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The management
of an information technology infrastructure
in schools in the Western Cape Province

by

Catharina Elizabetha Perkins

submitted as full requirement for the degree of

Master of Education

in the subject

Education Management

at the

University of South Africa

Degree Code: 07439 / DIS 743 W

Supervisor: Professor RJ Botha

November 2012

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Dedication

This research is dedicated to all the teachers who act as network administrators. You are the unsung heroes who do so much for so little.

Acknowledgements:

To my Lord and Saviour Jesus Christ

To Richard and our children Nikola, Jaco and Daniel who made so many sacrifices over the past few years

To Mom and Dad who have always seen the racehorse in me.

To my sisters Welmarie and Petra

To Professor Botha for all his guidance and support

To UNISA for accepting my proposal and then honouring me with a bursary, without which I would never have completed this work

To Trevor Greenfield, Mike Chiles, Bruce Erasmus, Marius Burger, Eloise de Beer, Ighsaan Francis, Mike Schordilis, Sue Werry, Pam Miller, Marius Vos, Peter Davidson, Greg van Schalkwyk, Shahied Barnes, Max Brock, Shamiel Dramat, Gerda Mallan, and Malie Zeeman, for your inspiration and support.

To Suzanne Wallace who did fix the world

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Catharina Elizabetha Perkins

Degree: Master of Education (M.Ed)
Subject: Education Management
Supervisor: Professor RJ Botha

Summary

This research conceptualises IT infrastructure management at secondary schools in the WCED (Western Cape Education Department). This includes whether or not secondary schools in the WCED make use of a full time, on-site network administrator or whether a teacher acts as on-site network administrator. The literature review studied the effectiveness of IT infrastructure management which includes hardware, software, policies, computer network, security; staff management and BYOD (bring your own device). The management of IT infrastructure at secondary schools within the WCED differs widely from school to school, and its functionality depends on many factors. The quantitative study revealed problem areas within IT infrastructure management at secondary schools in the WCED. Furthermore the quantitative study also revealed that there is a need for best practice guidelines with regards to IT infrastructure management in order to improve service delivery. The literature review provided sources for best practice IT infrastructure management.

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Die bestuur van rekenaar tegnologie in skole van die Wes Kaapse Onderwys Departement

deur

Catharina Elizabetha Perkins

Graad: Meesters in onderwys (M.Ed)
Onderwerp: Onderwys beheer
Studie leier: Professor RJ Botha

Opsomming:

Rekenaar infrastruktuur by sekondere skole in die WKOD (Wes Kaapse Onderwys Departement) word in die navorsing beskryf. Die studie ondersoek verskillende strukture naamlike skole wat 'n voltydse netwerk administrateur het en skole waar 'n onderwyser die verantwoordelikheid aanneem van 'n netwerk administrateur. Die effektiewe beheer van rekenaar infrastrukture word bespreek. Dit sluit hardeware, sagteware, beleid formulasie, rekenaar netwerk, sekuriteit, personeel bestuur, en BYOD (bring jou eie toestel). Die bestuur van rekenaar infrastruktuur verskil van skool tot skool en die effektiewe bestuur daarvan word deur baie faktore beinvloed. Die kwantitatiewe studie het probleem areas vir die bestuur van rekenaar infrastruktuur by sekondere skole in die WKOD uitgewys. Die kwantitatiewe studie het verder die behoefte vir beste praktyk riglyne uitgewys om sodoende better dienslewering te verseker. Die literere studie het beste praktyk riglyne vir rekenaar infrastruktuur bestuur genoem.

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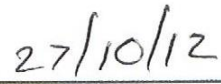in schools in the Western Cape
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Key terms

Best Practice; BYOD; Cloud, Computer; Computer lab; Facebook; FITS; Framework; Guidelines; Hardware; Head of department; ICT, Infrastructure; Information communication technology; Information technology; Infrastructure; IT; IT Infrastructure Management; ITIL; Management; Computer network; Network administrator; Online survey; Policies; Principal; Secondary school; Network security; Senior management team; Software; Teacher; WCED; Western Cape Education Department.

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I declare that: The management of an information technology infrastructure in schools in the Western Cape Province is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references

_____
SIGNATURE

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DATE   27/10/12

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CHAPTER 1: ORIENTATION OF THE STUDY

1.1   INTRODUCTION TO THE STUDY

IT (Information Technology) infrastructure encompasses a great variety of concepts relating to computers. It refers to a computer network that is made up of hardware (computers, cabling, servers, printers, etc.), software (operating systems, anti-virus software, etc.) and the implementation of such a network. Not only does it incorporate the hard IT assets but also the human process and organisational structures (SEER, 2008). The person responsible for the installation and maintenance of the hardware and software in a computer network is referred to as a network administrator.

The study will look at the current nature and state of IT infrastructure at schools in the WCED (Western Cape Education Department). This will include looking at whose responsibility it is to install and maintain the schools computer network or in other words who performs the duty of network administrator as well as looking at the nature of IT infrastructure management. One management approach is to have a dedicated full-time, on-site, network administrator who has no teaching responsibilities. The other management approach is to have a teacher take on the role of network administrator. A variant of the last approach is to use a teacher to do the daily maintenance and an outsourced company for more advanced support. The factors that influence the implementation of one of these approaches, as well as the success thereof, will be addressed in the research.

Businesses have been able to utilise best practice frameworks such as ITIL (Information Technology Library) within Service Management (ITIL, 2012). Service management frameworks such as ITIL have been migrated across to education environments by organisations such as FITS (Framework for ICT Technical Support) foundation. Effective IT infrastructure management will result in optimal network usage, monitoring usage, up-to-date anti-virus software, permanent internet connection, well defined user profiles, secure

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data, and effective updating of technologies. Furthermore the researcher will look at job satisfaction, structured user policies, clear job description, and good work relationships, which includes effective IT infrastructure management.

1.2   BACKGROUND TO THE STUDY

Since the IT field is ever changing, literature reviews were obtained by means of the internet, universities and different IT infrastructure frameworks such as ITIL and FITS. Trubitt and Muchane (2008) point out that a different environment does not lead to different responsibilities in the IT department. Universities are, however, more aware than secondary schools of the importance of the relationship between top management (principal) and the IT department.

Further research was conducted into businesses' IT services management frameworks and how they were adapted within the education sector. "Service Management is a set of specialized organizational capabilities for providing value to customers in the form of services." (ITIL, 2007: 45).

The researcher has made a casual observation that some secondary schools in the WCED have full time network administrators however at many schools the role of network administrator is fulfilled by a teacher who is also responsible for the teaching of computer related subjects.

During the forum for concerned IT teachers, held on Thursday 29 October 2009 at the University of Pretoria, (Zeeman, 2009) concerns were raised about the subject IT. Issues that were discussed include the decline in number of learners and the volume of work to be covered by IT teachers. The following two concerns raised by teachers directly pertain to this research. Firstly teachers are expected to maintain IT infrastructures at school, with the result that teaching time is eroded. Secondly, IT teachers are expected to "maintain computers, deal with viruses and software issues themselves" (Zeeman, 2009). Is this crisis meeting an indication that teachers are frustrated by the fact that they are expected by principals to maintain their schools computer networks?

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Apart from the technical challenges that computers bring about, there is also the management style of a principal that has an effect on the successful running of IT infrastructure. Soteros (2008:1) asks bluntly. "Is job satisfaction an indicator of management acumen?" Without hesitation he answers:

> Yes it is! The reports and research portray a widening gap between the needs of employees and management. The reasons for this dissatisfaction are job mismatch, job definition, pay and pay inequity, poor benefits, lack of support or feedback, lack of growth or advancement, favouritism, overwork, and loss of confidence in leadership. But the top reason employees leave an organization, according to 2007 Global Strategic Rewards Report, a study by Human Resource consulting firm Watson Wyatt, is stress (….).

According to Soteros (2008:1) there are a few simple rules that management can follow in order to be effective in the management of its IT staff. Managers of staff need to realise: "You are responsible and accountable for your staff's productivity, actions, and behaviour." Therefore "Without good systems, managers are left to try and manage a personality... "(Soteros, 2008: 1).

Schools are run like a business but with a very unique product, i.e. young adults who have to be able to successfully fit into society. Secondary schools face similar obstacles as businesses face and therefore need to take note of how successful businesses manage their IT infrastructure. Principals with their different leadership styles have the greatest influence on the direction of a school.

Through casual observation of practical situations, McMillan and Schumacher (2001) observed that the problem areas within IT infrastructure are usage of computer labs, network security, internet and network downtime, and printing control. Furthermore workload of those involved in IT infrastructure, implementation of computer usage policies, relationship between IT staff and principals, the time principals spend on IT infrastructure, appointment of staff, job description, and the role of a network administrator are also problem areas.

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Many principals in poor communities struggle with keeping their staff quota, and struggle financially. Understandably, they are forced to make use of teachers to fulfil the role of network administrator. This study will look at the effectiveness and implications of the approach of having a teacher taking on the role of network administrator.

There are many pitfalls and dangers surrounding the management of an IT infrastructure. Critical decisions concerning money allocation, service providers, accountability, staff establishment, and system maintenance need to be made. Would these decisions be made easier if management were provided with guidelines to reduce time spent on reasoning and justifying decisions? This leads to the research aims of the study.

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1.3   THE RESEARCH PROBLEMS AND RESEARCH AIMS OF STUDY

The management of IT infrastructure at secondary schools within the WCED differs widely from school to school, and its functionality depends on many factors. The main research problem for this study can be formulated as follows:

How are secondary schools in the WCED managing their IT infrastructure?
This leads to the following four sub-questions:

- What is the nature/state of IT infrastructure at secondary schools in the WCED?
- What are the problematic areas of IT infrastructure at secondary schools in the WCED?
- Is there a need for standardised guidelines (best practice) for the effective management of IT infrastructure at secondary schools in the WCED?

From the research problem the following aims are identified:

- To examine/study/investigate the nature/state of IT infrastructure at secondary school in WCED.
- To identify some of the problem areas in IT infrastructure at secondary schools in the WCED.
- To identify whether there is a need for standardised guidelines (best practice) for the effective management of IT infrastructures at secondary schools in the WCED.

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1.4   RESEARCH OBJECTIVES OF THE STUDY

The aims set out in Section 1.3 (The research problems and research aims of the study) cannot easily be measured since there is nothing specific to measure these aims against. Therefore objectives were set as targets towards achieving these aims. The research objectives drawn from the research aims are thus as follows:

With regards to examining the nature/state of IT infrastructure at secondary schools within the WCED the following objectives are formulated:

- o What is the current characteristics and behaviour with regards to IT infrastructure at secondary schools in the WCED
- o What are staff's experience with regards to IT infrastructures at secondary schools in the WCED

The second objectives of identifying some of the problem areas in IT infrastructure at secondary schools in the WCED are as follows:

- o Are there any problem areas with regards to current characteristics and behaviour with regards to IT infrastructure at secondary schools in the WCED
- o Are there any problems that staff experience with regards to IT infrastructures at secondary schools in the WCED, and if so what are these problems

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The third research aim, namely to determine whether there is a need for standard guidelines (best practice) with regards to IT infrastructure management at secondary schools in the WCED would depend on whether there are any problem areas within IT infrastructures at secondary schools in the WCED. Therefore the research objectives with regards to the need for standard guidelines (best practice) within IT infrastructure management at secondary schools in the WCED are as follows:

- o Are there any problem areas with regards to current characteristics and behaviour with IT infrastructure at secondary schools in the WCED
- o Is there a need for standardise guidelines (best practice) with regards to problems that staff experience with regards to IT infrastructures at secondary schools in the WCED

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1.5 RESEARCH METHODOLOGY

1.5.1 Research Approach
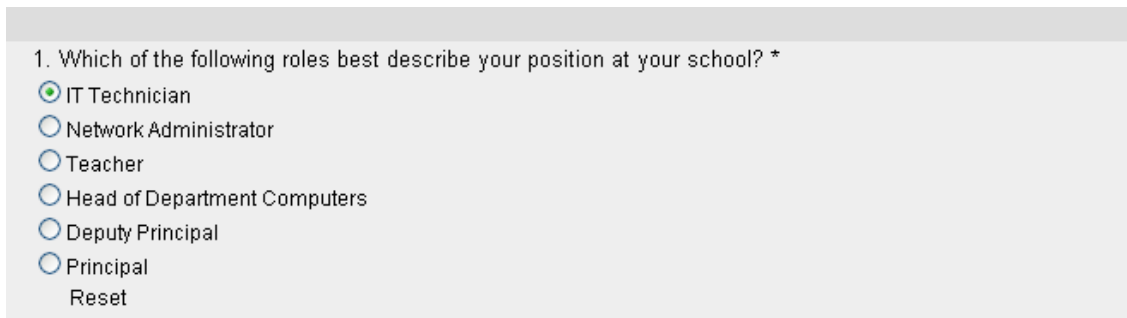
The research problem and sub problems will be addressed by means of a literature and quantitative study. Since no studies have been done on the management, of an IT infrastructure at secondary schools in South Africa, an explanation of the different elements that make up IT infrastructure at secondary schools will be given. The quantitative study will comprise of an online survey made available to principals and IT staff through WCED mailing lists, aimed at defining IT infrastructure and identifying problem areas within IT infrastructure.

1.5.2 Population and sampling

The population is schools in the Western Cape, which includes government and private schools totalling 236 schools. The sample of the population will be government secondary schools in the Western Cape Education Department (WCED). The sample consists of about 172 schools. The entire sample will be included, to maximize generalisation of results. A request, to participate in the research, will be sent out to all the government secondary schools in the WCED by means of their mailing lists and participation is open to all staff members.

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1.5.3   Instrumentation and data collection techniques

Online questionnaires will be created on the website http://www.esurveyspro.com/. The questionnaire is designed in such a way that participants will indicate the role that they fulfil at their school as shown in Figure 1.1

Figure 1.1

1.5.4   Data analysis and interpretation

An overall survey completion report is available as illustrated by Figure 1.2. The heading, of the summary, states how many responses there were to the question and the results. The summary sheet will form the information (organised data) for the deduction pertaining to the different aspects of IT structures at secondary schools in the WCED.

Figure 1.2

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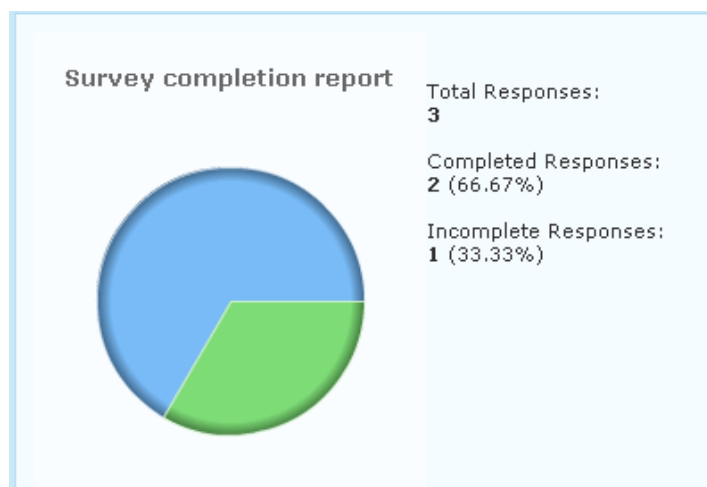
Summary reports are also generated for each question. Given below is Figure 1.3 the graphical representation of a summary sheet generated from the data obtained.

Page 1. Basic information

1. Which of the following roles best describe your position at your school?		% of Respondents	Number of Respondents
IT Technician		0.00%	0
Network Administrator	████	33.33%	1
Teacher	████	33.33%	1
Head of Department Computers	████	33.33%	1
Deputy Principal		0.00%	0
Principal		0.00%	0
Chart		*Number of respondents*	*3*
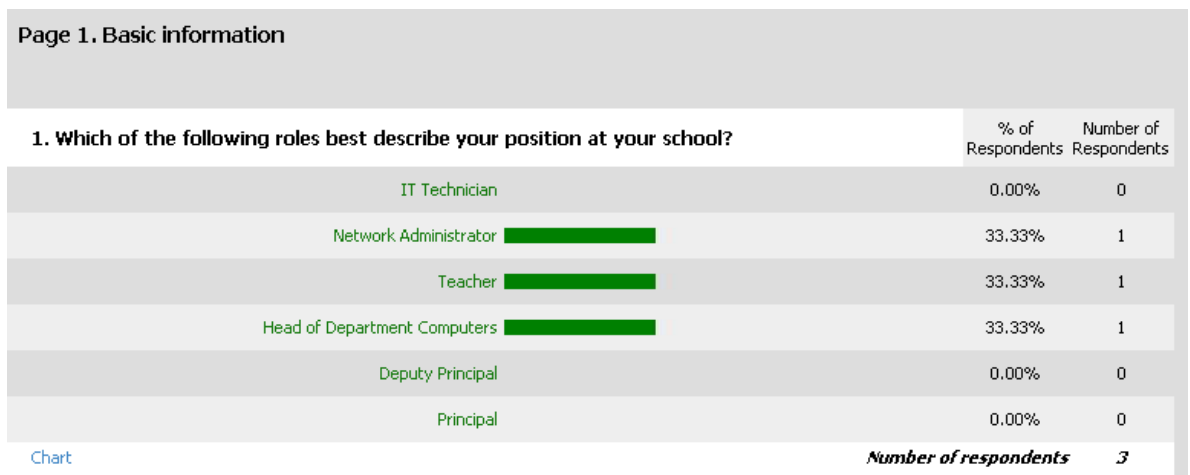
Figure 1.3

Statistical data will be investigated by means of quantitative data analysis while data that cannot, or is very difficult, to analyse statistically, will be investigated by means of qualitative data analysis, such as the comments made my respondents. Bar charts and pie charts will be used to supplement the quantitative data analysis. Qualitative data such as the opinions and attitudes of principals and IT staff, concerning the same issues, will be compared to see in which way they correspond or differ. This will reveal some of the underlying reasons for conflict or differences in opinions between principals and IT staff members.

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1.6.   RELIABILITY AND VALIDITY OF RESEARCH

1.6.1   Reliability

Reliability relates to the probability that repeating a research procedure or method would produce identical or similar results (Briggs & Coleman, 2007:92). Stability could influence the reliability of the results and by using a standard instrument such as a questionnaire, thorough instrument design, and pilot testing; reliability will be obtained (Briggs & Coleman, 2007:92).

IT infrastructure might change, while the research is being conducted. An example is a school that did not have a full time, on-site network administrator might appoint someone after the questionnaire has been completed. It would not be possible to repeat the questionnaire after, for example, six months, because the likelihood of these changes happening are slim. Fortunately the influence of one questionnaire will not be so great on the stability of this research (McMillan, 2001: 246).   Only one questionnaire will be completed by each participant and therefore equivalence will not be applicable to this research.

Agreement is important, as it refers to the extent in which technicians, network administrators, teachers, HOD computers, deputy principals and principals agree about certain statements. This will be reported as a percentage of agreement. If there isn't a high interrelated agreement it would mean that the way in which the IT infrastructure is viewed differs greatly between the IT staff and management.

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1.6.2 Validity

To assure validity, the following assumptions are made and data is collected to support these assumptions. These assumptions are firstly that the nature or structure of IT infrastructure management differs from school to school. Secondly that there are problematic areas within IT infrastructures at secondary schools in the WCED, and thirdly that because there are problem areas within IT infrastructure management there is a need for standardise guidelines (best practice).   The inference will involve constructs like attitudes, reasoning and characteristics (McMillan, 2001).   Furthermore it includes designing an instrument that is valid for the purpose of understanding the nature/structure of IT infrastructure within secondary schools in the WCED.

Content related evidence is judged by the appropriateness of the items on the instrument.   Content area's will include IT staff allocation, job satisfaction, networks, network security, policies, data management, user management, internet availability, trespassing management, communication and time management.

Concurrent validity will be used since both IT staff and management staff will have the same time frame to access and complete the online questionnaire. The correlating scores between management and IT staff are investigated. Concurrent validity would be supported if the scores for the two groups were very different.

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1.7   CHAPTER DIVISION

A skeleton layout of the research dissertation is given below. Each chapter focus on the main aims of the study namely to describe and identify problem areas within IT infrastructure management.

Chapter 1 introduces the background to the study including the concepts of IT infrastructure management.   It introduces the research problems in secondary schools in the WCED and whether there is a need for best practice guidelines.

Current literature on the management of IT infrastructures is provided in Chapter 2. Problem areas and possible solutions are discussed. Most of the literature was applicable to universities and businesses, as there is little literature available on this subject specifically orientated to secondary education. The literature review also identified a source for guidelines or best practice implementation within school environment.

Chapter 3 explains and motivates the research methodology. This includes the research approach, how the population and sampling is made up, instrumentation for data collection, and the interpretation of the data. The research data and how the raw data is going to be used are also provided in this chapter. This will include the raw data from the different online surveys and how they are prepared for analysis.

Chapter 4 will have an analysis and discussion of all the results from the quantitative online survey. Findings with regards to network stability, policies, and security, maintenance, job satisfaction will appear here. The responses, concerning the above will be compared between technicians, network administrators, teachers, HOD computers, deputy principals and principals and agreement between the different roles will be discussed. This chapter includes diagrams and charts.

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Chapter 5, the conclusion, will reveal the findings and recommendations. This includes the structure of IT infrastructure management at secondary schools in the WCED, whether there is a need for best practice guidelines with regards to IT infrastructure management and where such guidelines can be found.

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1.8.   DEFINITION OF KEY CONCEPTS AND KEYWORDS

1.8.1   Definitions

The word information technology, network administrator and the subject IT are key concepts in this research proposal. Firstly the Oxford Dictionary (2013: 1) defines information technology as "the study or use of systems (especially computers and telecommunications) for storing, retrieving, and sending information" In essence IT refers to any technology that store, process or moves data and information.

