Processor 3.2 Ghz Xeon - IBM Intel Xeon 3.2GHz, 2MB L2 cache Processor - x336	R 4,869.00	R 0.00	R 0.00	
4	Exchange server 2003 - 200 Offices for Congoella, Richards Bay, Port Elizabeth & Cape Town	R 4,850.00	R 19,200.00	R 22,088.31	0	IBM 73GB 15k U320 SCSI HS HDD	R 3,351.00	R 0.00	R 0.00	
Installation Costs										
					2	Central File Server & Exchange Server for Head Office - Server x336 Express, Intel Xeon 3.2GHz, 2MB L2 Cache, 2x512MB PC2-3200 DDR2 SDRAM, 0x5Bay 3.5" HS SCSI, 1 x 365W ps, Integrated dual Gigabit Ethernet, 3 yr On-Site Warranty, ServerRAID 6M Controller, 2 GB Additional Memory, 2nd Xeon Processor, 5X 73GB HDD, DLT Tape Drive	R 49,869.00	R 99,778.00	R 117,285.88	
50	Install and configure 4 File Servers, install and configure 4 x Exchange Post Offices, configure 77 Fat Clients with logn policies and test		30 hours @ R390/hour = R11,700 + R8000 (3 return flights Richards Bay, PE & Cape Town) + R 8000 (R1000 1 day for 8 days for accommodation and eat) = R 46,400	R 46,400.00				3 Citrix Servers Total Cost Price to Service Provider & 1 X File Server for HQ & 1 X Exchange Server for HQ	R 219,286.00	R 257,883.53
Total				R 317,929.50	Total				R 257,883.53	
Financed over 36 months @ 18%				R 11,493.70	Financed over 36 months @ 18%				R 12,658.22	
Software										
Windows 2003 Standard Server		R 4,473.00	R 22,365.00	R 26,311.76						
Windows Central Server CALs		R 497.00	R 37,695.00	R 44,156.47						
Installation Costs										
5 Installation and Configuration of Citrix Farm				R 22,000.00						
77				R 360,411.76						
40 Windows 2003 Standard Server		R 4,473.00								
Windows 2003 Server Cal.		R 178.00			Financed over 36 months @ 18%			R 12,658.22		

Monthly Server Administration and Management

		Thin Clients		Fat Clients		
	3 Citrix Servers					
30	30 hours Citrix Support per month	380	R 11,400.00	40	FCs : 1 File Server & 1 Exchange Server at HQ, 1 Server at each of 3 remote sites + Administration of SMS Services	380 R 15,200.00

Antivirus for PCs versus Citrix

Thin Clients				Fat Clients		
Axiz - Norton Antivirus 2007 for Fat-clients with 3 year maintenance	0	R 118.00	R 0.00	77	R 118.00	R 9,086.00
Windows 2003 Server Corporate Edition per server with 3 year maintenance	5	R 263.00	R 1,315.00	5	R 263.00	R 1,315.00
		Total	R 1,315.00		Total	R 10,401.00
		Over 3 Years	R 3,945.00		Over 3 Years	R 31,203.00
		Financed over 36 months @ 18%	R 142.62		Financed over 36 months @ 18%	R 1,128.06

2 X Workstation Visits per Annum for Software Upgrades

<p>Fat Clients: 30 Minutes per PC twice per annum => 77 hours labour at R220.00/hour = R16940/year => R1411.66/month;</p> <p>Thin Clients: Application upgraded on single instance on server and instantly all users are upgraded</p>	R 1411.66 / Month
---	--------------------------

Summary of Distribution of Devices used to calculate TCO

Hybrid Outsource Solution - Thin Clients & Fat Clients				
	Number of FC - Laptops	Number of FC - PCs	Number of TC	Total
Durban	4	5	38	47
Richards Bay	0	2	12	14
Port Elizabeth	0	2	6	8
Cape Town	0	5	21	26
Total	4	14	77	95
		18	77	95
Minimum Mandatories of Desktop Allocation				
	Number of FC - Laptops	Number of FC - PCs	Total	
Durban	4	5	9	
Richards Bay	0	2	2	
Port Elizabeth	0	2	2	
Cape Town	0	5	5	
		Total Minimum Fat Client Requirements	18	
Common Denominator for Fat Clients vs Thin Client TCO Analysis				
	Number of Thin Clients	Number of Fat Clients		
Mandatory Fat Clients Constant Variable	18	18		
Outsource Comparison Analysis	77	77		
Total Desktops	95	95		