Secondly a network administrator is:

> A person who manages a local area communications network (LAN) or wide area network (WAN) for an organization. Responsibilities include network security, installing new hardware and applications, monitoring software upgrades and daily activity, enforcing licensing agreements, developing a storage management program and providing for routine backups, not to mention ensuring that it is up and running all the time. (PCMag.com Encyclopedia, 2013: 1)

In the subject Information Technology a learner will:

- use appropriate techniques and procedures to plan solutions and devise algorithms to solve problems using suitable techniques and tools'…
- understand and use Internet technologies for various tasks;
- comprehend and apply the concepts of data and information management to understand how a knowledge-driven society functions; and
- understand the social implications of ICTs and how to use ICT technologies responsibly (Department of Education, 2003: 10)

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The subject IT is usually taken by learners that want to further a career in engineering or a computer related field. Within the WCED the subject focuses around Java programming and database management.

1.9.   CONCLUSION

The aim of the research is to investigate the nature/status of IT infrastructure management of secondary schools in the WCED. The focus area within the objective of establishing the staff allocations structures is to determine whether or not there are full time, on-site network administrators at secondary schools in the WCED or do teachers act as full time or part time on-site network administrators. This will include identifying problem areas within network administration, network security, policies, internet access, job satisfaction and implementation of policies. How successful is management's approach to its IT infrastructure, and furthermore the researcher aims to establish if there is a need for good practice guidelines for management in order to streamline the effectiveness of IT infrastructure and, ultimately, improve service delivery. What sources are available for management to find best practices for IT infrastructure management? In the next chapter, current literature on IT infrastructure management will be given.

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CHAPTER 2: CONCEPTUALISING THE MANAGEMENT OF AN IT INFRASTRUCTURE

2.1 BACKGROUND TO AN IT INFRASTRUCTURE AT SECONDARY SCHOOLS

The guidelines for the practical examination of the subject IT at secondary schools in the WCED provide a basic idea of what type of hardware, software and networks are currently being used at secondary schools. In the CIRCULAR: 0034/2009 of the WCED (2009), Mr Ighsaan Francis sets out the responsibilities, procedures, and requirements that schools must meet for practical IT exams. Furthermore the Department of Basic Education (2011, 11) provides the following guidelines regarding the resources that secondary schools must have in place for teaching the subject IT:

Resources required for offering Information Technology Infrastructure, equipment and finances for the subject are the responsibility of the school.

In Information Technology learners are required to work individually on a computer during contact time and need access to the Internet.

Schools should have a business plan for the subject that addresses the following:

• Initial capital layout for setting up a computer laboratory. The layout should provide for the following:

- Entry-level computers (to ensure a lifespan of 4 - 5 years), networked

o One computer per learner per period (during contact time)

o Provision for sufficient computers to enable the practical examination to be completed in two sittings

- One high-speed printer per computer room

- Internet access

- Data projector or demonstrating software

- Software (operating system, Office suite, security software - antivirus, Internet security, software for solution

development)

• Budget

- Annual running costs

o Software licensing (operating system, application software, security software, solution development

software)

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   o Cartridges, paper and storage media

   o Breakage and maintenance (regular service plan)

   o Insurance

   o Internet connectivity

   - Sustainability plan

   o To upgrade or replace software and equipment every 4 - 5 years

   (Department of Basic Education, 2011, 11)

To the researcher's knowledge this is the first document from the department requesting an initial capital layout, budget and planning from schools with regards to IT infrastructure for secondary schools.

2.1.1 Components

The management of IT infrastructure entails five basic components (Kroenke, n.d. cited by Spencer and Johnston, 2003: 3): "hardware, software, data, procedures, and people". According to Spencer and Johnston (2003) failure in any one of these components will result in information technology becoming visible. Guidelines for the implementation of practical examinations for the subjects CAT (Computer Application Technology) and IT contains one of the few documents from the department outlining the requirements for practical examinations in the subjects CAT and IT.   (Government Gazette, 2008).

In order to meet the basic requirements for practical examinations in grade 12 most school computer labs would have processors with minimum power of 2 GHz (Giga Hertz), memory of no less than 512 MB (Mega Byte) of RAM (Random Access Memory)(WCED, 2009a). Schools must ensure that the number of working computers is never lower than the number of learners per class.

It is a necessity for schools to provide internet access to learners, but this creates a number of problems such as security, speed, and protocols. Therefore not all schools have the technical support to enable student's access to the internet. Internet access creates one of the biggest security risks and ignorance can no longer be seen as a defence mechanism. The requirements for these practical

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examinations are very strict and sound structures need to be in place for the practical examination to be legal and fair.

2.1.2   Networks

In the CIRCULAR: 0034/2009 of the WCED (2009b), schools are warned that unless the security of a server based network can be guaranteed it shouldn't be used. In these cases the lab computers need to be removed from the network and function as stand-alone machines for the duration of the exam. This is not the most effective way to deal with file transmission security.   With user permissions set up correctly and updated firewalls secure, making use of a networks is a more effective way of conducting a practical exam. Furthermore the installation and maintenance of wireless technologies add extra security considerations.

Schools have a wide variety of software products to choose from but the factors that influence their decision are costs, department requirements and support. Running a server based network is more expensive then running a peer to peer network? Most schools make use of Microsoft server software but there are a few schools that have open source server software. Application software is mostly Microsoft products even though schools can use open source software such as Open Office.

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2.2 HOW AN EFFECTIVE IT INSTITUTION CAN EFFECTIVELY BE MANAGED

2.2.1 The goal of invisibleness

Information technology has long gone reached the point of commoditization, meaning it has "reached a point in its development where one brand has no features that differentiate it from other brands, and consumers buy on price alone" (Microsoft, 2009). Information technology became strategically invisible. Carr (2003) in his controversial article "IT doesn't matter" simply states: "As information technology's power and ubiquity have grown strategic importance has diminished."

This doesn't mean that technology isn't important. It means that technology can no longer be an end in and of itself. IT organizations succeed when the people they serve succeed. "For your typical end users (or at least 98 percent of them), technology itself simply doesn't matter"(Chester, 2006: 57). Information technology is a tool for "teaching projects, administration projects, admission projects, financial aid projects, finance projects, human resource projects, or campus-wide projects to enhance communication, share information and create efficiencies" (Chester, 2006:58). Therefore, effective IT infrastructure will appear as invisible.

Spencer and Johnston (2003: iv) makes it clear that although change in technology is unavoidable there are undisputable "principles and practices that simply do not change over time." The aim of conceptualising an IT infrastructure management is not just to describe some of the best practices for effective IT infrastructure management but also look at sources for obtaining these management strategies whereby IT will obtain the goal of invisibleness.

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2.2.2   The visibility of an IT infrastructure

When we say that effective IT infrastructure will appear invisible, then ineffective IT infrastructure will be visible. What does this mean? Staff and students will be aware that technology is not functioning as it should. They are not confident to use the wide variety of IT support devices.   We pay little attention to technological devices when they are functioning correctly yet we are very aware of their importance when they are not working. From a management point of view, what will the key factors be that will lead to IT becoming visible?

Van Wyk in his blog e4Africa (2012) mentions six factors that lead to ineffective use of technology within education of which three are pertaining to this research:

> **Poor leadership**: Where the principal, management team and governing body do not give clear direction in general educational matters, it is doubtful that they will do so when it comes to the use of advanced technology. If sound leadership is lacking, this matter must be addressed before you even think of introducing technology.

> **Inadequate infrastructure:** This aspect is often overlooked. Technology cannot be introduced in a vacuum – electricity, security and reasonable space must be provided before it is brought into a room…

> **Technical support:** Nothing is as disheartening to teachers as when the technology fails when they try to use it. Planning to introduce technology in the school must include maintenance and support aspects. (Van Wyk, 2012: 1)

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2.2.3   Planning for an IT infrastructure

Bogarad (2009: 2) makes it clear that building "a truly successful IT organization is not an easy task. It requires strong leadership, intelligence, some hard work, determination... The allure of an easy methodology is understandable." Planning for technology should be an ongoing process. Typically there should be a yearly update of the overall network plan and technical standards (Long, 2000).

A network is based around current and standard building blocks.   These building blocks are usually referred to as the OSI (Microsoft Support, 2002) ranging from the physical infrastructure to network applications. Each layer depends on the layer below it. At the bottom is the physical layer consisting of the pathway that the cables run through. The network layer includes protocols and electronics that turn electrical signals into messages. This can be the routers, switches (connect all the cables together), firewalls, and NIC (Network cards). These devices assign names and addresses to devices on the network and they govern how messages are passed.   The application layer turn messages into services. This includes electronic mail, directories, web servers and browsers et al. "Guided by an overall plan, individual building blocks can be renewed to upgrade and improve each of the areas over time, providing a gradual improvement in the function and capacity across the entire network "(Long, 2000: 43).

Long (2000), further points out, that decision makers make the mistake of treating network costs as capital costs, instead of operating costs. Networks require ongoing hardware and software installation and maintenance. The only exception here could be the cabling which, usually, is capital expense, since it has a life span of about 10 years. On the other hand the devices that the cables connect to have a much shorter life span, of which switches are an example. Switch technology change quickly and they have a life span of typically three years. Simple networks must have the capacity to evolve into

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more complex networks, "that can support advanced services when those services are needed" (Long, 2000:41).

Soteros (2008: 1) states that, "Without good systems, managers are left to try and manage a personality – which is a minefield.   Good systems include corporate vision, objectives, values, and standards."

2.2.3.1 Considering open standards when acquiring software or hardware

The aim of an open standard is to promote interoperability. The emphasis should not be on open source (code is available and distributed freely) or proprietary (license to use bought) software but on open standards.

> An Open Standard is a specification to enable interoperability or portability developed through a consensus process. Open Standards can be implemented by both Non-OSS and Open Source products. Essentially OSS (Operations Support System) is code, and Open Standards isn't. The Open Standards process is neutral with regard to software development, welcoming all and favouring none in its quest for the best solution. (Welsh, 2004: 1)

Open standards are standards that are available to the public and anyone either a developer or a corporation can add them into their software program. Open standards come to fill the need for interoperability. The problem that computer industry had before open standards was how to communicate two systems of different vendors. Each vendor was producing his proprietary solution and communication was almost impossible. Examples are those of Microsoft Windows and Macintosh operating systems.

Open source standards-conformant e-learning software is not free of risks and is not necessarily the most cost-effective option where commercial vendors have implemented open standards and demonstrated easy interoperability. One of the most important potential problems with open-source software, even if implemented with open standards, is the lack of support typically expected

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from commercially developed software. There are no help lines, no on-site visits, and, in the absence of a strong open source developer community with sufficient goodwill to support users, there may be no readily available support at all. (Dalziel, 2003: 6)

2.2.3.2 Outsourcing

Outsourcing is constantly being debated and principals need to ascertain the role outsource companies are going to play in their school's infrastructure. As a rule schools should have full control over issues that directly affect its daily running, but it often makes sense to leave non critical issues to others. (Long, 2000: 42). Most outsourcing failures result from a mismatch between the school's needs and the outsource service agreements and management plan.

No matter how successful a school is; external perspectives and expertise are important for ensuring that a school is moving forward in the right direction (Bogarad, 2009: 2). Bogarad makes a comparison between one of the world's best golf players who makes use of a coach, and a successful business which invest in the time of experts in IT. However, in most schools, teachers fulfil the role of both network administrator and teacher. This is time consuming and it is inevitable that one of the two will be neglected. Outsourced companies are employed to set up the networks and are usually called out when there is a failure in the network. These services are very expensive which leads to more responsibilities being given to teachers, in order to lower costs. The unwillingness of schools to address critical issues due to high costs is never as prominent as during the final grade 12 practical CAT or IT exams. The WCED (2009b) provides schools with detailed requirements that must be met. A lack of planning causes these schools to outsource at the last minute, in order to deal with critical security flaws in the system. This approach is sometimes too late and arrangements must be made for learners to write at other venues.

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2.2.3.3 Budgeting

(a)   Hidden costs

Technology fails to follow a predictive path.   Many of the unique attributes associated with IT are viewed as benefits; they do, however have significant hidden costs (Wierschen and Ginther, 2002:52).

Wierschen and Ginther (2002:52) point out that the physical life of computer hardware often exceeds its useful life. Hardware that is newly bought over a period of years from various manufactures, with different system setups, different operating systems, and no standard application configurations, result in incompatibilities. Providing support for this conglomeration of hardware and software requires significant additional training and support for integration among the systems.   Schools have countless old computers parts lying around that are not compatible with newer bought equipment. Standardisation has improved considerably over the last few years but still remains elusive for all aspects of IT.

Each time hardware purchases are made, more advanced technologies are acquired, but at the same cost as the previous purchase. The availability of laptops could be an example of this. For the same price today you could get a more powerful laptop in a year's time. So which department gets the new hardware?   This can cause dissatisfaction between staff if the newest technologies usually go to management, and the rest of the staff have to be satisfied with hand downs (Wierschen and Ginther, 2002:53).

Keeping up with the newest hardware and software, places constant strain on budget planning, and added onto that, the hidden cost of user support. A high level of user support accompanies the implementation and use of technology.   Users need assistance with installation of software, recovery of data and programs, maintenance of security measures, and training, which should be constantly available (Wierschen and Ginther, 2002:54). Teachers are

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not adequately trained to do these tasks. An ICDL (International Computer Driving Licence) course for teachers should empower them to do many of these tasks, freeing up the time of IT staff.

(b)   Designing IT budgets

The scope of an IT infrastructure budget encompasses a wide field including new systems, new applications, major upgrades, network expansion. The cost for hardware and software must be taken into consideration for each of these fields. Furthermore ongoing management is needed for monthly support costs, such as personnel or third-party service providers, basic upgrades of memory, storage capacity, communications, supplies, and the replacement of disposable components e.g. keyboards and mice (Spencer & Johnston, 2003: 148).

Through annual budgets, the cost of supporting existing technology and new purchases can be projected. Planning must include: desktops, laptops, printers, servers, network equipment, communication, and other related hardware and software.   It is advised to budget for training because "Users who know the system and the organizations' application software will be more productive, make fewer errors, and be able to better serve" (Spencer & Johnston, 2003: 149). Budget planning must span over three years, which should be updated annually (Spencer & Johnston, 2003: 149, Wierschen & Ginther, 2002: 57). Ideally a budget should include the replacement costs of hardware such as PC's (Personal Computers) (Wierschen and Ginther, 2002:57). However such a high hardware turnover would not be possible for most schools due to financial and human resources constraints.

Another important consideration is in how much detail should the budget be? This is a question that is constantly being debated. The purpose of creating a budget is not to identify every item planned for purchase that year, but rather provide an idea of the resources that may be required, accepting that the actual budget items might change over time.

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In the case where actual estimates are not known, a percentage increase for years two and three can be projected. Maintenance or replacement of disposable items is a good example: maintenance cost and replacement of keyboards, and mice will increase over time. Some items, such as software upgrades and maintenance cost, can be estimated for each year. Other items may be specific to a budget year. For instance, the servers are fine for the next year, but one of them needs to be replaced in the following budget year. Where budget numbers are unknown because of lack of experience, take a best guess and plug in a number. Track this number closely over time and revise it to more realistic estimates as your experience grows. (Spencer & Johnston, 2003: 149)

After the initial budget is set up principals and IT staff should review years two and three of the budget to determine what has changed over the past 12 months that might affect the next 24 months, making the necessary adjustments. Add a third year to the budget. It should also be noted that being under budget can be just as dangerous as being over budget, since it means that there has been a failure to execute plans. (Spencer & Johnston, 2003: 150). Once a budget is designed follow it up, keeping in mind that it is a planning tool. Coordination must take place when purchases of PC and other IT assets are made, by keeping inventories and tracking equipment throughout the school (Wierschen & Ginther, 2002:57).

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Table 2.1 to table 2.4 was taken from Spencer & Johnston (2003:150) depicting a sample technology budget for labour and fees, hardware, networks, communication and software. The first budget segment is labour and fees since it is typically the category where most of the expenses go to. There is a provision made for the purchase of technical publications such as books, newsletters, magazines, and specialized software. Schools should also include sending their technical staff on technical conferences.

Table 2.1

Labour and Fees	2013	2014	2015
Payroll			
Meetings			
Overhead costs			
Staff			
Network administrator			
Services/fees (outsourcing)			
Consulting services			
Maintenance (third party)			
Support contracts			
Education			
Training non-technical staff			
Training technical staff			
Publications (technical)			
Conferences (technical)			
Technical publications			
Subtotal			

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Next is the budget for hardware or else worded "network", since it includes all the components needed for all the computers to move information. This is where the main infrastructure costs lie. Also included are the disposable items like keyboards and mice. These items can be stored with supplies, such as writing materials, and drawn from inventory by staff as needed. A frequent error made in technology budgets is not planning for expansion or growth. If principals intend to expand the school, they must not forget to include new workstations and servers in the technology budget.

Table 2.2

Hardware/Network	2013	2014	2015
Infrastructure			
Cable upgrade and testing			
Power protection			
Switch and router upgrades			
Disposable items			
Printers, scanners, cameras			
Keyboards, mice, other			
Interactive white boards			
Servers (new)			
Servers (upgrade)			
Clients (new)			
Clients (upgrade)			
Routers, switches			
Projectors			
Subtotal			

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The communication section of the budget should include the cost of all data communication. This includes internet service provider (ISP) fees.

Table 2.3

Communication	2013	2014	2015
Connectivity (line cost) ISP (Internet service provider)			
Subtotal			

Software is often overlooked in a budget. Table 2.4 is a sample budget for the purchase of software. If a school is planning on expanding the number of learners, the cost of operating systems and application systems license fees must also be considered.

Table 2.4

Software	2013	2014	2015
Operating /network software Virus protection Firewall protection Licenses (upgrade) Licenses (new)			
Subtotal			

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(c)   Contracts

IT at some stage involves the signing of contracts with vendors or support services. These contracts are signed between the principal, governing body and the vendor. In many ways contracts have become impersonal, and more often than not the contracting parties never meet or speak, especially in the age of the internet where electronic purchases are common. It is important to increase the focus on the relationship elements of IT contracts, resulting in better deals, with more institutionally personalized attention, better support when things do not work out. Principals can get the sales representatives, sales organization, and the entire vendor organisation on board to help the school to succeed. The vendor must see that the success of the schools will mean success for itself. A few simple strategies evolving around building of relationships can improve service delivery. (Kossuth and Ballman, 2004).

Kossuth and Ballman (2004:39) states that there must be good inter departmental communication. Much of IT activities centre on purchasing, maintenance, licensing, and infrastructure support. It is important to centralize these activities in order to minimize cost. The purchase of printer cartridges is a good example. The administration department would order their printer cartridges independently from the IT department, meaning that vendors can charge different prices even though these printers might all be the same model. By insisting on a master agreement for the entire school these inconsistencies can be avoided.

This stretches beyond asking questions like "Why can't you do X?" Enquire beforehand whether or not vendor uses subcontractors to avoid dealing with a "one person" installation service. A principal can ask for a list of customers similar to their school, who have terminated their relationship with the vendor during the past three to five years. By comparing the vendor's explanation of the circumstances to the former customers explanation can reveal a lot about a company. Principals need to establish contact with the head of the sales organisation and of the vendor's technical team before a contract is signed.

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Secondly, principals can make sure that vendors know that his or her opinion carry weight within the community. This does not mean threatening the vendor but just making them understand that you will be truthful to others about the vendor's services, if it isn't up to standard.

Even after contracts are signed it is advisable for principals to stay in contact with the vendor's competition, and to let them know about it. Below are two examples of what to ask when comparing vendors:

- I understand that Vendor X's software does thus and so. How are you planning to enhance your product to perform the same/similar functions?
- Tell me in detail how the key attributes or your product/service compare with Vendor X. (Kossuth and Ballman, 2004:39)

A vendor who understands the structure and needs of a school is in a much better position to help that school implement the right hardware and software. One way to get vendors involved is to set up meetings between all staff involved and the vendor themselves. "Vendor responsibilities, coordination of vendor efforts, suggested enhancements to products and services, upcoming projects, potential other clients for the vendor, and overall strategic planning of technology" can be discussed (Kossuth and Ballman, 2004:39). Another way of keeping the vendor involved is to be proactive. Principals should let the vendor know when their product is performing well. When there are complaints the response will be based on good will instead of the "Oh no not them again." This feeds on the notion that IT staff frequently complain about lack of recognition for good service and the abundance of recognition for bad service.

Principals can establish technical teams/committees/structures to which the vendors are invited to. By participating in these meetings vendors will develop a richer understanding of the context in which their technologies must function. This will also allow the school to evaluate its IT vision against available and

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emerging technologies. "Tapping into the collective experience and expertise of vendors members is a valuable addition to the IT department's knowledge." (Kossuth and Ballman, 2004:40). Furthermore the committee does not only have to consist of existing vendors, but prospective vendors serving the same service technology areas can be included as well. This will prevent current vendors from becoming complacent. Care should also be taken to ensure that written contracts are in place even though the personal relationship between vendor and school might be good as this will avoid confusion and extra costs later on.

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(d)   Vendor scorecards

Franklin W. Olin College of Engineering has developed the Olin-devised Standard Score Card, which can easily be adapted for secondary schools (Kossuth & Ballman, 2004:41). This approach is beneficial in discussing decisions between staff, principals and governing bodies. The IT staff member who completes the scorecard should also present it. It takes effort and time to set up vendor scorecards, but it is definitely worth while considering that it relies on a template that is easy to use and adapt.

Table 2.5

Olin College Sample Scorecard					
Category	**Example**	**Pre-Sale Wt.**	**Sale Cycle Wt.**	**Post-Sale Wt.**	**Warranty Period Wt.**
Flexibility	Buy/lease	10	10	9	8
Responsiveness	Call back, scheduled appointment	10	10	10	10
Understanding of customer environment	Business cycles, other customers	10	9	8	8
Technical support	Skill set, levels	8	8	10	10
Sales support	Senior-level support, executive sponsor	7	8	8	7
Engineering support	Levels, service level agreements	7	9	8	8
Training	Quality, quantity	2	3	6	0
Delivery	Payment terms	0	5	5	0
Future proofing	Future projects, product roadmaps	8	10	8	9
Financial status	Dunn and Bradstreet	7	7	7	8
Colleague experiential information	Implementation experience	8	4	4	0
Other vendor activities	Partnership	9	9	9	10
Resources	Number of staff hours of support	8	9	9	9
Meetings	Timing number	4	4	5	6

Table 2.5 shows Olin College sample vendor scorecard for the purchase of hardware.   Training was most important after the sale but of only medium importance to the process given the hardware in question. Payment terms were of medium importance during and after the sale. Financial status was of high - but not critical importance in this case. Colleague information was most important during the pre-sales process due to the importance of colleague's

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implementation experience feedback. Partnership is of high importance at all times. Resources are important throughout the process and the meetings are of additional value after the sale. (Kossuth and Ballman, 2004:42)

Table 2.6 shows an example of an Olin college scorecard for a major network infrastructure investment. Flexibility, responsiveness, partnership and technical support remain the most critical factors for both hardware and network infrastructure since these reflect on the relationship between vendor and institution which form the backbone of any successful network investment. After the new network was delivered colleagues became more experienced resulting in less training and sales support needed as shown by the dropping of scores between the pre-sales and the post sales period. Future proofing, financial status, resources and engineering support have become more important due to expertise levels increasing and the effectiveness of new network being investigated. The column, Warranty Period could be added to Table 2.6 due to the varying importance of warranties on different categories investigated.

Table 2.6

Olin College Sample Scorecard					
Category	Example	Pre-Sale Wt.	Sale Cycle Wt.	Post-Sale Wt.	Warranty Period Wt.
Flexibility	Buy/lease	10	10	9	8
Responsiveness	Call back, scheduled appointment	10	10	10	10
Understanding of customer environment	Business cycles, other customers	10	9	8	8
Technical support	Skill set, levels	8	8	10	10
Sales support	Senior-level support, executive sponsor	7	8	8	7
Engineering support	Levels, service level agreements	7	9	8	8
Training	Quality, quantity	2	3	6	0
Delivery	Payment terms	0	5	5	0
Future proofing	Future projects, product roadmaps	8	10	8	9
Financial status	Dunn and Bradstreet	7	7	7	8
Colleague experiential information	Implementation experience	8	4	4	0
Other vendor activities	Partnership	9	9	9	10
Resources	Number of staff hours of support	8	9	9	9
Meetings	Timing number	4	4	5	6

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(e)   Planning for network threats

Securing a network before deployment has become standard procedure in business today. Furthermore, security threats from within and without a school need to be addressed by principals on a daily basis. "According to some estimates, internal security breaches still represent as much as 51 percent of all unauthorized system accesses and the majority of thefts that occur" (Spencer & Johnston, 2003: 154).   The IT staff members prevent security problems by securely configuring computers and networks before they are deployed, since vendors usually set computers to default settings with minimal secure configurations. Consistency is very important in the development of standards. Standards will make it easier for staff to maintain secure configurations and help to identify security problems more quickly.

2.2.4   Policies and Procedures

Wada and King realise that with "continuing developments in information technology (IT), the desire for academic freedom and for the open exchange of ideas and information is increasingly testing not only the operational reliability of the institutional electronic infrastructure but also the legal and ethical base of the institutional policy infrastructure" (2001:14). What is the role of schools in regulating "cyberslacking" (surfing so much that employees don't get their jobs done)? How can schools encourage students' academic imperatives to experiment with new technological ideas such as Facebook, when those ideas may negatively affect the schools infrastructure? Schools "can expect to face such challenges with greater and greater frequency" (Wada and King, 2001:14). Solving the problem when the challenge arises in the form of an "incident" is not ideal; therefore strong IT policies need to be in place at schools.

Developing an IT policy is a significant undertaking and needs resources dedicated to the entire process, from the definition of requirements through the

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application of policy to real-life cases. "Institutions that do not make this policy a part of the day-to-day IT infrastructure will find it difficult to meet the challenges they will face potentially under high pressure and media scrutiny." (Wada & King, 2001:14)

Even though policies are not very interesting to read they are a necessity. Shorter versions of policies such as acceptable use policies would be read more, and would make all users aware of them. Policies can be made clearer by providing examples of what users can and cannot do (Oxley, 2005). Many schools such as Wynberg Girls High School (2013) make their acceptable computer usage policies available on their schools website.

An acceptable use policy defines the use of hardware, software and communication equipment. Everyone is expected to follow the policies without exception. Schools have two distinct groups of users, namely employees and students; therefore IT policies should include three sections: one for employees, one for students, and one that applies to both groups (Oxley, 2005).

2.2.4.1 Licensed Software

Unauthorised programs and files may be transported into the schools computer system from home computers, via the internet, or loaded directly by users without the approval. School principals must ensure that policies make provision for the installing of unauthorised and pirated software. These files could easily contain viruses that will jeopardise the safety of the computer and stored data, as well as violate possible licensing or copyrights. (Spencer and Johnston, 2003: 59)

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2.2.4.2 Electronic mail

E-mail and instant messaging are referred to as electronic communication. The three areas that an acceptable use policy should address are: discriminatory activity, harassment and displaying and distribution of offensive material.

If obscenity and pornography are not tolerated in the workplace, it is unthinkable that these activities would be ignored at secondary schools. Aside from any personal reasons it is against the law. With emerging cyber forensics and e-evidence, the plaintiff's ability to subpoena e-mail messages, and the history of sites visited, the ability to prove a case is significantly easier. However if a school does not have appropriate policies in place and a method to monitor staff and learners, it has little chance of defending itself.

2.2.4.3 Copyrighted material

Principals are not aware of the fact, that if learners or staff who use the schools computer network to illegally download music, videos or games, the school is liable and responsible (Spencer & Johnston, 2003: 56). All users must be made aware that such activities will not be tolerated. This can be reinforced by means of a statement in the acceptable use policy.

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2.2.5 Security

Security of a system is a main concern, and many feel content that when a computer isn't slow that everything is in order.   Being able to use malicious software that is undetected has a huge advantage. Many principals are not aware of the importance of this simple function of security:

> For over 50% of networks last year, the perimeter was the only line of defence against hacking and viruses… Internal   network   security   is potentially the biggest security issue of 2006. All the industry data is pointing to the same conclusion: watch the inside of your network as closely as you do the outside, Or else. (Campbell, 2006: 1)

He goes on to discuss six ways in which internal security can be breached. What is interesting is that he emphasises the importance of educating users. A school network is used by everyone and therefore everyone has joint responsibility, but this is seldom viewed this way.

Network administrators need hours and hours a day just addressing these security issues, and this is only a small part of a network administrator's duties. Tasks also include forgotten passwords, access control, email risks and so on. A large amount of stress is created by trying to stay one step ahead, and many times this is created by negligence on the part of the users. Decision makers need to realise that demands placed on IT staff is constantly on the increase. The demands for using new technologies are increasing, resulting in the technical support staff needing to learn and maintain these new technologies. Oxley (2008:7)

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2.2.5.1 Hacking attempts

Hackers will not use their own computers to participate in illegal activities. A school network is the ideal point from where they can hack into unauthorised sites. Once again the principal will be held accountable for these actions even if he/she was not aware of these activities. Learners should be monitored very closely to ensure that the schools network isn't used for hacking.

2.2.5.2 Stealing information

Information can be stolen with a variety of ways such as handheld devices, flash drives, and the internet. Teachers make use of networks to store their exam question papers. Policies are designed to offer protection from inadvertent events, as well as fraud and theft. Many network administrators and managers might feel comfortable with their system security but even though it might be password protected, sensitive data may be accessible. "Today children have enough understanding of computers to open and view files. Many of your users have all the skills necessary to search for, open and view data that is not properly secure". (Spencer & Johnston, 2003: 58)

There have been many incidents where individuals read, reproduced, or transmitted information they should not have had access to in the first place. Rather than trying to define what people should and should not read, it may be best to simply state that if people do not believe they have access to information, they should not attempt to access that information (Spencer & Johnston, 2003: 60).

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2.2.6   Staff management

Chester (2006: 58) makes it clear that measuring a business's outcomes is as important as measuring job performance. Quantifiable data are necessary to motivate and direct employees, support IT investment decisions, and show that it delivers strategic value.   It is important to make these figures public, even if they show weaknesses, in order to improve accountability of staff members, show staff shortages and motivate members.

The measurement of employee performance may be resisted initially, but it helps employees set priorities. Principals need to take note that a scoreboard approach, coupled with unreasonable expectations will lead to unreasonable pressure, demoralization, and a reduction in productivity. (Chester, 2006: 59)

According to Soteros (2008: 1) managers need to realise: "You are responsible and accountable for your staff's productivity, actions, and behaviour." Secondly he states that "Without good systems, managers are left to try and manage a personality – which is a minefield. Good systems include corporate vision, objectives, values, and standards" (Soteros, 2008: 1)

Soteros (2008: 1) emphasizes on the skill to "Embrace the differences and put them to use. " Principals need to set "quantifiable objectives and make staff accountable to them." Furthermore they need to seek "better ways to do it. Innovative companies listen to their customers and their staff and then change to meet their needs." To what extent has a manager gone to hire the best? "Get the right person the first time. Seek out hiring best practices and interview with technical and behavioural questioning." Taking the effort to call at least two professional references is non-negotiable.   Asking the right questions is a daunting task for decision makers, but there are specialised companies such as Kaplan Selftest (2013) which provides assistance to decision makers to assess the right area of expertise.

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Some employees have too many shortcomings to list, but are considered "too expensive to fire", and hence, continue to influence the course of IT infrastructure. The cost of such a miscreant to a school far outweighs the separation costs (Bogarad, 2009: 3). Not everyone who says that they know a lot about computers is great or even good enough. The main asset of every organization is its best people, not every warm body on the payroll. But too often, principals aren't even sure what their IT staff do and whether they are good at it. Principals need to deal with employees that are a burden and find ways to attract the best possible candidates for maintaining its IT infrastructure.

Bogarad (2009: 3) offers some basic advice when it comes hiring the best person for the job:

- Do not outsource to low-paid people who know nothing about your organization, your department, and your needs, and who know very little about IT.
- If you want talent, look for talent and passion, not for conformity
- Highly talented people who you'd want to hire are usually not unemployed.
- Compromise: Most skills can be easily taught, but curiosity and drive are not as easy to instil. (Bogarad, 2009: 3)

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2.2.6.1 Job description of IT staff

At school level there are two distinctive services within an IT infrastructure namely that of network administrator and the service of technician. "Several types of positions exist in networking, each with different average salaries and long-term potential, and one should possess a clear understanding of these. Unfortunately, job titles in networking and in IT generally, often lead to confusion among beginners and experienced folks alike. Bland, vague or overly bombastic titles often fail to describe the actual work assignments of a person in this field." (Bradley, 2010)

What types of services could be expected to be performed within a secondary school environment?   An example of a comprehensive description for a network administrator can be found at Kingsport City (2010) school.

2.2.6.2 Job satisfaction

Soteros (2008:2) asks bluntly. "Is job satisfaction an indicator of management acumen?" To this he replies: "Yes it is!" resulting in the "widening gap between the needs of employees and management."

> The reasons for this dissatisfaction are job mismatch, job definition, pay and pay inequity, poor benefits, lack of support or feedback, lack of growth or advancement, favouritism, overwork, and loss of confidence in leadership. But the top reason employees leave an organization, according to 2007 Global Strategic Rewards Report, a study by human resource consulting firm Watson Wyatt, is stress. (Soteros,2008:2)

Oxley takes a closer look at overworking of IT support staff. If technical support, which is supposed to be client orientated, is not taking place it will lead to complaints. Furthermore he states that maintenance can only be done when the labs are off limits and many a time that is after hours.   Oxley (2008:3)

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emphasises the need for clarity concerning working overtime, either through financial means or time given off. Planning in this regard is crucial, quieter times can be used to execute disruptive tasks.

Oxley feels that the salaries being offered should attract the best candidates for the job. Government schools have government employed support staff posts available for secretaries and cleaners, yet there are no government posts available for IT support staff. If one would take away a functional network, one would take away an effective school.

Furthermore Oxley looks at the size of an IT department and how it can be determined by looking at other similar sized organizations. This would be an indication for principals on whether their IT department is understaffed. Understaffing at schools is due to the fact that there is a teacher who provides IT support to the whole school whilst carrying a full teaching load. A good starting point would be to look at schools with successful IT infrastructure management systems.   Oxley wants managers to convey to everyone what is reasonable to expect from IT support. Managers need to pay attention when IT staff complains about being overworked, and try to solve the underlying problems. "A good working environment with reasonable time demands and clear policies not only meet legal obligations and manage expectations, it reduces IT staff stress and turnover." (Oxley, 2008:3) Both the management team and staff will benefit when well trained staff serve the school community reliably and effectively.

Trubitt and Muchane (2008) focus on the skills of technical staff in order to ensure that the right message is sent out. IT support is becoming client orientated these skills are a necessity. They emphasize the fact that IT staff needs to make use of different media available to them to ensure that important IT messages are received. Rightfully Trubitt and Muchane (2008) points out that IT communications did not feature a few years ago and now there seems to be a scramble to discuss and share best practices as seen by the many forums being formed. Trubitt and Muchane mentions ITCOMM a

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Constituent Group of EDUCAUSE as an example of the many online forums that discuss best practices for IT support.

2.2.7. BYOD (Bring your own device)

Recently momentum has built to allow students to connect their own computing devices to school networks. This trend is also seen within the business world (Azzari, 2012) and schools will need to form a policy regarding BYOD. The driving force behind BYOB is the unstoppable commercialisation of IT and the blurred lines between business and personal life. A few schools allow and encourage this however it seems that BYOB policies place more strain on network infrastructure and we are going to see "more pushback from technology people because of the complexity, change, work, planning and resources required." (Livingston : 2012).

Azzari (2012: 5) points to the advantages that allowing BYOD could have, ranging from "Superior, familiar and more productive user experience", simplicity of implementation and cost savings. Azzari (2012) furthermore warns against letting users connect their personal devices in an ad-hoc manner since this can leave data vulnerable to security breaches, either internally or externally. According to Azzari (2012) there are three different approaches organisations could follow. The first is the liberal approach where any device would be allowed. The second is a hybrid approach where an option is given between a limited number of devices and thirdly a zero tolerance approach where users have to use what they are given. These approaches all have have advantages and disadvantages.

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Livingston (2012: 1) raise the following questions that school management teams need to consider regarding BYOD policies and implementation:

- Are you already using Google or Zoho or some cloud solution? Without cloud apps BYOD is going to be nearly impossible to implement in a meaningful way…
- How will you define BYOD?
  - Will there be a minimum device or specification?
  - Will smartphones be one of the devices?
- How's your network - is it ready for
  - Wifi everywhere with multiple roaming wireless devices
  - Centralized data security
- How will you address logistics?
  - Will students be charged with keeping their devices charged, ready and safe/secure?
  - Will you have "loaner" devices?
  - Will devices be locked up somewhere/somehow during lunch, tests, sports?...
- How's your budget?
  (Livingston, 2012: 1)

Livingston (2012: 1) refers to the "cloud" and therefore one need to look at what cloud computing is. TechTarget (2012) states that cloud computing "is a general term for anything that involves delivering hosted services over the Internet." The cloud can be private or public and the service is managed by the service provider. A simple example would be google docs or a web based email provider such as gmail.

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2.3   ORIGIN OF BEST PRACTICE FOR IT INFRASTRUCTURE MANAGEMENT WITHIN EDUCATION

IT infrastructure management's use of best practices was first introduced by businesses.   Different IT service management frameworks were developed mainly because business's profits are affected by ineffective IT infrastructure management. Examples of such frameworks are COBIT (Control Objectives for Information and Related Technology), Val IT (Value IT framework), SPICE (Software Process Improvement and Capability Determination), PRINCE2 (PRojects IN Controlled Environments) and ITIL (IT Infrastructure Library). Of these ITIL soon became the leading IT service management framework. It was from the ITIL framework that Becta (British Educational Communications and Technology Agency) developed the FITS framework which is aimed at primary and secondary education. According to Cartlidge, et al. (2007:3) "ITIL has grown to become the most widely accepted approach to IT Service Management in the world" and it is worthwhile having closer look at this successful framework which educational IT infrastructure frameworks further adapted to suit educational needs.

2.3.1   Information Technology Infrastructure Library (ITIL)

Cartlige, et al. (2007:3) goes on to explain that ITIl is a public framework for the governance of IT, which focuses on the evaluation and improvement of IT service delivery. This framework takes into consideration the perspective of both the business and the customers.

Cartlige (2007: 9) states that some of the advantages of ITIL are:
* increased user and customer satisfaction with IT services
* improved service availability, directly leading to increased business profits and revenue
* financial savings from reduced rework, lost time, improved resource
* management and usage
* improved time to market for new products and services

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∗ improved decision making and optimized risk.

Originally ITIL consisted of 31 associated books covering all aspects of IT service provision. In 2007, ITIL V3 consolidated ITIL into five core books covering the service lifecycle, together with the Official Introduction. The five core books cover each stage of the service lifecycle (Figure 2.1), from the initial definition and analysis of business requirements in Service Strategy and Service Design, through migration into the live environment within Service Transition, to live operation and improvement in Service Operation and Continual Service Improvement.
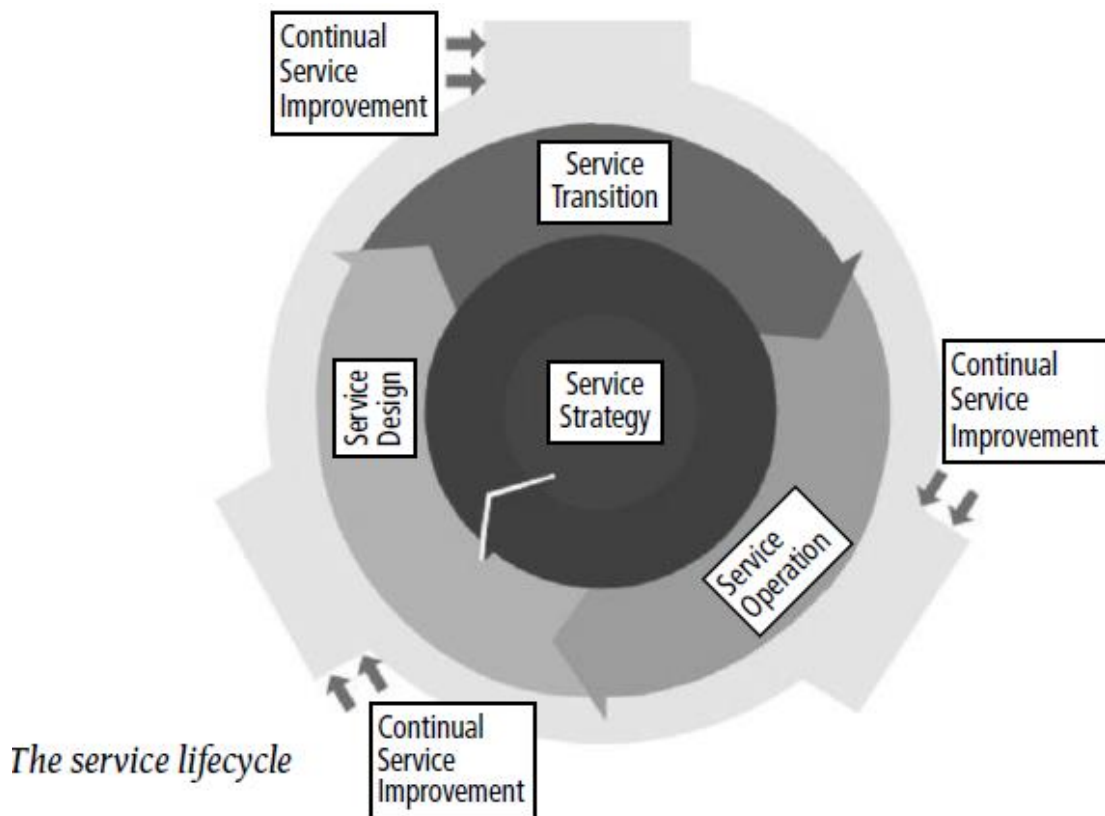
Figure 2.1

Even within the business world there is not much research being done on service management. Egeler (2008: 3) states that "there is a huge gap in research that should be closed in the future, mainly but not only because IT

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service management can become a valuable asset to most organisations if they take the right approach."

Egeler (2008: 4) looked at the claims made by Cartlidge et al. (2007: 9) and pointed out that there is not much scientific proof of any of the benefits of implementing ITIL. Egeler (2008: 4) aimed his research at testing some of these claims against the results of a simulation approach. The results of the simulation showed that each construct (service reliability, service efficiency, service consistency and client orientation) is contributing to the results of the simulation even though their contribution is different. Service reliability, service efficiency, and client orientation were identified as major contributors to improved business value and the contribution of service consistency was found to be minor in relation to the three other constructs.

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2.3.2   FITS the Framework for ICT (Information and communication technology) Technical Support within education

FITS (Framework for ICT Technical Support) was established in September 2009, with the help and support of Becta . Unfortunately Becta was closed due to the withdrawal of government funding. According to the National Archives (2011: 1) Becta was the UK (United Kingdom) "government agency leading the national drive to ensure the effective and innovative use of technology throughout learning."