Appendix 7: Vendor Quotations



128 KBit/s Diginet Plus circuit between CONGELLA and ALTON

INSTALLATION CHARGES	AMOUNT (Rand)
Termination at CONGELLA	517.00
Termination at ALTON	517.00
DP Network Terminating Unit at CONGELLA	603.00
DP Network Terminating Unit at ALTON	603.00
SUBTOTAL (excluding VAT)	2240.00
VAT 14.00%	313.60
TOTAL	2553.60

MONTHLY RENTAL CHARGES	AMOUNT (Rand)
DP Network Terminating Unit at CONGELLA	525.00
DP Network Terminating Unit at ALTON	525.00
Local Leads at CONGELLA	180.00
Local Leads at ALTON	180.00
Diginet Plus Port at CONGELLA	372.00
Diginet Plus Port at ALTON	372.00
Line Charge (164 Km)	1508.91
SUBTOTAL (excluding VAT)	3662.91
VAT 14.00%	512.81
TOTAL	4175.72

Telkom SA Ltd Non-Voice Services

Whilst every effort has been made to ensure that the information in this database is correct, it must not be construed as a representation or undertaking on the part of Telkom SA Ltd or its employees that may form the basis of any claim for loss sustained following from reliance on the information contained herein. Care should be taken to ensure that the database date and program versions are the most recent as is made available on the Telkom Internet Home Page:
www.telkom.co.za

Tariffs - Version 6.0.17
Quotation date: 03-12-2006



**192 KBit/s Diginet Plus circuit between
CONGELLA and MAITLAND**

INSTALLATION CHARGES	AMOUNT (Rand)
Termination at CONGELLA	517.00
Termination at MAITLAND	517.00
DP Network Terminating Unit at CONGELLA	603.00
DP Network Terminating Unit at MAITLAND	603.00
 SUBTOTAL (excluding VAT)	 2240.00
VAT 14.00%	313.60
 TOTAL	 2553.60

MONTHLY RENTAL CHARGES	AMOUNT (Rand)
DP Network Terminating Unit at CONGELLA	525.00
DP Network Terminating Unit at MAITLAND	525.00
Local Leads at CONGELLA	180.00
Local Leads at MAITLAND	180.00
Diginet Plus Port at CONGELLA	434.00
Diginet Plus Port at MAITLAND	434.00
Line Charge (1269 Km)	3612.34
 SUBTOTAL (excluding VAT)	 5890.34
VAT 14.00%	824.65
 TOTAL	 6714.99

Telkom SA Ltd Non-Voice Services

Whilst every effort has been made to ensure that the information in this database is correct, it must not be construed as a representation or undertaking on the part of Telkom SA Ltd or its employees that may form the basis of any claim for loss sustained following from reliance on the information contained herein. Care should be taken to ensure that the database date and program versions are the most recent as is made available on the Telkom Internet Home Page: www.telkom.co.za

Tariffs - Version 6.0.17
Quotation date: 03-12-2006



**64 KBit/s Diginet circuit between
CONGELLA and MAITLAND**

INSTALLATION CHARGES	AMOUNT (Rand)
Termination (CONGELLA)	517.00
Network Terminating Unit (CONGELLA)	803.00
Termination (MAITLAND)	517.00
Network Terminating Unit (MAITLAND)	803.00
 SUBTOTAL (excluding VAT)	<hr/> 2240.00
VAT 14.00%	313.60
 TOTAL	<hr/> 2553.60 <hr/>

MONTHLY RENTAL CHARGES	AMOUNT (Rand)
Network Terminating Unit (CONGELLA)	270.00
Network Terminating Unit (MAITLAND)	270.00
Local Leads (CONGELLA)	180.00
Diginet Port (CONGELLA)	310.00
Local Leads (MAITLAND)	180.00
Diginet Port (MAITLAND)	310.00
Line Charge (1269 Km)	2041.50
 SUBTOTAL (excluding VAT)	<hr/> 3561.50
VAT 14.00%	498.61
 TOTAL	<hr/> 4060.11 <hr/>

Telkom SA Ltd Non-Voice Services

Whilst every effort has been made to ensure that the information in this database is correct, it must not be construed as a representation or undertaking on the part of Telkom SA Ltd or its employees that may form the basis of any claim for loss sustained following from reliance on the information contained herein. Care should be taken to ensure that the database date and program versions are the most recent as is made available on the Telkom Internet Home Page: www.telkom.co.za

Tariffs - Version 6.0.17
Quotation date: 03-12-2006



**64 KBit/s Diginet circuit between
CONGELLA and ALTON**

INSTALLATION CHARGES	AMOUNT (Rand)
Termination (CONGELLA)	517.00
Network Terminating Unit (CONGELLA)	603.00
Termination (ALTON)	517.00
Network Terminating Unit (ALTON)	603.00
	<hr/>
SUBTOTAL (excluding VAT)	2240.00
VAT 14.00%	313.60
	<hr/>
TOTAL	2553.60
	<hr/>