According to Trevor Greenfield CEO (Chief Executive Officer) of the FITS Foundation (2011:1), FITS is a "not-for-profit organisation limited by guarantee to manage the on-going development and support of FITS so that it became self-funding. " Trevor goes on to explain the main aims of The FITS Foundation which are:

- to provide a resource for senior leaders and practitioners in the education sector
- to spearhead the professionalisation of the ICT workforce in the Education sector
- to improve the quality of ICT technical support services through the use of a structured service delivery framework
- to have a positive impact on teaching and learning experiences and outcomes" (Greenfield: 1)

One of the first things FITS did was to create international accreditation for all those involved in ICT technical support in education. There are two levels of accreditation which have been registered with the Qualifications and Credit Framework (QCF). They are SQA Level 3 Certificate in ICT Support in Education for Practitioners (QCF) and SQA Level 4 Certificate in ICT Support in Education for Managers (QCF). Two matching training courses were created which run over two or three days, depending on the course, and delivered by one of a number of training partners located around the UK and internationally.

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Becta ICT Advice (2004) has established a number of key areas that best practice can be implemented. They are repeatable processes, project management, consistency, customer care and communication. FITS's (2003) processes are derived from the ITIL framework which FITS has adapted to form manageable and relevant sets of procedures for schools to implement. What makes FITS so attractive is the fact that schools can follow different process implementation paths. Factors that would influence the path chosen are whether a school IT infrastructure is already in place and are providing technical support as appose to a school that does not have any IT infrastructure or technical support. Furthermore FITS's processes allow schools to "bypass all the mistakes commonly made and implement the process successfully from the start." The ten processes that currently form the backbone of FITS are given below. (FITS: 2006)

- Service Desk: The single point of contact within the school for all users of ICT

- Incident Management: Quickly fix faults by restoring the ICT service to the user

- Change management: Manage, record and approve the introduction of ICT changes

- Release Management: Plan, test and control the installation of new software and hardware

- Configuration Management: Implement and maintain up-to-date records of ICT hardware and software

- Problem Management: Detect the underlying cause of faults and apply a permanent fix

- Availability and Capacity Management: Carry out proactive detection and prevention of ICT problems

- Service Level Management: Define, agree and document the required service levels with the users

- Service Continuity Management: Minimise the impact on ICT service of an environmental disaster

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- <u>Financial Management</u>: Ensure that the ICT is implemented and managed in a cost-effective way

FITS (2006) provides a five step implementation guideline. Visible leadership and team support is very important. FITS is most effective in schools where there is a close working relationship between technicians, network administrators and senior management. Thorough planning is also essential, since a technician needs to have a good understanding of overall scope of FITS before implementation can start. Enough time must be since it can take anything between six months to a year to implement all to FITS processes successfully. The challenge of introducing a new system to users can be overcome by having a formal launch of FITS. Forming a FITS support group with other schools will enable the sharing of skills and mutual experiences. Becta ICT Advice (2004) emphasise measuring of service delivery to users and the effectiveness of processes used by technical staff in the deployment of FITS. Current performance and potential issues can thereby be identified. It is important to keep in mind that ICT users will judge performance on perception, and not always hard facts. Customer care is vital since the way technical staff interacts with teaching staff can affect their perception of service delivery.

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CHAPTER 3: RESEARCH METHODOLOGY

3.1 INTRODUCTION

In the previous chapter the researcher looked at the background of IT infrastructure management at schools. This encompassed the different components that make up IT infrastructure management namely budgeting, outsourcing, policies, licensed software, security, staff management, and BYOD. Regarding effective IT management the goal of invisibleness was defined.

The research methodology with regards to the empirical section of this research will be discussed in this chapter. One of the advantages of empirical research such as a survey is that it annuls the effect of personal or subjective experiences. This chapter contains a detailed account of the research method and design used. The researcher will address the quantitative sampling technique used, how population selection was done, research instrumentation, and the data collection procedures. Finally the data analysis and processing methods followed by the presentation of data will be discussed. Validity and reliability requirements will be addressed and how these requirements for validity and reliability were considered and met.

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3.2   RESEARCH DESIGN

The following research design (Figure 3.1) or plan was followed for the research (Schneider, 2012).
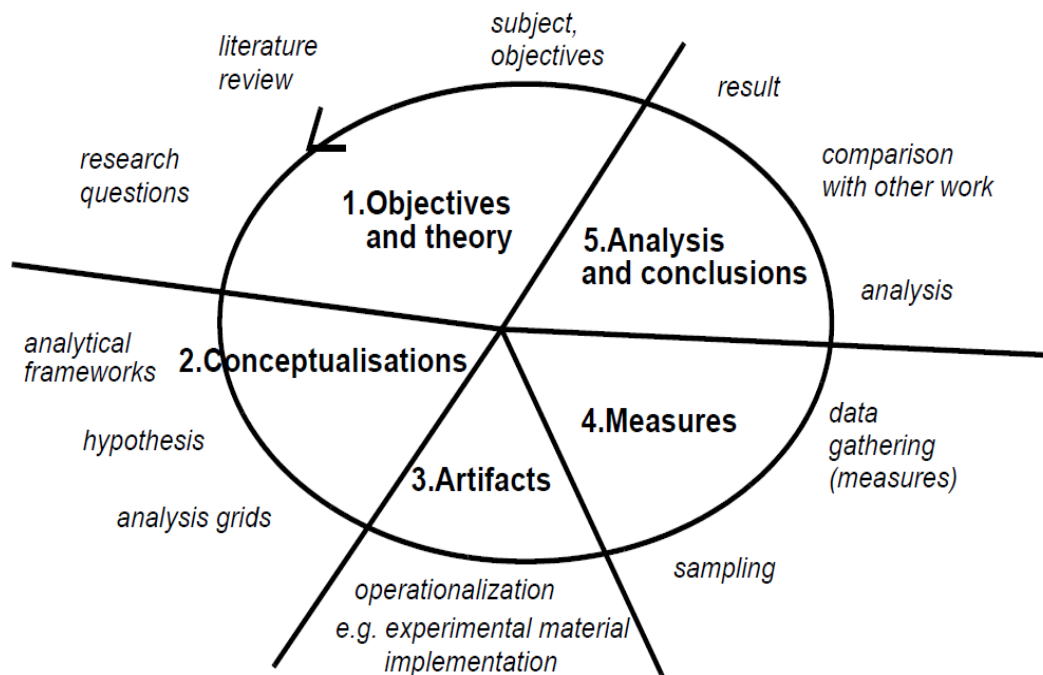
Figure 3.1

• **Objectives and Conceptualisations:** During these phases questions were formed, major concepts were identified and problem statements were defined. Literature review was undertaken as well as conceptualising objectives for research. Analytical frameworks were also being formed.

• **Artefacts:** developed research materials namely survey, and identifying potential online survey software.

• **Measures**: use online survey software to collect data

• **Analyses & conclusion:** Analyse the statistics and link to problem statements (Schneider, 2012)

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3.2.1   Quantitative research design

The research design describes the procedure for conducting the study, including when, from whom and under what conditions the data was obtained and also how the research was set up and the methods of data collection that was used. The researcher made use of an online survey as the only method of data collection.

The researcher made use of three non-experimental research designs namely descriptive research, relationships, and comparative research.   Descriptive research was used to address the aim of studying the nature/state of IT infrastructure at secondary schools in the WCED. Relationships where drawn between the position that a staff member held and their opinion regarding IT infrastructure.   The researcher paid close attention to the position that participants held at their school, for example a principal or a teacher, since this allowed the researcher to use comparative research to draw comparisons between the opinions of different staff members regarding IT infrastructure management.

3.2.2   Rationale for choosing a quantitative research method

Quantitative research allowed for data to be represented statistically. This method maximized generalization of research and also allowed the researcher to establish relationships, based on the positions that respondents held at schools.

Relationships or associations were able to be drawn since one variable varied systematically with another variable.   This was done through comparing different responses based on the position that participants had at their school. Relationships are important in our understanding of IT infrastructure management as it allows us to make preliminary identification of possible causes of important IT infrastructure management issues.   The purpose of using

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comparative research was to investigate the relationship of one variable to another by simply examining whether the value of the dependent variable in one position group from the value of the dependent variable in the other position group. Example hereof was the comparison between the answers given by principals compared to those of network administrators with regards to whether or not they found the daily IT infrastructure management easy.

It is therefore the aim of the researcher to describe characteristics, encouraging best practice IT infrastructure management implementation through school policy making. Furthermore the research is aimed at assisting managers with decision making with regards to IT infrastructure management.

3.2.5   Incentive for questionnaire completion

As it is often a problem for researches to retrieve completed questionnaires, the researcher provided an incentive to possible respondents. The researcher contacted Greenfield of FITS as their aims are "to provide a resource for senior leaders and practitioners in the education sector, to spearhead the professionalisation of the ICT workforce in the Education sector, to improve the quality of ICT technical support services through the use of a structured service delivery framework, to have a positive impact on teaching and learning experiences and outcomes focussing on ICT best practices for schools" (FITS, 2012). Greenfields response is given in Appendix H. Greenfield offered participating schools a 10% membership discount and this membership discount was used as an incentive for participation in the survey.

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3.2.6 Research problem and research aims

As stated in the introduction the management of IT infrastructure at secondary schools within the WCED differs widely, and its functionality depends on many factors. The main research problem for this study was formulated as follows:

How are secondary schools in the WCED managing their IT infrastructure?

This lead to the following four sub-questions:

- What is the current nature/state of IT infrastructure at secondary schools in the WCED?
- What are the problematic areas of IT infrastructure at secondary schools in the WCED?
- Is there a need for standardised guidelines (best practice) for the effective management of IT infrastructure at secondary schools in the WCED?

From the research problem the following aims were identified:

- To examine/study/investigate the nature/state of IT infrastructure at secondary school in WCED.
- To identify some of the problem areas in IT infrastructure at secondary schools in the WCED.
- To identify whether there is a need for standardised guidelines (best practice) for the effective management of IT infrastructures at secondary schools in the WCED.

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3.2.7 Research objectives

Since aims cannot easily be measured objectives were set as targets towards achieving these aims. The research objectives drawn from the research aims were thus as follows:

With regards to examining the nature/state of IT infrastructure at secondary schools within the WCED the following objectives were formulated:

- o What is the current characteristics and behaviour with regards to IT infrastructure at secondary schools in the WCED
- o What are staff's experience with regards to IT infrastructures at secondary schools in the WCED

The objectives of identifying some of the problem areas in IT infrastructure at secondary schools in the WCED were as follows:

- o Are there any problem areas with regards to current characteristics and behaviour with IT infrastructure at secondary schools in the WCED
- o Are there any problems that staff experience with regards to IT infrastructures at secondary schools in the WCED, and if so what are these problems

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The third research aim, namely to determine whether there is a need for standard guidelines (best practice) with regards to IT infrastructure management at secondary schools in the WCED would depend on whether there are any problem areas within IT infrastructures at secondary schools in the WCED. Therefore the research objectives with regards to the need for standard guidelines (best practice) within IT infrastructure management at secondary schools in the WCED were as follows:

- o Is there a need for standardise guidelines(best practice) with regards to current characteristics and behaviour with IT infrastructure at secondary schools in the WCED
- o Is there a need for standardise guidelines (best practice) with regards to problems that staff experience with IT infrastructures at secondary schools in the WCED

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3.3 POPULATION AND SAMPLING

3.3.1 Sampling procedure

The following sampling procedure was followed. The population was secondary schools within the Western Cape Province which included private and government schools totalling 236 schools. The sample of the population was government secondary schools in the WCED. The sample consisted of about 172 schools. A request, to participate in the research, was sent out to all the government secondary schools in the WCED by means of their mailing lists as well as the Computer Studies subject mailing list for the WCED.

Respondents were the staff of these schools that completed the online questionnaire. Notably the questionnaire's first question identified each respondent as one of the following: IT technician, network administrator, teacher, HOD computers (Head of Department Computers), deputy principal, or principal. Distinction needed to be made between decision makers and other staff, since decision makers are the key players with regards to IT infrastructure management at schools.

Originally two online questionnaires were planned based on the respondent's position at their school. One questionnaire was planned for principals and deputy principals while the other questionnaire was for teaching and network administrators. Due to the complexity of reaching these different respondents the final design method was a single questionnaire allowing distinction between decision makers and other staff members. The questionnaire was web based and the website eSurveyPro was used to collect the data. A free account was sufficient and allowed for unlimited surveys, unlimited questions, and unlimited responses.

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3.3.2 Types of sample selected and justification for choice of sample

As stated above the sample was government secondary schools of the WCED. The reason for excluding private schools within the Western Cape Province was due to the different management structures with regards to IT infrastructures. It was not within the aims of this study to draw up comparisons between IT infrastructure management of private and government schools. The focus of this study was government secondary schools in the WCED. The entire sample was included, to maximize generalisation of results.

3.3.3   Informed consent

Authorisation from the WCED was obtained at the beginning of the research in 2009. The researcher needed authorisation from the mailing list administrator of the Western Cape Department of Education's schools mailing list. As the researcher was already a member of the Western Cape's Education Departments Computing mailing list no authorisation was needed to post emails.

Obtaining consent for the survey to be sent out onto the WCED schools mailing proved to be most difficult. It took more than a month from the original survey request to when it was finally sent out on this mailing list.

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3.3.4   Anonymity and confidentiality

Great emphasis was placed on ensuring anonymity and confidentiality of participants. The only information available to the researcher regarding participants was the time they started and completed the survey as well as their IP address. The researcher did not record any of the IP addresses nor take any IP addresses into account when analysing the data.

It was important to the researcher that respondents were aware that their participation would be confidential and it was also noted in the introductory letter of the email linking respondents to the survey. Appendix B contains the sample introduction for the final surveys used.

3.3.5   Ethical measures and considerations

Using an online questionnaire allowed the researcher freedom to receive an unlimited number of responses, without having any financial expenditure which one would expect from a paper based questionnaire such as paper, printing and postage. Great care was taken with the questions not to cause any type of "psychological difficulties, such as anxiety, shame, loss or affronts to human dignity" (McMillan and Schumacher, 2001:196) and thereby having no legal infringement on human rights. The researcher was honest and truthful with the participants, disclosing to them what the purpose of the research was.

The motivation for the research was constantly revisited and remained improving self-understanding, satisfaction of helping, and sharing knowledge. The communication with Greenfield, CEO of FITS, was always open in order to ensure that a good relationship was maintained.

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3.4   **INSTRUMENTATION**

There were two types of instrumentation used during the research. Extensive literature reviews were undertaken and then the researcher used an online survey as a means of incorporating quantitative research.

3.4.1   **Online Questionnaire**

The aim of online questionnaire was to describe incidence, frequency and distribution of characteristics of the population namely schools in the Western Cape Education Department. Research regarding the use of online questionnaires was thorough in order to minimise any errors. The online questionnaire proved to be versatile, efficient and allowed for generalization of research results.

3.4.1.1   **Advantages of using a web based questionnaire**

The many advantages of having a web based questionnaire outweighed any other method. One of the greatest advantages of using a web based questionnaire was use of the census sampling technique, meaning that the entire population was included in the sample. A large number of possible respondents were reached. The department has a list of all the admin emails of schools and by sending out one email to all the schools the entire sample population was reached. Apart from obtaining permission from the relevant Education Department, no prior arrangements were required. Respondents had time to consider their responses, as well as the reassurance that their participation was anonymous and confidential. Another advantage of this method was that subtle biased influences as one would find in an interview, was not possible. There was also no time delay after a respondent completed the survey, meaning that these results were available immediately.

Provision was made to provide incentives to complete questionnaires. Fortunately the FITS foundations CEO Greenfield allowed participants of the survey a 10% membership discount. The details thereof are given under the

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heading 3.2.5 Incentive for questionnaire completion". The questions dealt with respondent's daily experiences and interest, which made completion of the survey relevant to respondent's daily dealings.

3.4.1.2 Disadvantages of web based questionnaire

There were disadvantages that needed to be considered. Although the researcher stated clearly that the survey was for employees of secondary schools in the WCED, the researcher had no control over who completed the questionnaire. Having the survey available on restricted mailing lists allowed for sample population to be reached.

It was not possible to give assistance to participants, and the researcher had to rely on the online software to be user friendly enough for all participants. Incomplete questionnaires posed problems, although the number of incomplete questionnaires was considerably lower than originally anticipated. The impact of incomplete questionnaires was reduced by putting the most important questions first, and by providing participants with incentives to complete the survey.

Respondents needed to have basic internet knowledge in order to complete the online questionnaire. If the respondents' internet connection was slow or there were constant connection problems, respondents could have become discouraged to complete the questionnaire. This could mean that better responses from schools with well-maintained networks were received. One of the ways that the impact of slow internet connection could be minimised by participants was to use the save and return to survey later option that eSurveypro made provision for.

There are approximately three hundred and fifteen high schools in the WCED. A 10% sample of the population is just over 30. Thirty or more respondents to each of the questionnaires formed a reliable sample group.

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3.5 DATA COLLECTION PROCESS

Planning for the use of the online survey was undertaken from the beginning of the research in order to maximise effectiveness of questionnaire. Considerable time was spent on designing the questions as well as incorporating the positions that participants held at schools in such a way as to provide answers to the research problem and sub problems. The survey needed to draw descriptive incidents, frequency and explore attitudes. What proved to be very valuable for the research design was the development of clear instructions for the respondents.

3.5.1 Pilot survey

Annexure A contains the pilot survey that was used. The pilot survey was sent to private schools in South Africa. Appendix H contains the email that Dr Pam Miller used to ask the respondent to participate in the survey.
Eight other invitations were sent to private schools. Two schools responded and completed the pilot survey and this led to changes in the pilot survey.

3.5.2 Aims of the pilot survey

The most important aim of the pilot survey was to ascertain how possible respondents would react if they received a request to complete an online survey via email. A further aim was to ensure that the email sent out on the Western Cape Computer Studies mailing list and the Western Cape Education Department's school mailing list would link to a well-designed survey. One completed survey was received from the pilot survey.

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3.5.3 Final survey distribution

The final survey was distributed through two mailing lists namely the WCED's Computer studies mailing list and the WCED's schools mailing list. The first two online survey requests were sent out on 30 March 2012 to the Computer Studies mailing list of the WCED. The first survey request was sent out by Miller on the Computer Studies mailing list.

The third survey was sent out on the WCED's school mailing list. The first request for the survey to be emailed to the WCED's schools mailing list was on 5 May 2012. This proved to be the most difficult to send out. The first request was sent out on 3 May 2012 and the response thereof is given in Appendix J.

By the 11th of May the researcher sent out a second enquiring as to why the survey request had not been sent out which is given in Appendix K.

The survey request went out 25 May 2012, after sending the mail that is in Appendix L.

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3.6   **DATA ANALYSIS AND PRESENTATION**

Data analysis of the quantitative research only commenced after the third online survey was closed. The surveys were sent out on two mailing lists namely the Computer Studies mailing list of the WCED and the WCED schools mailing list. The reason for the delay between sending out the first two online survey requests and the third survey request was due to the fact that permission needed to be obtained from the administrator of the s school mailing list.

3.6.1   **Data analysis**

During the data analysis phase the following processes were followed in order to extract meaningful data. The researcher had to go through these steps in order to prepare the data for analysis.

Appendix C, Appendix D and Appendix E show the raw data from the first, second and third online survey. Rows were highlighted in grey to indicate respondents that did not answer any questions. In order for the online survey to provide meaningful results the researcher removed the respondents who did not answer any of the optional questions. These results are illustrated in Appendix F. The remaining data was coded and given in Appendix G

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3.6.2 Data presentation

The researcher made use of a bar graph to represent the data. Figure 3.2 shows the column graph that represents the number of participants from the different roles that they fulfil at their school.

Figure 3.2

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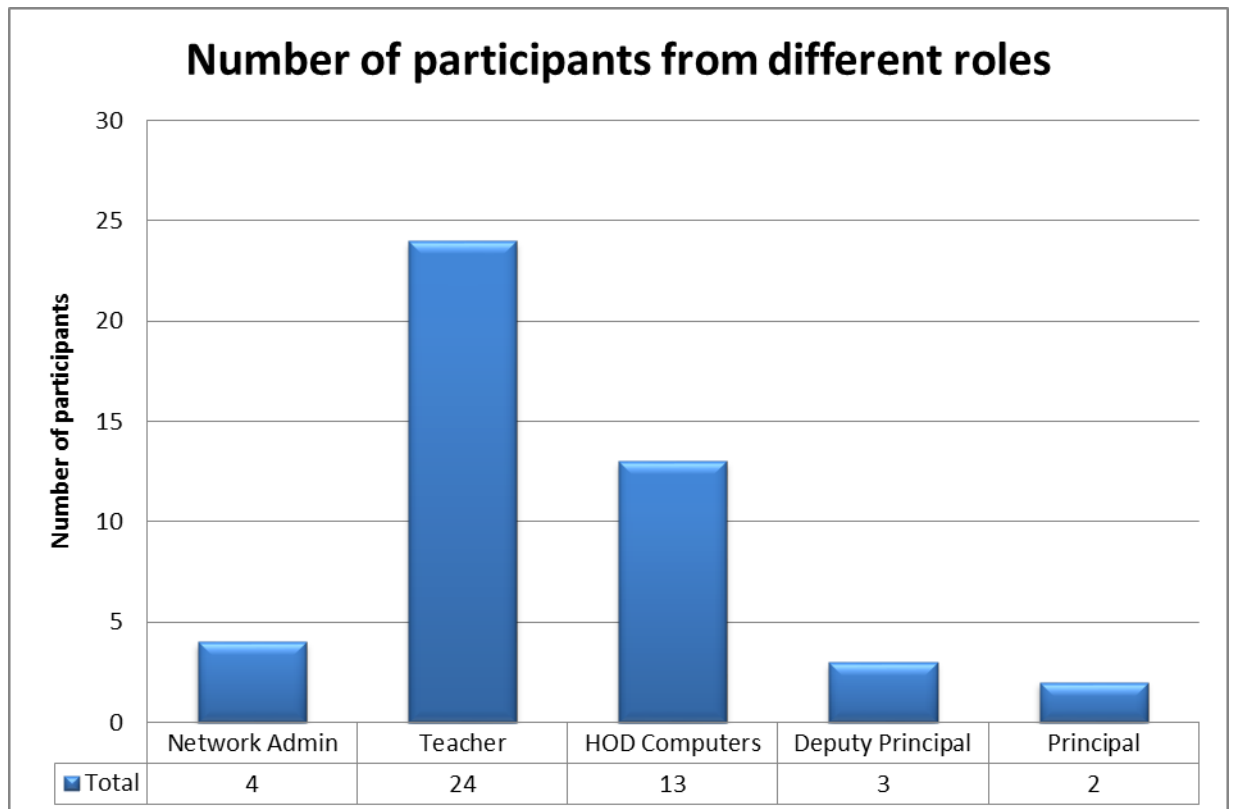
The data from Figure 3.2 is displayed as a pie diagram in Figure 3.3 which illustrates the percentage of representation that each of the roles had. The final analysis combined the column diagrams and percentage role representation.

Figure 3.3

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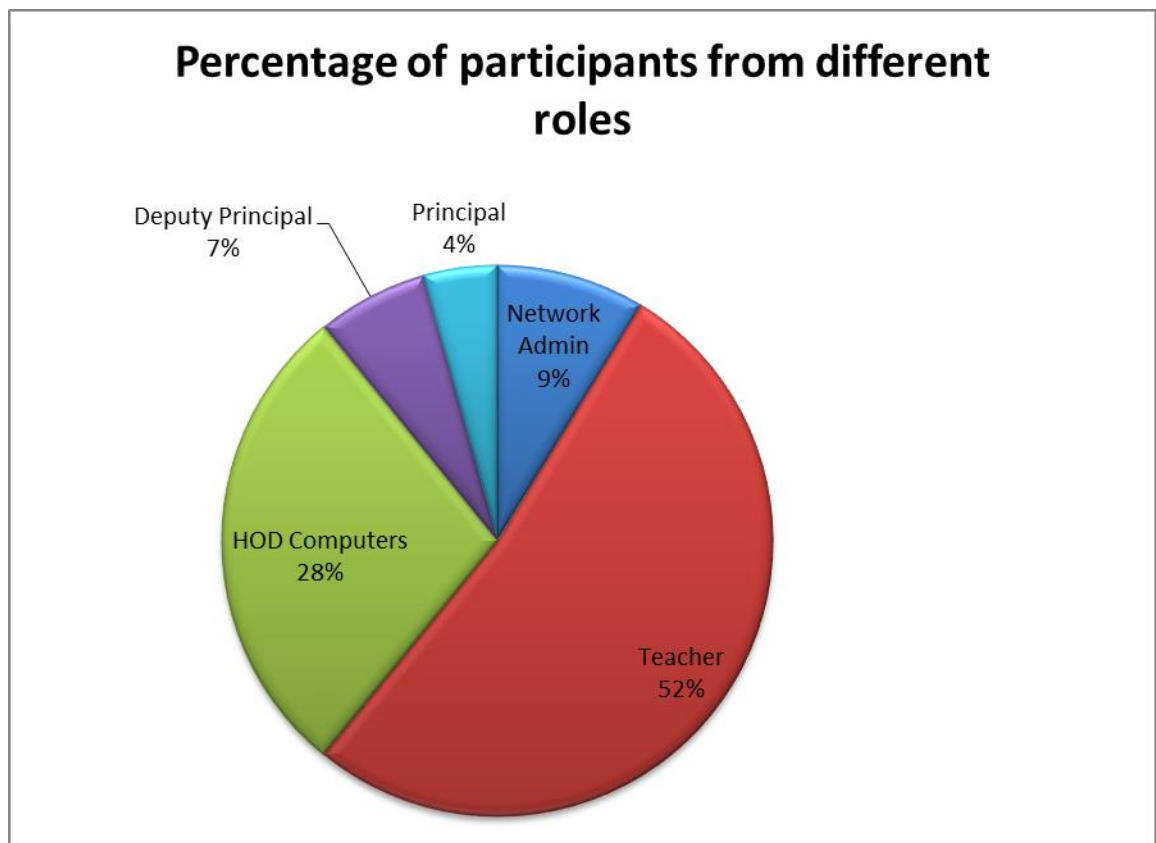
3.7 VALIDITY AND RELIABILITY IN QUANTITATIVE RESEARCH

The use of a census population required that reliability and validity be addressed in detail. Reliability was obtained by using an online questionnaire which is a standard instrument. The use of a pilot questionnaire further ensured that reliability for the research was maintained. Although IT infrastructure undergoes constant change the questions were designed to make provision for minimising effects of change on results. A large sample could be reached through the use of an online survey being sent out on two prominent email mailing lists.

It was important for the research to identify the different roles that participants fulfilled at schools as to obtain the level of agreement between these roles. A high level of interrelated agreement meant that IT infrastructure was viewed similarly between for example principals and teacher.

The instrument used for the online questionnaire was valid for the purpose of the research namely understanding IT infrastructure management within secondary schools. The content areas that were addressed included network stability, staff allocations, network security, network protocols, data management, user management and job satisfaction. These all contributed to making the research valid. Concurrent validity was used, as network administrators and principals were measured at the same time.

3.7.1 Researches role and competency

The researcher placed great emphasis on being detached from the study to avoid being biased. It was therefore important to ensure universal context-free generalizations. The researcher introduced herself in the beginning of the survey in order to indicate competency in requesting respondents to complete the survey. This is the only point where the researchers' personal input is given.

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The survey was designed in such a way that only the first question was compulsory, allowing the respondents to exit the survey at any point thereafter. Pilot surveys also allowed the researcher to either remove or change leading questions. The researcher has also worked within the field of IT infrastructure management. It was during this time that the researcher's attention was first drawn to the need for guidelines within IT infrastructure management which lead to the research.

3.7.3 Reflexivity

Central to the description of the research design were data collection and data processing methods that aimed to answer the research problem and sub problems. For this reason quantitative research was used to ensure that research biased influences would be minimised. Furthermore Chapter 3 shows that data collection, data processing were conducted in such a manner as to ensure credibility in results obtained.

The procedures, design, and instruments and literature review make it possible for any other researcher to replicate the study. (McMillan & Schumacher, 2001:54). The sample that was drawn, secondary schools in the represented the population, was described fully. The researcher provided evidence of validity and reliability of the research. A pilot study was conducted before and allowed the researcher to make considerable changes to the final online questionnaire. The respondents remained anonymous and their responses confidential, however this lead to a weakness in the research since respondents could have being outside the census population.

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3.8   CONCLUSION

The research design and method highlights that the researcher took care of data collection procedures in order to answer the research questions. Credibility was obtained through results that approximate reality and that are dependable and reasonable. Incentives to complete the online survey were used to increase questionnaire completion.

The researcher was able to reach the population by means of distributing an online survey through two prominent and reliable mailing lists. This research method also ensured that the different school positions reflected the population's schools positions. In other words, there are more teachers than principals therefore more responses were from teachers than from principals. Data collected through a thorough design process allowed the researcher to accumulate more information about the management, behaviour, attitudes, opinions, and ideas that different staff members of secondary schools.

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CHAPTER 4: ANALYSIS, INTERPRETATION AND DISCUSSION OF RESEARCH RESULTS

4.1   INTRODUCTION

The non-experimental design allowed for descriptive research focusing on current attitudes, behaviours and characteristics of secondary schools in the Western Cape Education Department (WCED).   Facts are the basis for generalization, therefore the first step in finding out whether there is a need for best practice guidelines is to analyse the different IT infrastructure management approaches. The researcher needed to look at how secondary schools in the WCED manage their IT infrastructure.   Once the phenomenon is described adequately, relationship questions can be addressed (McMillan & Schumacher, 2001:284).

Analysis of the data collected from the online survey, concentrated on the frequency of answers.   There were 46 responses to the online questionnaire. From the response to the opening question the researcher was able to categorise the respondents into their different school positions.   The respondents were made up of 4 network administrators, 24 teachers, and 13 heads of department computers (HOD computers).   There were 3 deputy principals, and 2 principals.

The demography of the participant's positions at the different schools resembles that of a single school.   Therefore most of the participants were teachers (52%), then HOD computers (28%), thereafter network administrators (9%), deputy principals (7%) and finally principals (4%).

In order to draw meaningful analysis, the general results of each question will be looked at as well as a comparison between the positions of the respondents and how their answers differed in relation to the research problems.

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The survey concentrated on the types of IT infrastructures, IT infrastructure problematic areas, and indirectly whether there is a need for best practice guidelines for secondary schools in the WCED. Sources for standardised guidelines or best practice of IT infrastructure management at secondary schools in the WCED were provided in Chapter 2, conceptualising the management of an IT infrastructure.

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4.2 ANALYSIS, INTERPRETATION AND DISCUSSION FOR ONLINE SURVEY

4.2.1 Response to statement 1: We have a full time on site network administrator

Table 4.1

Code	Value	Frequency	%
1	Yes	19	41%
2	No	27	59%
3	Not Sure	0	0%
4	Unanswered	0	0%
Total		46	100%

Table 4.2

	Yes	No	Not Sure	Unanswered	Total
Network Admin	3	1	0	0	4
Teacher	5	19	0	0	24
HOD computers	8	5	0	0	13
Deputy Principal	2	1	0	0	3
Principal	1	1	0	0	2
Total	19	27	0	0	46
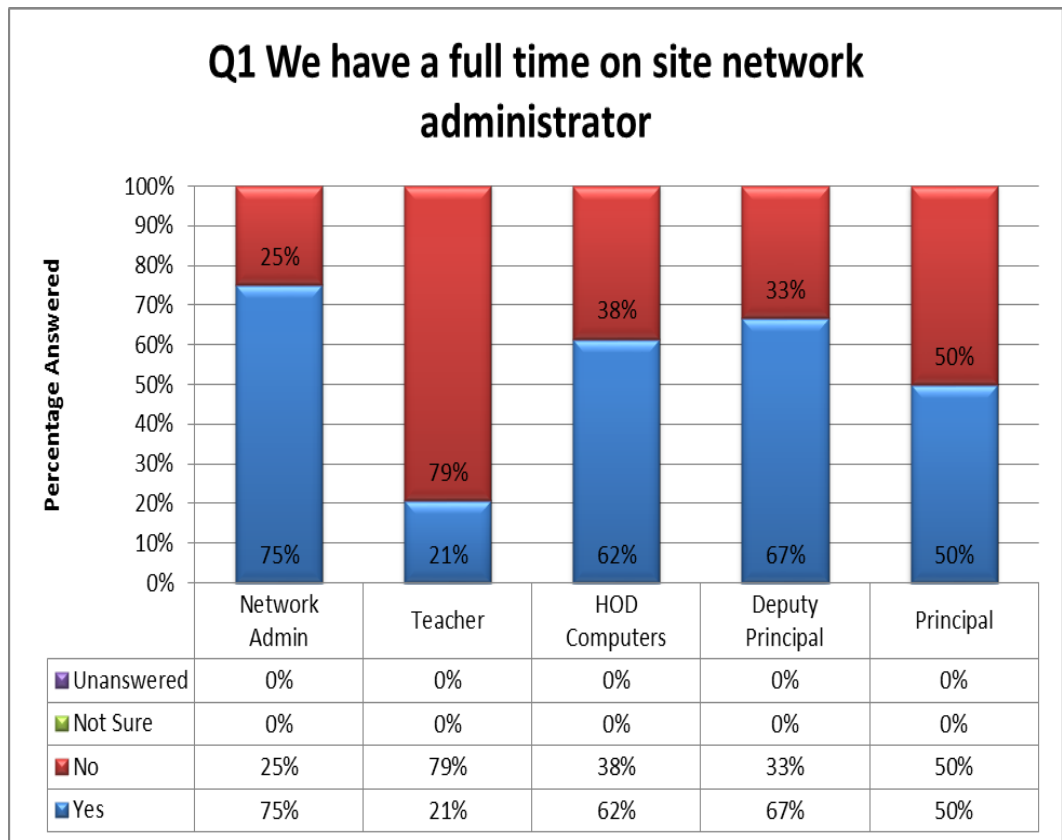
Figure 4.1

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The response to the statement: We have a full time on site network administrator, was varied and provided the basis and a reference point to other questions. 75% (3/4) of the network administrators stated that their school have a full time on site network administrator. Teacher's response was the opposite, where only 21% (5/24) of all the teachers participating in the questionnaire stated that they have full time on site network administrator at their school. 62% (8/13) HOD computers indicated that they had a full time on site network administrator at their school. One of the two principals had a full time on site network administrator and at the other principal's school there wasn't a full time on site network administrator. Most of the deputy principals, 67% (2/3) indicated that they have a full time on site network administrator at their school. Altogether 41% (19/46) responded yes to: We have a full time on site network administrator and the remaining 59% (27/46) indicated that they did not have a full time network administrator at their school.

4.2.1.1   Interpretation and discussion

A comparison between the teachers and the network administrators highlights that the results are almost opposites of each other. Teachers might feel that because they do not see the network administrator, there isn't one at the school. The question also didn't specify whether a full time network administrator could be a teacher or not, therefore it isn't clear whether the network administrator could also be a teacher. This allowed the answers to be influenced by a participant's perception of how they viewed the criteria for a full time on site network administrator. It was the intention of the question to imply that a full time network administrator would not carry any teaching responsibilities but since this was not clearly stated, it cannot be assumed that all participants viewed a full time network administrator in this light. The high number of negative responses to this statement could be an underlying cause for the frustrations that teachers who act as network administrators have. This is an indication for a need of best practice guidelines with regards to IT staff's workload.

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4.2.2 Response to statement 2: A teacher acts as the network administrator

Table 4.3

Code	Value	Frequency	%
1	Yes	21	46%
2	No	24	52%
3	Not Sure	0	0%
4	Unanswered	1	2%
Total		46	100%

Table 4.4

	Yes	No	Not Sure	Unanswered	Total
Network Admin	2	2	0	0	4
Teacher	10	14	0	0	24
HOD computers	6	7	0	0	13
Deputy Principal	2	1	0	0	3
Principal	1	0	0	1	2
Total	21	24	0	1	46

Q2 A teacher acts as a network administrator	Network Admin	Teacher	HOD Computers	Deputy Principal	Principal
Unanswered	0%	0%	0%	0%	50%
Not Sure	0%	0%	0%	0%	0%
No	50%	58%	54%	33%	0%
Yes	50%	42%	46%	67%	50%

Figure 4.2

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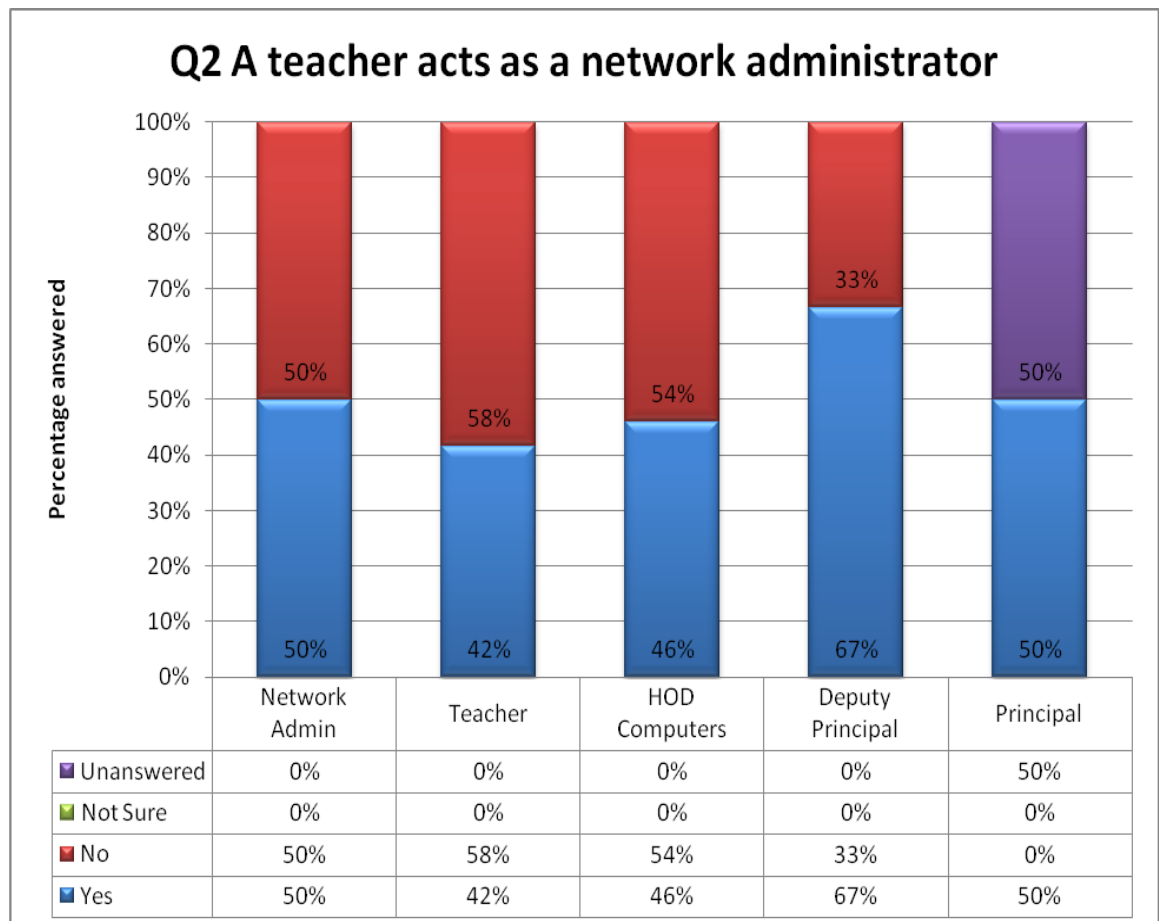
Regardless of whether or not a teacher acts as a network administrator, the response of network administrators were split 50/50 (2/4). The results showed that 42% (10/24) of teachers have a teacher who acts as a full time network administrator at their school, which is similar to that of HOD computers, namely 46% (6/13). Deputy Principals had the highest percentage of responses for having a teacher act as a network administrator at 67% (2/3). Interestingly one of the two principals did not give a reply to this answer, resulting in 50% of principals acknowledging that they have a teacher act as a full time network administrator.

This question forms one of the key questions to establish whether there is a need for best practice guidelines. Altogether 46% (21/46) responded yes to: a teacher acts as a network administrator. This correlates closely to question 1: we have a full time network administrator where 41% (19/46) of the total responses where yes.

4.2.2.1   Interpretation and discussion for statement 2

The implications of such a large number of respondents, who indicate that a teacher acts as a network administrator, correlate to some of the comments made by participants in relation to workload and time management. Notably a principal did not answer this question. It is possible that the principal could have missed this question. Another possibility is that he or she did not want to answer the question. If this is the case it highlights the important role that these teachers fulfil being both network administrator and teacher. There are considerable financial advantages to a school for having a teacher act as a network administrator which could be the reason for there being so many teachers who act as network administrators at secondary schools in the WCED.

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4.2.3   Response to statement 3: Some of our server maintenance is outsourced

Table 4.5   Table 4.6

Code	Value	Frequency	%
1	Yes	33	72%
2	No	12	26%
3	Not Sure	1	2%
4	Unanswered	0	0%
	Total	46	100%

	Yes	No	Not Sure	Unanswered	Total
Network Admin	0	3	1	0	4
Teacher	19	5	0	0	24
HOD computers	10	3	0	0	13
Deputy Principal	3	0	0	0	3
Principal	1	1	0	0	2
Total	33	12	1	0	46

Q3. Some of our server maintenance is outsourced

	Network Admin	Teacher	HOD Computers	Deputy Principal	Principal
Unanswered	0%	0%	0%	0%	0%
Not Sure	25%	0%	0%	0%	0%
No	75%	21%	23%	0%	50%
Yes	0%	79%	77%	100%	50%

Figure 4.3

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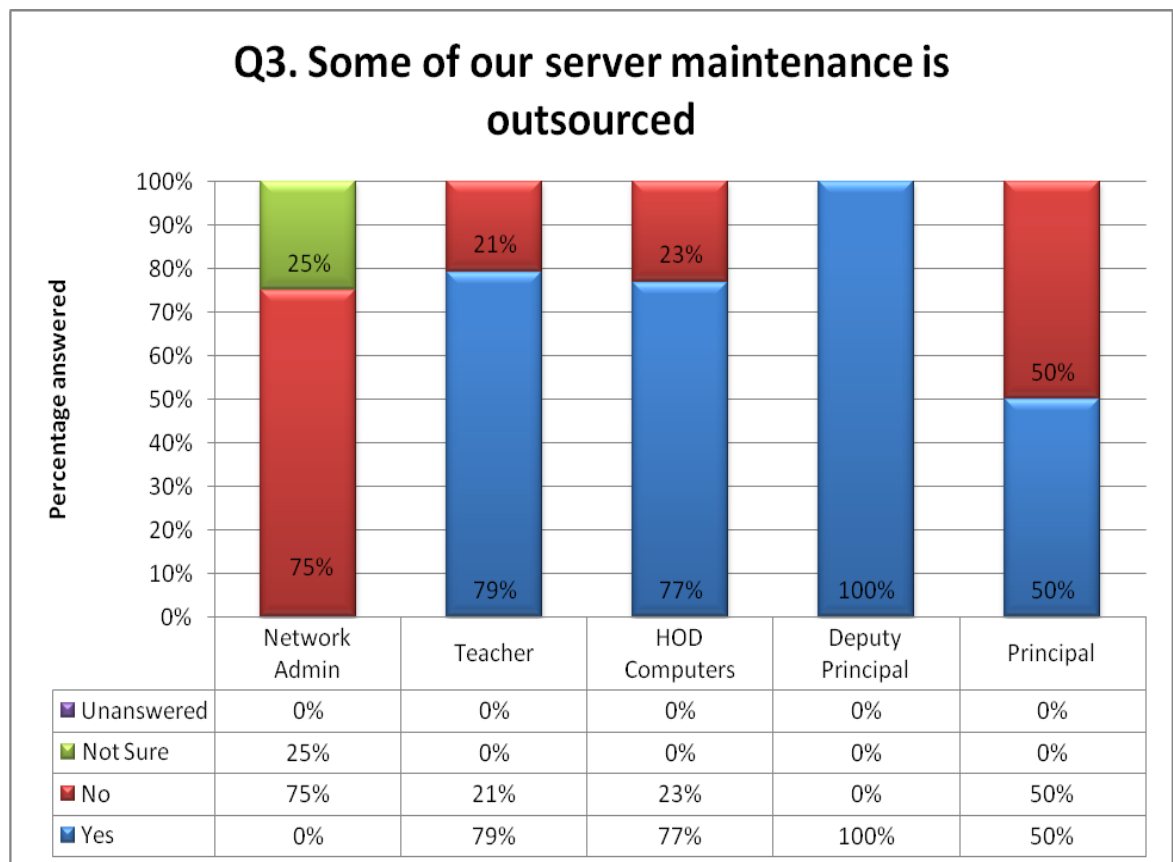
With regards to the statement: some of our server maintenance is outsourced, the response proved to be considerably different between network administrators and the other respondents. 75% (3/4) network administrator respondents indicated that none of their server maintenance is outsourced and the remaining respondent was unsure whether some of the server maintenance at his or her school is outsourced. At the schools where there are dedicated network administrators, server maintenance is not outsourced. 79% (19/24) of teachers indicated that some of the server maintenance was being outsourced. This corresponds to the responses of HOD computers which was 77% (10/13). All three deputy principals indicated that their school's server maintenance was being outsourced. This is a very high percentage, and one would expect deputy principals to know whether or not server maintenance is outsourced. The principals were split 50/50. Looking at the overall results it is clear that at most schools server maintenance was being outsourced.