MONTHLY RENTAL CHARGES	AMOUNT (Rand)
Network Terminating Unit (CONGELLA)	270.00
Network Terminating Unit (ALTON)	270.00
Local Leads (CONGELLA)	180.00
Diginet Port (CONGELLA)	310.00
Local Leads (ALTON)	180.00
Diginet Port (ALTON)	310.00
Line Charge (161 Km)	1156.27
	<hr/>
SUBTOTAL (excluding VAT)	2876.27
VAT 14.00%	374.68
	<hr/>
TOTAL	3050.95
	<hr/>

Telkom SA Ltd Non-Voice Services

Whilst every effort has been made to ensure that the information in this database is correct, it must not be construed as a representation or undertaking on the part of Telkom SA Ltd or its employees that may form the basis of any claim for loss sustained following from reliance on the information contained herein. Care should be taken to ensure that the database date and program versions are the most recent as is made available on the Telkom Internet Home Page:
www.telkom.co.za

Tariffs - Version 6.0.17
Quotation date: 03-12-2006



64 KBit/s Diginet circuit between CONGELLA and NORTH END

INSTALLATION CHARGES	AMOUNT (Rand)
Termination (CONGELLA)	517.00
Network Terminating Unit (CONGELLA)	603.00
Termination (NORTH END)	517.00
Network Terminating Unit (NORTH END)	603.00
SUBTOTAL (excluding VAT)	2240.00
VAT 14.00%	313.60
TOTAL	2553.60

MONTHLY RENTAL CHARGES	AMOUNT (Rand)
Network Terminating Unit (CONGELLA)	270.00
Network Terminating Unit (NORTH END)	270.00
Local Leads (CONGELLA)	180.00
Diginet Port (CONGELLA)	310.00
Local Leads (NORTH END)	180.00
Diginet Port (NORTH END)	310.00
Line Charge (682 Km)	1748.00
SUBTOTAL (excluding VAT)	3268.00
VAT 14.00%	457.52
TOTAL	3725.52

Telkom SA Ltd Non-Voice Services

Whilst every effort has been made to ensure that the information in this database is correct, it must not be construed as a representation or undertaking on the part of Telkom SA Ltd or its employees that may form the basis of any claim for loss sustained following from reliance on the information contained herein. Care should be taken to ensure that the database date and program versions are the most recent as is made available on the Telkom Internet Home Page:
www.telkom.co.za

Tariffs - Version 6.0.17
Quotation date: 03-12-2006

Appendix 8: Authorisation Letter from National Ship Chandlers to Conduct Research

NATIONAL SHIP CHANDLERS (NATAL)

1989 (PTY) LTD.
(DURBAN)
REG. NO.: 89/00448/07

SHIP CHANDLERS

DIRECTORS:
Capt. K. THORSEN (NORWEGIAN)
J.M. JOANNOU
S. STYLIANOU

TELEPHONE: (031) 2054221
AFTER HOURS:
3035400, 2060040
7013712
E-mail: natship@natship.co.za
Web site: www.natship.co.za



TELEGRAMS & CABLES "NATSHIP"

GENERAL WHOLESALE MERCHANTS

438 SYDNEY ROAD
DURBAN 4001
P.O. BOX 18461
DALBRIDGE 4014
SOUTH AFRICA
TELEX: 6-22287 NATDB
FAX: (031) 2054194
(031) 2052220

26 September 2006

The Graduate School of Business
University of Kwa-Zulu Natal
Private Bag X 54001
Durban
4000

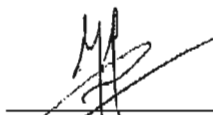
To Whom It May Concern:

Approval Letter of Authorisation for Research at National Ship Chandlers for Navin Radhalal

This serves to confirm approval for Navin Radhalal to undertake research within National Ship Chandlers Information Technology environment and is authorised to undertake questionnaire surveys and interviews as required.

I understand that the information gathered and utilized will be used explicitly for research purposes, and/or otherwise communicated to me in writing.

Feel free to contact me if there is anything else you may require.