4.2.3.1   Interpretation and discussion for statement 3

Some concern was raised for one respondent who is a network administrator who did not know whether some of the server maintenance at his or her school is outsourced. What are the implications of this response? Does this reflect on the professional expertise level of this administrator? Surely an administrator would know whether some or none of the server maintenance is outsourced, or could it possibly be that this respondent did not understand the meaning of the term "outsourced". It was the understanding of the researcher to refer to "outsourcing" as obtaining outside contractors to provide hardware or software maintenance on servers. The responses of the teachers and the HOD computers form a group due to their results being so close to each other. Further investigations into such a high percentage of schools making use of outsourcing their schools server maintenance could reveal which areas of server maintenance are most commonly outsourced and what were the financial implications for schools that made use of outsourcing server maintenance.

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4.2.4   Response to statement 4: All new software is thoroughly checked to ensure value to teaching.

Table 4.7   Table 4.8

Code	Value	Frequency	%
1	Yes	29	63%
2	No	9	20%
3	Not Sure	7	15%
4	Unanswered	1	2%
	Total	46	100%

	Yes	No	Not Sure	Unanswered	Total
Network Admin	3	0	1	0	4
Teacher	11	8	4	1	24
HOD computers	10	1	2	0	13
Deputy Principal	3	0	0	0	3
Principal	2	0	0	0	2
Total	29	9	7	1	46

Q4. All new software is thoroughly checked to ensure value to teaching

	Network Admin	Teacher	HOD Computers	Deputy Principal	Principal
Unanswered	0%	4%	0%	0%	0%
Not Sure	25%	17%	15%	0%	0%
No	0%	33%	8%	0%	0%
Yes	75%	46%	77%	100%	100%

Figure 4.4

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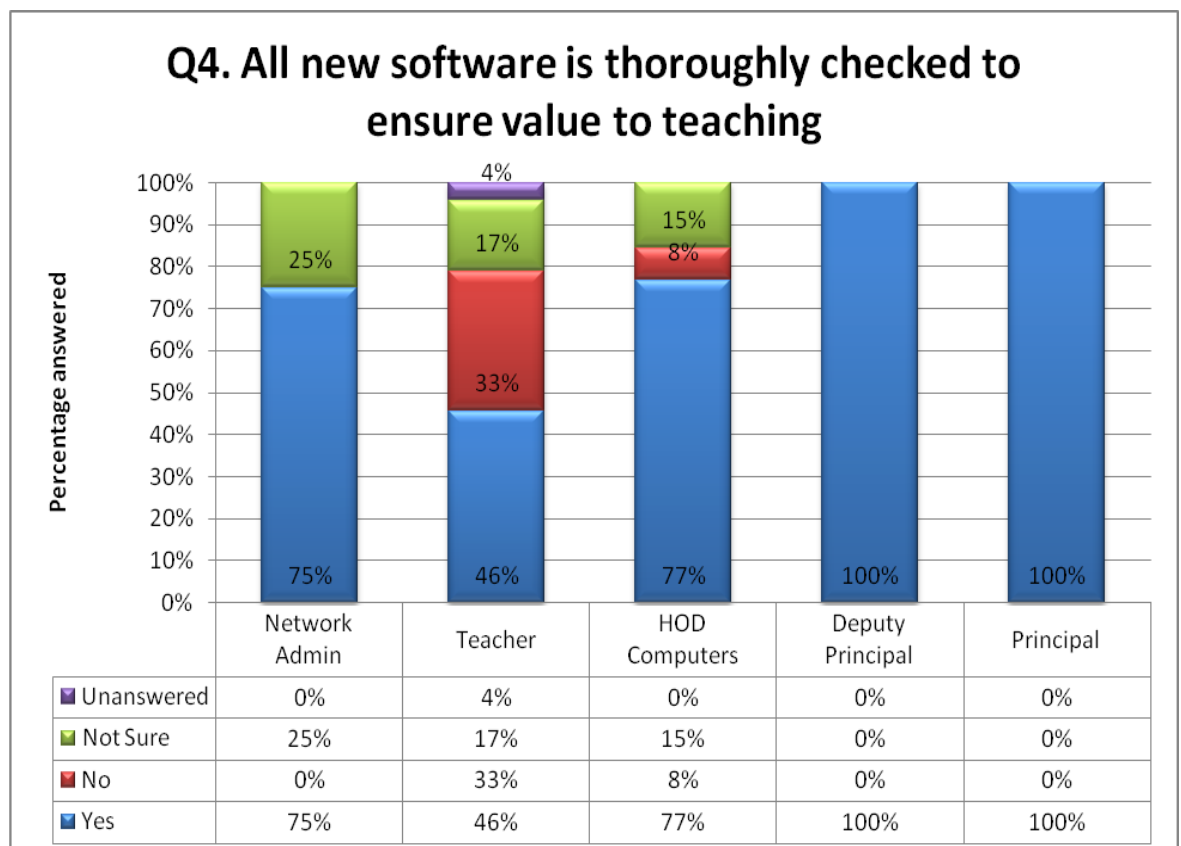
75% of network administrators indicated that all new software is thoroughly checked to ensure value to teaching. This correlates with the 77% of HOD computers who also indicated that software is thoroughly checked at their school to ensure quality teaching. This view is however *not* shared with 46% (11/24) of teachers who felt that software is *not* thoroughly checked to ensure value to teaching. All the deputy principals and principals stated that software is thoroughly checked to ensure value to teaching.

Only 33% (8/24) teachers and 8% (1/13) of HOD computers felt that software was not thoroughly checked to ensure value to teaching. 25% (1/3) of network administrators, 17% (8/24) of teachers and 15% (1/13) of HOD computers stated that they were not sure whether software was thoroughly checked to ensure value to teaching. Only one teacher did not answer the question.

4.2.4.1   Interpretation and discussion for statement 4

The reason for having this question is to establish to what extent software roll out at schools are tested. This would give the researcher a good idea as to whether or not there is a need to have standard guidelines for the roll out new software at schools.

The high number of respondents who agreed with this statement indicates that top management in schools realise the importance of managing their selection of software that is installed on their school network. The 8 teachers who felt that software is not tested should not be overlooked, but once again testing software is a very time consuming process which not all schools have the staff to effectively accomplish this task.

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4.2.5 Response to statement 5: Users have a definite procedure to report IT incidents

Table 4.9

Code	Value	Frequency	%
1	Yes	38	83%
2	No	6	13%
3	Not Sure	2	4%
4	Unanswered	0	0%
	Total	46	100%

Table 4.10

	Yes	No	Not Sure	Unanswered	Total
Network Admin	4	0	0	0	4
Teacher	18	5	1	0	24
HOD computers	12	0	1	0	13
Deputy Principal	3	0	0	0	3
Principal	1	1	0	0	2
Total	38	6	2	0	46

Q5: Users have a definite procedure to report IT incidents

	Network Admin	Teacher	HOD Computers	Deputy Principal	Principal
Unanswered	0%	0%	0%	0%	0%
Not Sure	0%	4%	8%	0%	0%
No	0%	21%	0%	0%	50%
Yes	100%	75%	92%	100%	50%

Figure 4.5

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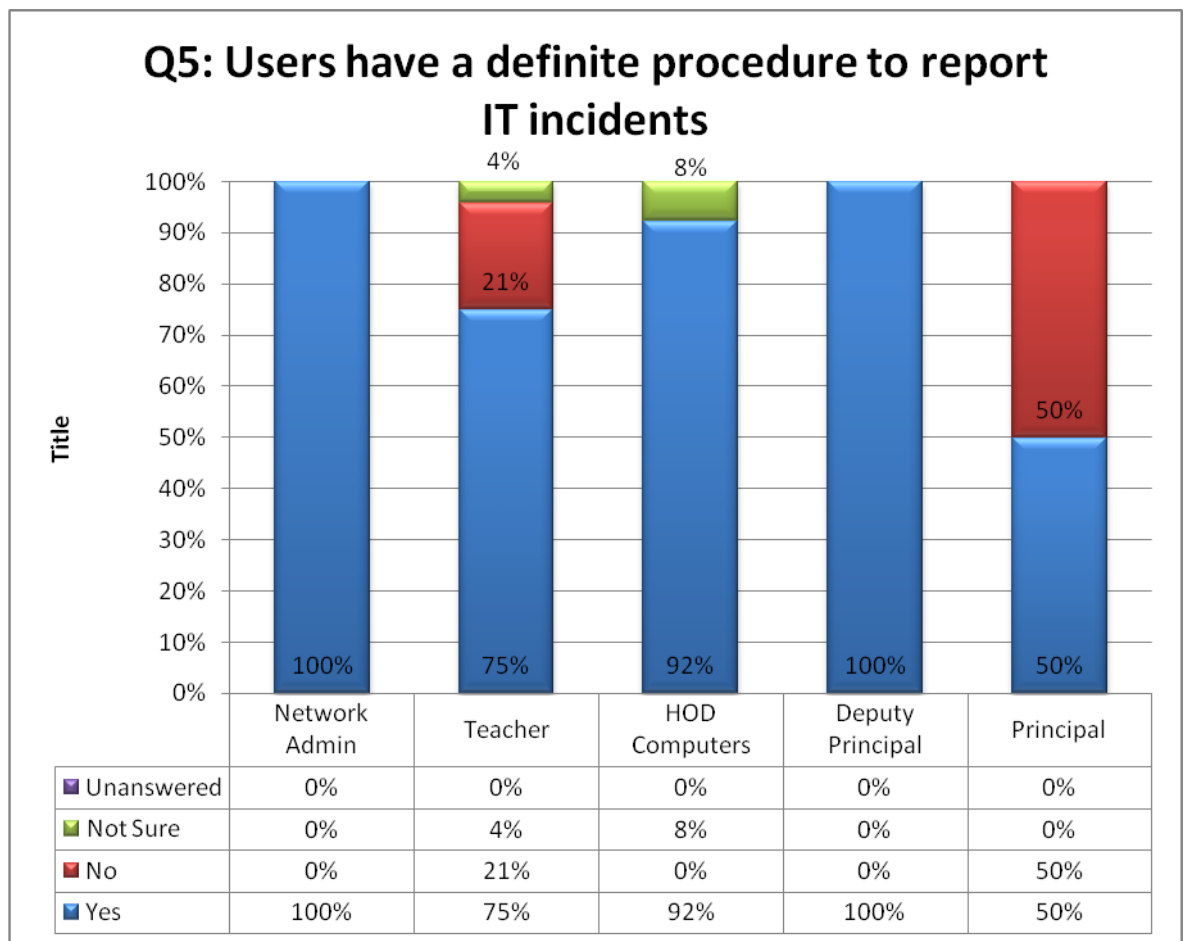
This question revealed the most correlation between the different school positions. All network administrators (100%) and all deputy principals (100%) stated that there were definite procedures in place for IT incidents. This is followed closely by HOD computers where 92% (12/13) indicated that users have a definite procedure to report IT incidents. However one HOD computers was not sure as to whether or not users have a definite procedure to report IT incidents.

75% (18/24) of teacher indicated that users have a definite procedure to report IT incidents. Only 21% (5/24) of the teachers felt users did not have a definite procedure to follow when reporting IT incidents. One teacher was unsure if a definite procedure to follow was in place when reporting IT incidents.

Of the 2 principals, only one was certain that there was a definite procedure to follow when reporting IT incidents. This is significant since it indicates that the other principal did not know if such a procedure existed in their school. Overall 82% of participants felt that there was a definite procedure to follow when reporting IT incidents. This is a high number and an indication that at most schools the staff was aware of reporting procedures to follow when IT incidents occur.

4.2.5.1   Interpretation and discussion for statement 5

The initiative for reporting IT incidents usually originates from network administrators and the high number of respondents who agreed with the statement indicates that most staff members are aware of these procedures. The 4% of teachers who were unsure about the statement indicates that they are either unaware of these procedures or that procedures are not in place.

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4.2.6   Response to statement 6: Hardware and software are tested before staff or learners use it

Table 4. 11

Code	Value	Frequency	%
1	Yes	35	76%
2	No	7	15%
3	Not Sure	3	7%
4	Unanswered	1	2%
	Total	46	100%

Table 4. 12

	Yes	No	Not Sure	Unanswered	Total
Network Admin	4	0	0	0	4
Teacher	17	4	3	0	24
HOD computers	10	2	0	1	13
Deputy Principal	2	1	0	0	3
Principal	2	0	0	0	2
Total	35	7	3	1	46
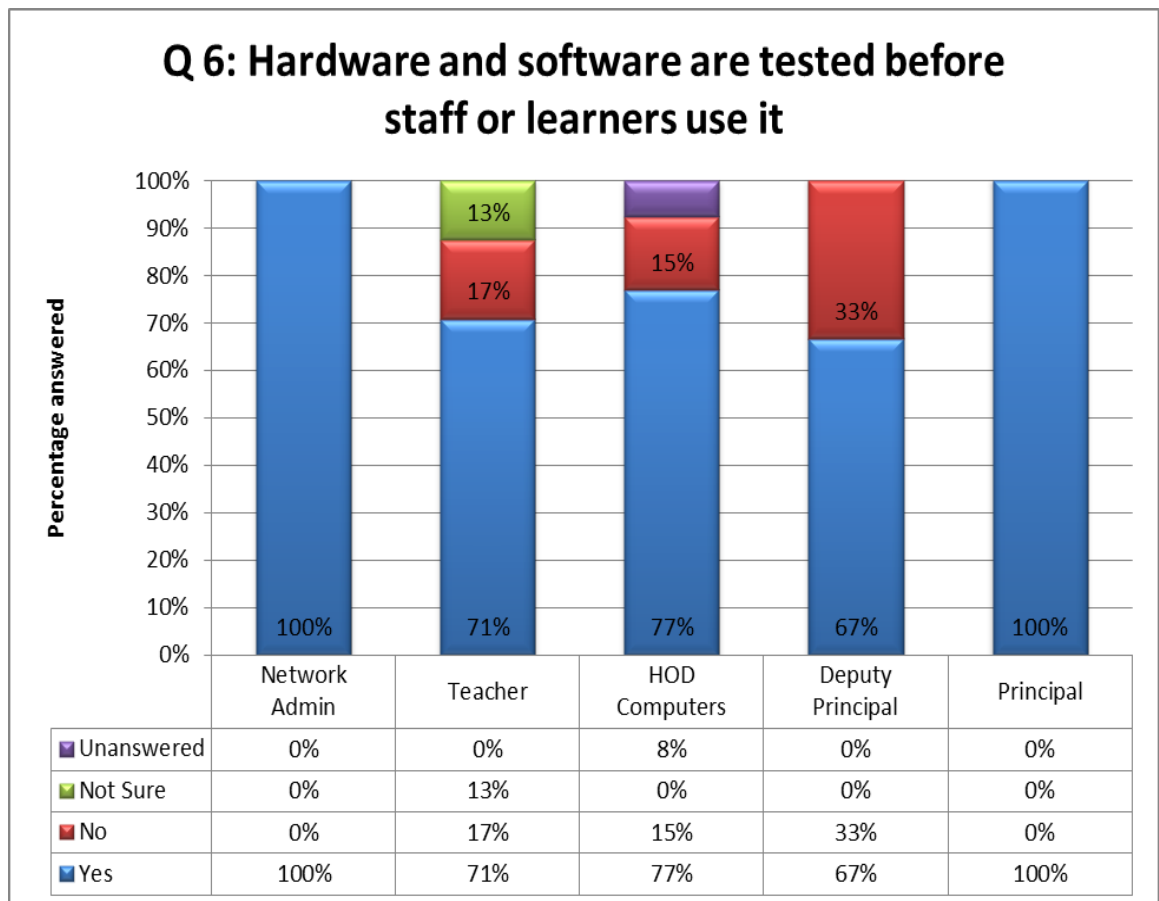
Figure 4.6

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All network administrators and all principals felt that hardware and software are tested before staff or learners use it. This view is however not shared by all participants. The responses of teacher, HOD computers, and deputy principal's correspondent to within 10% of each other.

71% (17/24) of teachers, 77% (10/13) of HOD computers, and 67% (2/3) of deputy principals stated that hardware and software are tested before staff or learners use it. One deputy principal (33%), two HOD computers (15%) and four teachers (17%) indicated that hardware and software were not tested before staff or learners use it. Three teachers (13%) were not sure whether or not hardware and software are tested before staff or learners use it. One HOD computers did not answer this question.

This is one of only two statements that both the network administrators and the principals feel exactly the same about. The other 50% of the network administrators and 50% of the principals agreed that a teacher acts as a network administrator at their school.

4.2.6.1   Interpretation and discussion for statement 6

Such a high agreement among the participants of the questionnaire is an indication that most staff members feel that hardware and software are adequately checked before it is used. This is a good indication that senior management take time to ensure that they have the right product before it is purchased or used. Installing and maintaining IT infrastructure is very expensive which could be the driving force for making sure that all hardware and software are checked before it is used. Schools need to make 100% sure that they have the right product before they purchase it, otherwise it would result in funds being wasted. That would also explain why there are such long delays before hardware and software are purchased.

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4.2.7 Response to statement 7: Students are brought before disciplinary committees for computer related offences

Table 4.13 Table 4.14

Code	Value	Frequency	%
1	Yes	34	74%
2	No	9	20%
3	Not Sure	3	7%
4	Unanswered	0	0%
	Total	46	100%

	Yes	No	Not Sure	Unanswered	Total
Network Admin	3	1	0	0	4
Teacher	18	4	2	0	24
HOD computers	8	4	1	0	13
Deputy Principal	3	0	0	0	3
Principal	2	0	0	0	2
Total	34	9	3	0	46

Q7. Students are brought before disciplinary committees for computer related offences

	Network Admin	Teacher	HOD Computers	Deputy Principal	Principal
Unanswered	0%	0%	0%	0%	0%
Not Sure	0%	8%	8%	0%	0%
No	25%	17%	31%	0%	0%
Yes	75%	75%	62%	67%	100%

Figure 4.7

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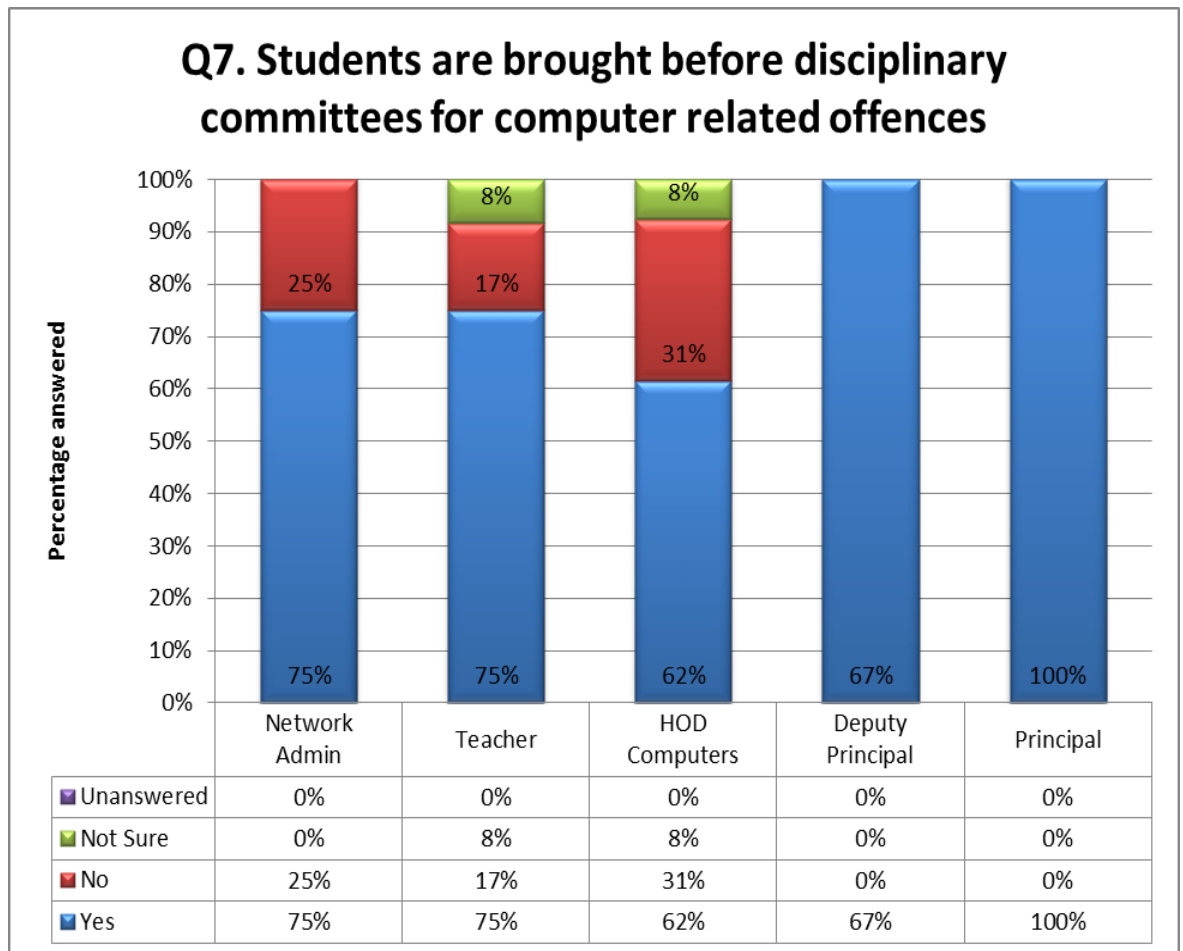
Overall a high number (74%) of participants agreed that students are brought before disciplinary committees at their schools. These results show that all the principals and deputy principals agreed with this statement. 75% of network administrators and 75% of teachers also felt that students are brought before disciplinary committees for computer related incidents at their schools. The lowest agreement with the statement came from the deputy principals (67%) and HOD computers (62%).

Some network administrators, teachers, and HOD computers disagreed with the statement that students are brought before disciplinary committees for computer related offences. The highest disagreement with the statement came from HOD computers namely 31% (4/13), thereafter 25% (1/4) network administrators and the least disagreement with the statement that students are brought before disciplinary committees for computer related offences came from teacher with 17% (4/24). Two out of the twenty four teachers (8%) and one out of the thirteen HOD computers (8%) were unsure on whether or not students are brought before disciplinary committees for computer related offences.

4.2.7.1   Interpretation and discussion for statement 7

Noticeably 9/46 participants disagreed with the statement that students are brought before disciplinary committees for computer related incidents. In order for school computer networks to be effective students need to know that they will be held responsible for their responsible use of the schools network. With social media becoming more and more intertwined school life, active awareness campaigns need to be initiated from schools.

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4.2.8   Response to statement 8: It is easy to deal with the day to day ICT/IT department issues

Table 4.15

Code	Value	Frequency	%
1	Yes	24	52%
2	No	18	39%
3	Not Sure	4	9%
4	Unanswered	0	0%
	Total	46	100%

Table 4.16

	Yes	No	Not Sure	Unanswered	Total
Network Admin	3	0	1	0	4
Teacher	12	9	3	0	24
HOD computers	6	7	0	0	13
Deputy Principal	2	1	0	0	3
Principal	1	1	0	0	2
Total	24	18	4	0	46

Q8. It is easy to deal with the day to day ICT/IT department issues

	Network Admin	Teacher	HOD Computers	Deputy Principal	Principal
Unanswered	0%	0%	0%	0%	0%
Not Sure	25%	13%	0%	0%	0%
No	0%	38%	54%	33%	50%
Yes	75%	50%	46%	67%	50%

Figure 4.8

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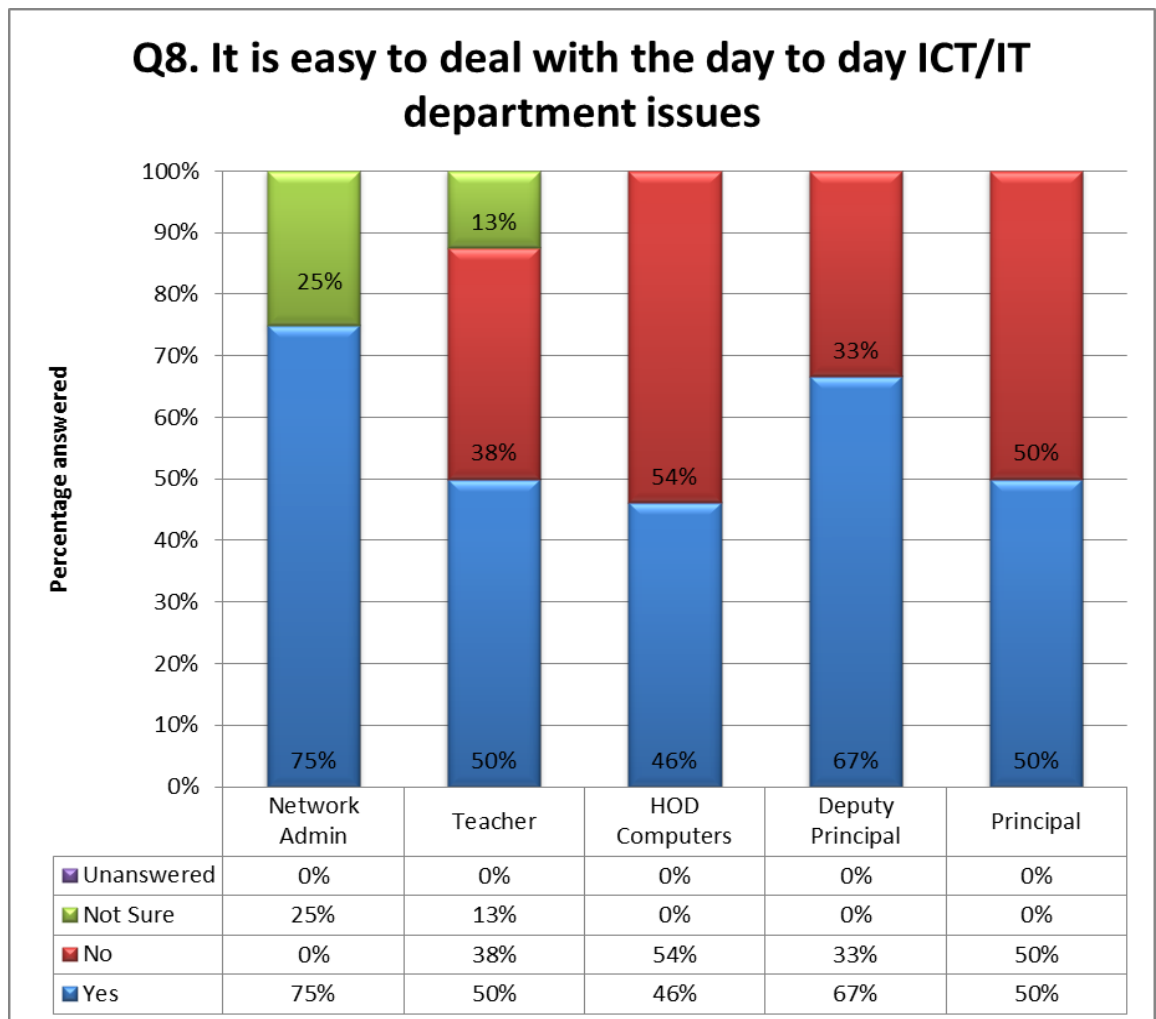
With regards to the statement: It is easy to deal with the day to day ICT/IT department issues, 52% (24/46) of the participants agreed, 39% (18/46) disagreed, and 9% (4/46) were unsure. All participants responded to this statement. Network administrators had the highest agreement with the statement at 75% which represents three out of the four network administrators. The other network administrator was unsure on whether to agree with the statement or not; thus none of the network administrators disagreed with this statement.

50% (12/24) of teachers indicated that they found it easy to deal with the day to day ICT/IT department issues while 38% (9/24) teachers disagreed. The remaining 13% (3/24) were unsure on whether or not it was easy to deal with the day to day ICT/IT department issues. HOD computers were almost evenly split as 46% (6/13) agreed with the statement and 54% (7/13) disagreed. 67% (2/3) of the deputy principals agreed with the statement and the remaining principal (33%) disagreed with the statement. After the network administrators 75% (3/4) the deputy principals had the highest agreement of 67% (2/3). The two principals were split 50/50 on whether or not they agreed with the statement.

4.2.8.1   Interpretation and discussion for statement 8

39% (18/46) who disagreed with the statement that it is easy to deal with the day to day ICT/IT department issues were teachers, HOD computers, deputy principals and principals. The reason for this can be multiple ranging from hardware, software, security issues and implementation of protocols. More and more attention is also required from top management to the use of social media sites such as Facebook and Twitter as a means of influencing school matters.

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4.2.9   Response to statement 9: I am happy with the way our school network is being maintained

Table 4.17   **Table 4.18**

Code	Value	Frequency	%
1	Yes	27	59%
2	No	14	30%
3	Not Sure	5	11%
4	Unanswered	0	0%
	Total	46	100%

	Yes	No	Not Sure	Unanswered	Total
Network Admin	4	0	0	0	4
Teacher	11	9	4	0	24
HOD computers	9	3	1	0	13
Deputy Principal	2	1	0	0	3
Principal	1	1	0	0	2
Total	27	14	5	0	46
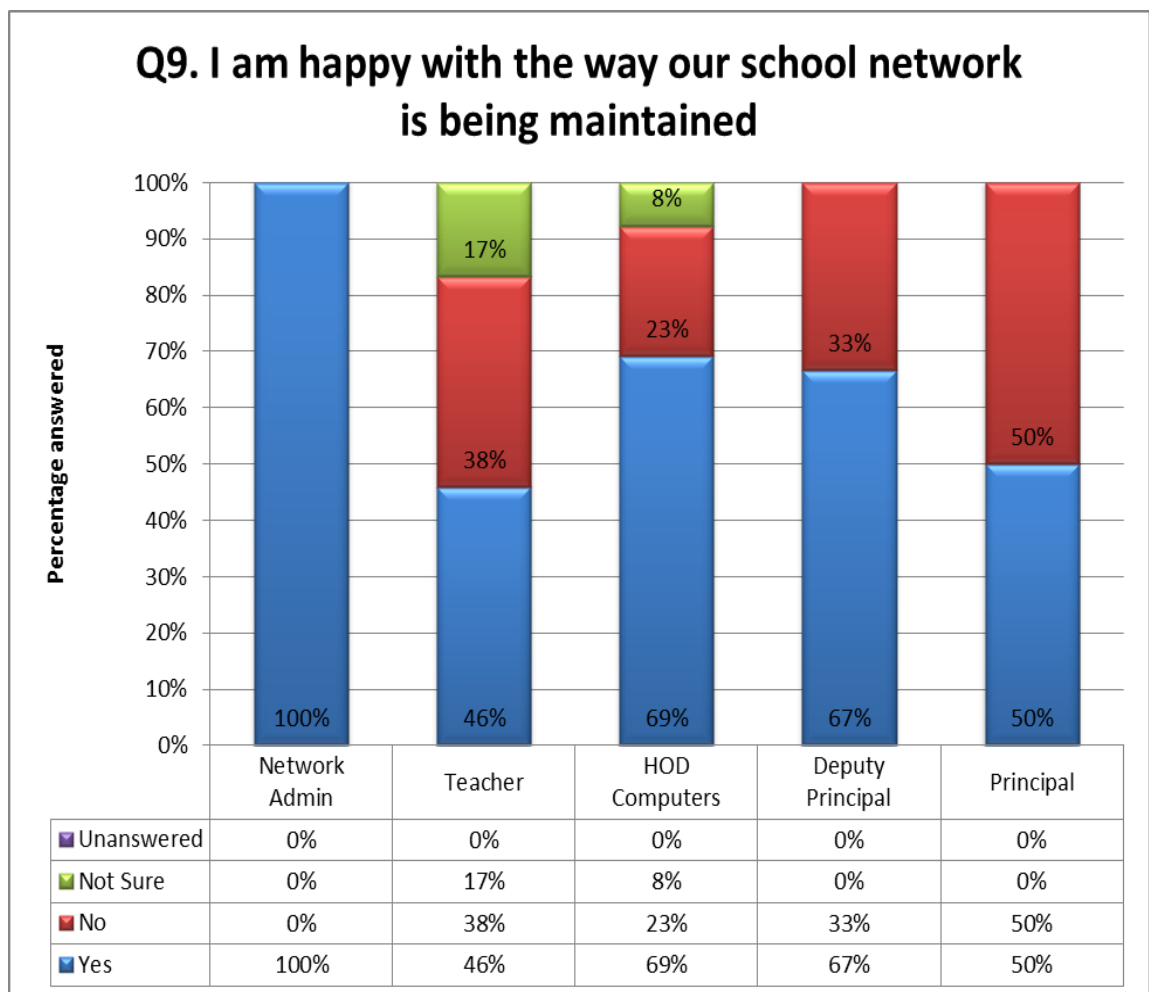
Q9. I am happy with the way our school network is being maintained

	Network Admin	Teacher	HOD Computers	Deputy Principal	Principal
Unanswered	0%	0%	0%	0%	0%
Not Sure	0%	17%	8%	0%	0%
No	0%	38%	23%	33%	50%
Yes	100%	46%	69%	67%	50%

Figure 4.9

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To the statement: I am happy with the way our school network is being maintained, 59% of participants agreed, 30% disagreed and 11% were unsure on whether they agree or disagree with the statement.

All network administrators indicated that they were happy with the way that their school networks were being maintained however their high level of agreement was not shared with the other respondents, as only 46% (11/24) of the participating teachers, 60% (9/13) of HOD computers, 67% (2/3) of the deputy principals agreed with the statement. Of the two principals only one agreed that he was happy with the way their school networks were being maintained.

38% (9/24) of the teachers, 23% (3/13) of HOD computers, 33% (1/3) deputy principals, disagreed with the statement that they were happy with the way that their school network was being maintained. 17% (4/24) teachers and one HOD computers were unsure on whether they were happy or not with the way their school networks were being maintained.

4.2.9.1 Interpretation and discussion for statement 9

We should pay close attention to how the successful teachers view their schools' network. Only 46% (11/24) felt that they were happy with their schools network. Users of the school network had little agreement with the network administrator. Schools need to take note of teachers who strongly rely on a working network so that they can teach effectively.

This question reflects on the work quality that network administrators deliver and all users of school computer networks revealed varying degrees of dissatisfaction with the way that their schools network were being maintained. By combining this result with other questions reasons for this high level of disagreement are obtainable. Teachers who act as network administrators are not able to keep up with all the demands that an effective network requires and that can also lead to reduced maintenance.

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4.2.10 Response to statement 10:   Internet is down more than twice a term

Table 4.19   Table 4.20

Code	Value	Frequency	%
1	Yes	17	37%
2	No	24	52%
3	Not Sure	4	9%
4	Unanswered	1	2%
	Total	46	100%

	Yes	No	Not Sure	Unanswered	Total
Network Admin	0	4	0	0	4
Teacher	11	10	2	1	24
HOD computers	5	6	2	0	13
Deputy Principal	0	3	0	0	3
Principal	1	1	0	0	2
Total	17	24	4	1	46
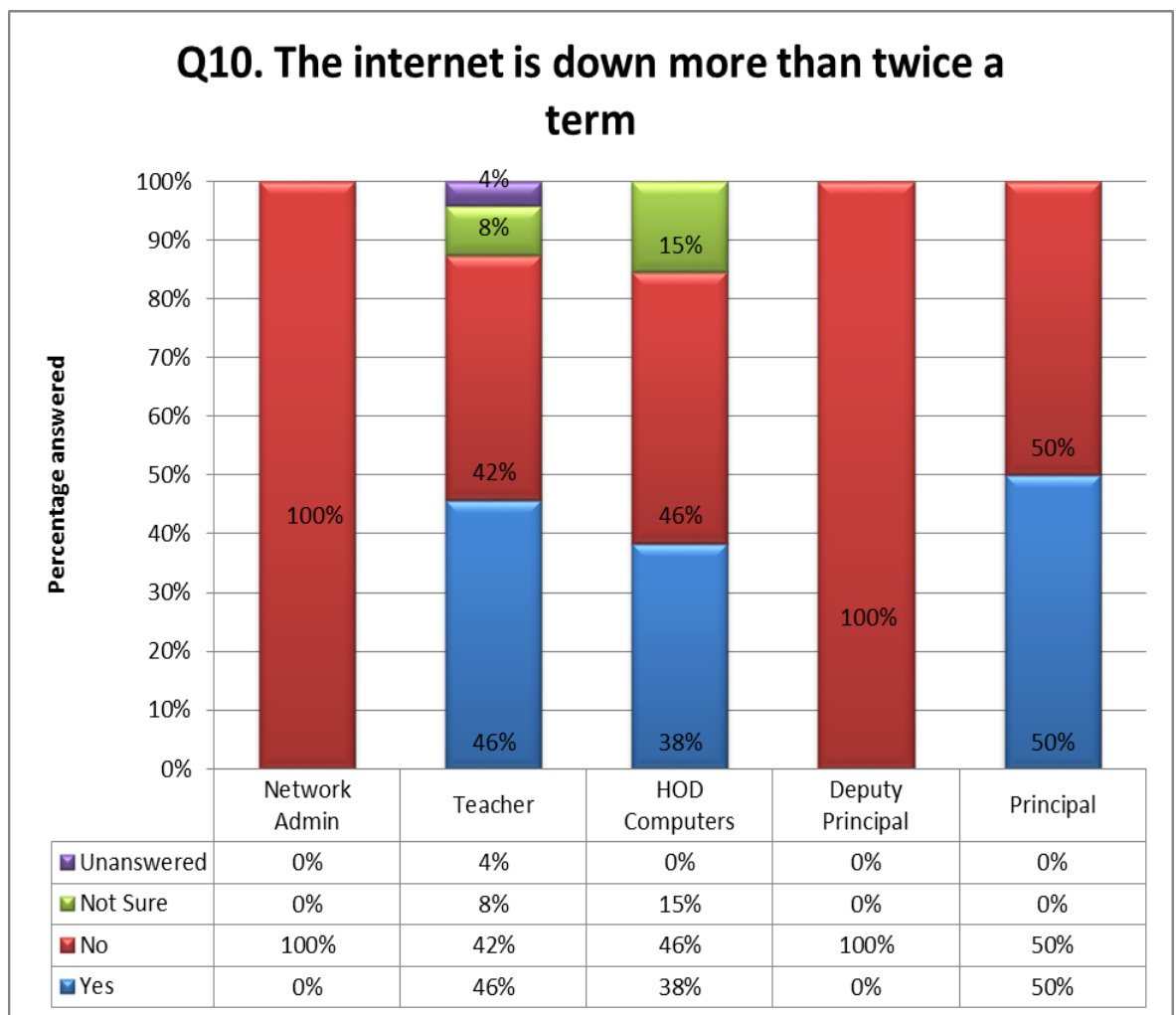
Q10. The internet is down more than twice a term

	Network Admin	Teacher	HOD Computers	Deputy Principal	Principal
Unanswered	0%	4%	0%	0%	0%
Not Sure	0%	8%	15%	0%	0%
No	100%	42%	46%	100%	50%
Yes	0%	46%	38%	0%	50%

Figure 4.10

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37% (17/46) of all participants agreed with the statement that the internet is down more than twice a term. 52% (24/46) disagreed while 9% (4/46) were not sure if their internet was down more than twice a term.

All network administrators (4/4) and all deputy principals (3/3) disagreed with the statement: the internet is down more than twice a term. 42% (10/24) of teachers, 46% (6/13) of HOD computers, and 50% (1/2) of principals disagreed with the statement that the internet is down more than twice a term.

8% (2/24) of teachers and 15% (2/13) of the HOD computers were not sure whether the internet was off more than twice a term. Only one teacher did not answer this question.

4.2.10.1   Interpretation and discussion for statement 10

Internet that is often down at schools is an indication that a schools network is not functioning effectively for all teaching purposes. The fact that there are such a high number of participants 37% who agreed to the statement that the internet is down more than twice a term indicates that their school network is not as reliable as one should expect. The 42% (10/24) of teachers who disagreed with the statement is noteworthy. More and more teachers rely on accessing the internet in order to accomplish the required teaching outcomes. Teachers feel frustrated when the internet is off and there are multiple reasons why internet access at schools is unreliable. Problems with the internet service provider can also contribute to the statistics, but it is more often due to infrastructure management that unreliable internet access occurs.