John Michael Joannou
Chief Executive Officer
National Ship Chandlers (Pty) Ltd
Tel: 031-205 4221
Cell: 082 8000 317



CAPE TOWN OFFICES: TEL: (021) 518923/34
RICHARDSON BAY OFFICES: TEL: (029) 797351/2
PORT ELIZABETH OFFICES: TEL: (041) 484763/4

TELEGRAMS & CABLES: "NATCAPE"
TELEGRAMS & CABLES: "NATSHIP"
TELEGRAMS & CABLES: "NATSHIP"

TELE: 62-1986 NATOT FAX: (021) 511-6586
TELE: 6-31396 NATDB FAX: (031) 7974776
TELEX: 64-9762 DEKAS SA FAX: (041) 4847661



Authorisation for the Conducting of Research at the National Ship Chandlers (Pty) Ltd

I, Navin Radhalal - Student No. 204519884, am currently completing my MBA at the University of KwaZulu-Natal (UKZN). The final requirement for obtaining the degree is for me to complete a dissertation, for which I humbly seek permission to conduct research at National Ship Chandlers (Pty) Ltd.

The proposed research topic will be:-

“A Comparative Analysis on the Total Cost of Ownership between Thin- clients & Fat-clients in an Outsourced Desktop Environment”

The research project aim will be to: -

“Draw a conclusion on whether the Total Cost of Ownership of Thin-clients is lower than that of Fat-clients within an outsourced desktop environment for National Ship Chandler’s desktop platform.”

The investigative questions of the dissertation are: -

- **What are user’s experiences of utilising thin-clients?**
- **What are the training requirements for deploying thin-clients?**
- **What will be the ideal plan for the implementation of thin-clients?**

The motivation for choosing this research topic is that National Ship Chandlers management believe that due to increasing costs of annual software licensing and the continuous decline of PC and Laptops costs, a thin-client on the desktop is not a cost-effective option for the organisation. The Chief Executive Officer (CEO) also wants to outsource the entire desktop environment as this in line with the organisation’s rationalisation, cost-reduction and refocus on core business deliverable strategies for National Ship Chandlers.

Two motives will be investigated and studied in detail:

- National Ship Chandlers management would like to undertake a post-mortem review of their transition from fat-client (PC/laptop) environment to their new thin-client environment.
- Based on the to-date hardware, software and support costs a detailed comparative analysis has to be investigated outlining whether a thin-client environment yields a lower TCO than a fat-client in an outsourced desktop environment for National Ship Chandlers.

The research requires for a questionnaire survey to be completed by all of the 95 information system clients at National Ship Chandlers. There are 40 questions to be

answered and each respondent could complete the questionnaire within ten minutes. Each respondent will be notified that: -

- The participation in the questionnaire survey is strictly voluntary and they could withdraw at any stage and for any reason from the study.
- There will be no risk to the confidentiality of the data collected or their anonymity.
- All data collected would be disposed off, upon completion of the study.
- Their participation in the study would add valuable input to the challenges that face the National Ship Chandlers computing environment and user productivity.


My supervisor for this study is Professor Manoj Maharaj, who is the Head of Department for the Information Technology Department at the University of Kwa-Zulu Natal. His contact details are as follows:

- Mobile : 083 786 6034
- Email : maharajms@ukzn.ac.za

The results of the study will assist National Ship Chandler's CEO to make an informed business decision on whether to migrate back to a fat-client environment (Personal Computers) or maintain the status-quo thin-client environment.

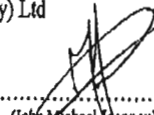
I believe that the proposed dissertation would add value to the productivity of users of the information systems applications at National Ship Chandlers and therefore the productivity of the organisation as a whole and that the permission to conduct the research is granted.

Signature of Research Applicant



.....
(Navin Radhalal)

Signature of Chief Executive Officer Authorising Access to the National Ship Chandlers (Pty) Ltd



.....
(John Michael Joannou)

Appendix 9 : Ethical Clearance Letter

RESEARCH OFFICE (GOVAN MBEKI CENTRE)
WESTVILLE CAMPUS
TELEPHONE NO.: 031 – 2603587
EMAIL : ximbap@ukzn.ac.za



26 FEBRUARY 2007

MR. N RADHALAL (204519884)
GRADUATE SCHOOL OF BUSINESS

Dear Mr. Radhalal

ETHICAL CLEARANCE APPROVAL NUMBER: HSS/0047/07M

I wish to confirm that ethical clearance has been granted for the following project:

"A comparative analysis on the total cost of ownership between thin-clients & fat clients in an outsourced desktop environment"

Yours faithfully


MS. PHUMELELE XIMBA
RESEARCH OFFICE

cc. Faculty Officer (Christel Haddon)
cc. Supervisor (Prof M Maharaj)

Founding Campuses:  Edgewood
Westville  Howard College  Medical School  Pietermaritzburg 