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4.2.11 Response to statement 11:   Anti-virus software is updated at least once a week on all the computers

Table 4. 21

Code	Value	Frequency	%
1	Yes	37	80%
2	No	6	13%
3	Not Sure	3	7%
4	Unanswered	0	0%
	Total	46	100%

Table 4. 22

	Yes	No	Not Sure	Unanswered	Total
Network Admin	4	0	0	0	4
Teacher	18	4	2	0	24
HOD computers	12	0	1	0	13
Deputy Principal	2	1	0	0	3
Principal	1	1	0	0	2
Total	37	6	3	0	46
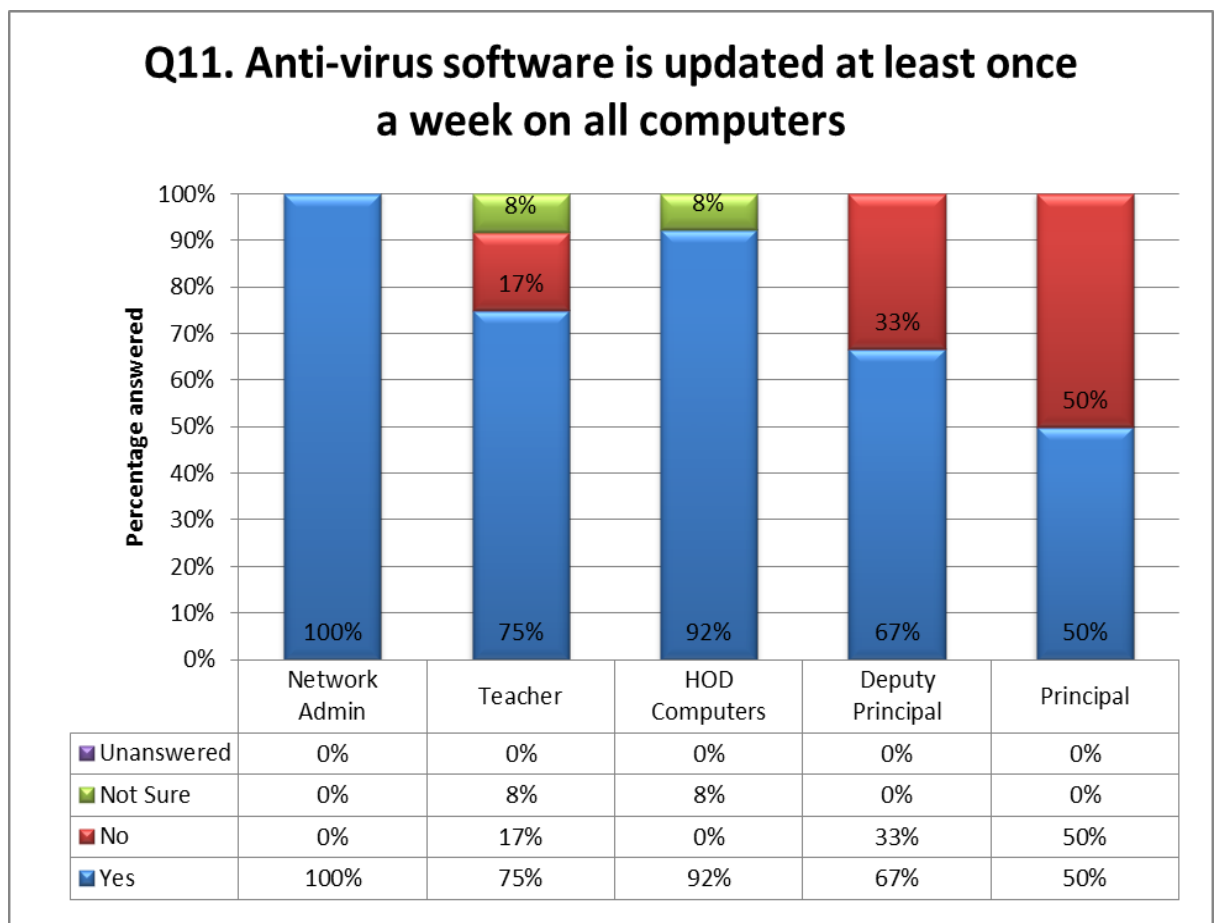
Q11. Anti-virus software is updated at least once a week on all computers

	Network Admin	Teacher	HOD Computers	Deputy Principal	Principal
Unanswered	0%	0%	0%	0%	0%
Not Sure	0%	8%	8%	0%	0%
No	0%	17%	0%	33%	50%
Yes	100%	75%	92%	67%	50%

Figure 4.11

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A very high number of respondents 80% (37/46) agreed with the statement that anti-virus software is updated at least once a week on all computers. Only 13% (6/46) disagreed with this statement, and 7% (3/46) were unsure whether their anti-virus software was updated at least once a week on all computers.

The highest agreement comes from all four the network administrators. This is followed by HOD computers with 92% (12/13), 75% (18/24) and teachers with 67% (2/3). Only one of the two principals agreed with the statement that anti-virus software is updated at least once a week on all computers.

It should be noted that there was a very low number of teachers namely 8% (2/24) and only one HOD computers who were uncertain as to whether or not anti-virus software was being updated at least once a week on all computers.

4.2.11.1 Interpretation and discussion for statement 11

The updating of anti-virus software is critical for the maintenance of an effective school computer network and there should have been an agreement by all participants with this statement. The fact that nine participants disagreed or were uncertain whether or not anti-virus software is being updated on a weekly basis is concerning. Network administrators should have realised that the negligence of anti-virus software updates could result in considerable time loss to solve virus infestations. Updating anti-virus software and staying prepared for any network security issues, demands the time required for updating in order to ensure continued optimal network performance. Considerable time may be needed initially to choose and install the correct anti-virus software for a school.

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4.2.12 Response to statement 12: There is an acceptable usage policy for staff.

Table 4.23

Code	Value	Frequency	%
1	Yes	27	59%
2	No	15	33%
3	Not Sure	1	2%
4	Unanswered	3	7%
	Total	46	100%

Table 4.24

	Yes	No	Not Sure	Unanswered	Total
Network Admin	4	0	0	0	4
Teacher	13	9	1	1	24
HOD computers	7	6	0	0	13
Deputy Principal	2	0	0	1	3
Principal	1	0	0	1	2
Total	27	15	1	3	46

Figure 4.12

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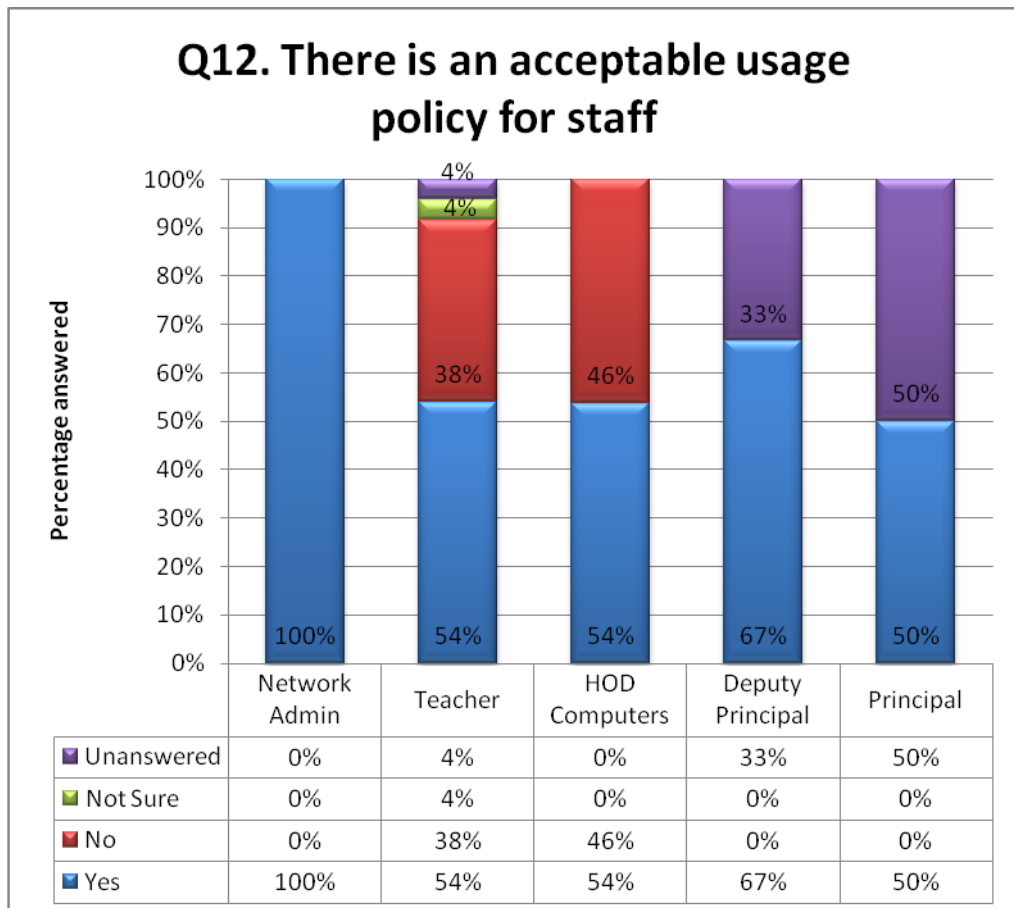
When asked if there is an acceptable usage policy for staff, 59% (27/46) of all the respondents responded that they did have such a policy However, 33% of participants did not have this policy, 2% (1/46) were unsure and three (7%) respondents did not reply to the statement.

All four network administrators agreed that there had an acceptable usage policy for staff. 54% (13/24) teachers, 54% (7/13) HOD computers and 67% (2/3) deputy principals also acknowledged that they had an acceptable usage policy. One principal agreed with the statement that there is of an acceptable usage policy at their school for staff. The other principal, one teacher and one deputy principal did not reply to this statement.

38% (9/24) teachers disagreed with the statement that there is an acceptable usage policy for staff and 46% (6/13) HOD also disagreed with this statement.

4.2.12.1   Interpretation and discussion for statement 12

All school staff members should be aware of an acceptable school network usage policy. The same diligence shown towards enforcing school computer network usage policies for students should also be enforced for their staff members.

Having one of the principals and one of the deputy principles not answer this question could be an indication that the issue of an acceptable usage policy for staff has not being addressed. The initiation and implementation of such a policy needs to come from senior management. With increased internet usage and online visibility it is important for schools to minimise liabilities from any illegal activity that staff might participate in.

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4.2.13 Response to statement 13: Teaching staff are confident to use ICT in their lessons.

Table 4.25   Table 4.26

Code	Value	Frequency	%
1	Yes	19	41%
2	No	17	37%
3	Not Sure	9	20%
4	Unanswered	1	2%
	Total	46	100%

	Yes	No	Not Sure	Unanswered	Total
Network Admin	4	0	0	0	4
Teacher	7	9	8	0	24
HOD computers	6	5	1	1	13
Deputy Principal	1	2	0	0	3
Principal	1	1	0	0	2
Total	19	17	9	1	46

Q13. Teaching staff are confident to use ICT in their lessons

	Network Admin	Teacher	HOD Computers	Deputy Principal	Principal
Unanswered	0%	0%	8%	0%	0%
Not Sure	0%	33%	8%	0%	0%
No	0%	38%	38%	67%	50%
Yes	100%	29%	46%	33%	50%

Figure 4.13

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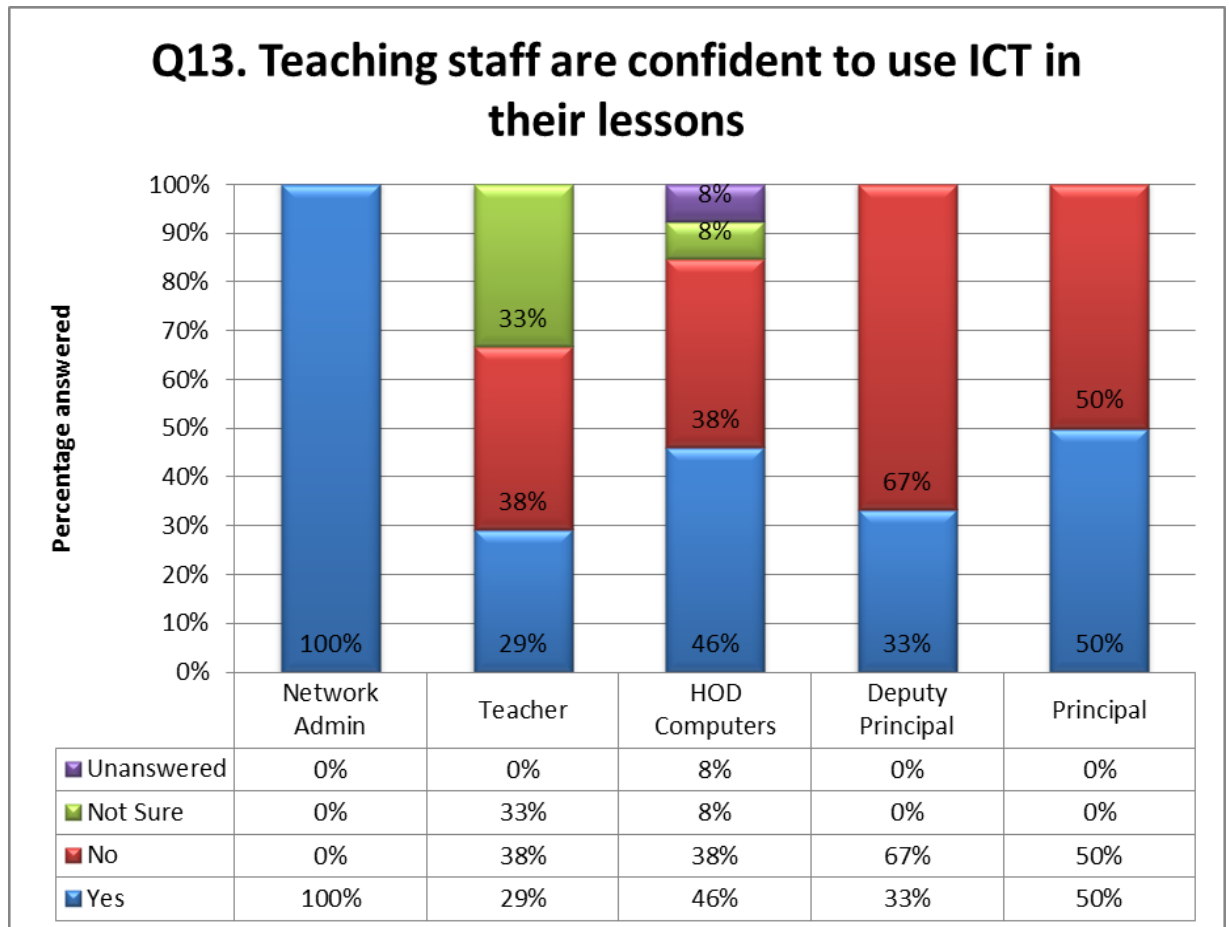
41% (19/46) of all participants agreed with the statement that teaching staff are confident to use ICT in their lessons.   37% (17/46) of all participants disagreed while 20% (9/46) were unsure whether or not teaching staff were confident to use ICT in their lessons. All four the network administrators agreed with the statement representing the highest group in agreement.   29% (7/24) of teachers, 46% (6/13) of HOD computers, 33% (1/3) deputy principals, and one of the two principals agreed with this statement. One HOD computers did not reply to this statement.

38% (9/24) of teaching staff, 38% (5/13) of HOD computers, 67% (2/3) of deputy principals and one of the two principals felt that teaching staff members are not confident to use ICT in their lessons. 33% (8/24) of the teachers and one HOD computers were unsure as to whether or not teaching staff are confident to use ICT in their lessons.

4.2.13.1   Interpretation and discussion for statement 13

The question did not distinguish between staff who make use of the schools computer network for teaching purposes, or staff members who do not make use of the school's network for teaching purposes. Staff members who for example did not have access to the school computer labs would not feel as confident to use the school network in those who make use of it on a daily basis. The low agreement from teaching staff is concerning and reveals a need for more exposure to school networks in order to improve usage of technology in teaching.

Teaching staff who often make use of computer labs would find the transition to a system where BYOD (bring your own device) are implemented easier. Although there are many factors involved, most teaching staff who are comfortable with different technologies and applications would welcome such a move at their school.

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4.3   RESPONSES TO REQUEST FOR COMMENTS

There were ten comments made from respondents for question 14 regarding IT/ICT infrastructure management.   Regarding the management of IT/ICT; Appendix M contains a summary of all the comments made by teachers, Appendix N contains the comments by HOD computers and Appendix O the comment made by a deputy principal.   In order to draw more meaning from the comments the researcher will look at all the individual data due to the valuable contribution of their comments to the research. The comments of each respondent will be discussed in conjunction with their individual responses to the twelve questions. The reason for this is to obtain a complete view of these respondents. The comments were grouped into their role at their schools, namely teachers (4.3.1 – 4.3.6), HOD computers (4.3.7 – 4.3.9) and deputy principals (4.3.10).

4.3.1   Discussion around respondent 5

Respondent 5, who is a teacher, commented: "I am the Librarian; I only manage the library system and am busy completing the ICDL course." This respondent is a teacher who makes use of the school network system during her normal day to day activities.   This school does not employ a full time network administrator nor does a teacher act as a network administrator. It is therefore not surprising that respondent 5 does not find it easy to deal with the day to day ICT/IT department issues even though hardware and software are tested before staff or learners use it.

Some of this schools' server maintenance is outsourced and all software is thoroughly checked to ensure value to teaching.   Users have a definite procedure to report IT incidents, and students are brought before disciplinary committees for computer related offences. As a librarian, it is understandable that this respondent is not sure whether he/she is happy with the way that their school network is being maintained, or whether anti-virus software is updated at least once a week on all the computers.

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Their internet isn't down more than twice a term and there is an acceptable usage policy for staff. Teaching staff are confident to use ICT in their lessons. This is a good indication that staff development in terms of using technology is being implemented at this school, which supports this teachers' statement that he/she is "…busy completing my ICDL course".

4.3.2 Discussion around respondent 11

Respondent 11 commented: "The ICT equipment and infrastructure are maintained by a part-time person who comes to the school once a week for two hours. This is hardly enough to maintain, not to mention progress, in the department."

Respondent 11 is a teacher and they do not have a full time network administrator nor is does a teacher act as a network administrator, and some of their server maintenance is outsourced. This correlates exactly with his/her comment: "The ICT equipment and infrastructure are maintained by a part time person who comes to the school once a week for two hours." Respondent 11 is unhappy with the way their schools' network is being maintained. Software is not thoroughly checked to ensure value to teaching and hardware / software is not tested before staff or learners use it. Users do not have a definite procedure to report IT incidents and there is no acceptable usage policy for staff. Furthermore, their internet is down more than twice a term and their teaching staff are not confident to use ICT in their lessons. Once again, this correlates to the statement: "This is hardly enough to maintain, not to mention progress, in the department."

Students are brought before disciplinary committees for computer related offences. Anti-virus software is being updated at least once a week on all computers; however he/she isn't sure whether it is easy to deal with the daily ICT/IT departmental issues.

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4.3.3 Discussion around respondent 24

Respondent 24, a teacher made a positive comment: "We are fortunate at our school in that we have suitably skilled individuals that can assist with network maintenance." At this school there isn't a full time on site network administrator since a teacher acts as a network administrator. None of their server maintenance is outsourced and users have a definite procedure to report IT incidents. Their students are brought before disciplinary committees for computer related offences. It is easy for this teacher to deal with the day to day ICT/IT department issues and hardware and software are tested before staff or learners use it. The internet isn't down more than twice a term.

This teacher is unsure whether or not he/she is happy with the way that the school network is being maintained, and unsure whether or not anti-virus software is updated at least once a week on all computers. Teaching staff members are not confident to use ICT in their lessons. Respondent 24 did not reply to the statement: "All new software is thoroughly checked to ensure value to teaching" neither did he/she reply to the statement: "there is an acceptable usage policy for staff." Even though there is a suitable, skilled person, who attends to the network, there are still shortcomings within the ICT/IT management structures.

4.3.4 Discussion around respondent 31

This teacher's comment focused on time management and workload: "Time to do things properly remains a constant problem." There is a possibility that this teacher is also the network administrator since he/she states that a teacher acts as a network administrator, that there isn't a full time network administrator, and that some of their server maintenance is outsourced. Due to time constraints new software isn't thoroughly checked to ensure value to teaching. It isn't easy for this teacher to deal with the day to day ICT/IT department issues and he/she isn't happy with the way the school network is being maintained. There also isn't an acceptable usage policy for staff. Despite the workload users have a definite procedure to report IT incidents.

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Hardware and software are tested before staff or learners use it, and anti-virus software is updated at least once a week on all the computers. He/she isn't sure whether students are brought before disciplinary committees for computer related offences or whether the internet is down more than twice a term. Neither is he/she convinced that teaching staff members are confident to use ICT in their lessons.

4.3.5   Discussion around respondent 35

Respondent 35, a teacher commented: "It consumes a lot of time to keep everything working, and having to teach as well does put a lot of stress on a teacher. Hardware maintenance and software support consumes huge chunks of time and some teachers who are older do not want to use ICT in their lessons which the IT teacher / administrator cannot control."

This teacher seems to be overwhelmed by the workload and the time that it takes to maintain their school computer network. From the responses of this teacher/network administrator their school network is in a very good condition as some of their server maintenance is outsourced. All new software is thoroughly checked, anti-virus software is updated at least once a week on all the computers and all hardware / software is tested before staff or learners use it and the users have a definite procedure to report IT incidents. Students are brought before disciplinary committees for computer related offences and there is an acceptable usage policy for staff. He/she is also happy with the way the network is being maintained which indicates work satisfaction, and their internet is not down more than twice a term. It is understandable that he/she isn't sure if teaching staffs are confident to use ICT in their lessons, since considerable chunks of his/her time is taken to maintain the network.

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4.3.6 Discussion around respondent 43

Respondent 43 commented: "I am the IT technician, teacher and LAN administrator." As stated in this teacher's comment, there isn't a full time network administrator at their school, and he/she takes on three roles namely IT technician, network administrator and teacher. Some of the server maintenance is outsourced, probably due to workload. He/she ensures that all new software is thoroughly checked and anti-virus software is updated at least once a week on all computers. Hardware and software are tested before staff or learners use it. Users have a definite process to report IT incidents. Students are brought before disciplinary committees for computer related offences and there is an acceptable usage policy for staff. He is happy with the way his/her network is being maintained.

This teacher isn't sure whether or not the internet is down more than twice a term or whether teaching staff members are confident to use ICT in their lessons. Importantly he/she does not find it easy to deal with the day to day ICT/IT department issues. The reason could be due to their work load.

4.3.7 Discussion around respondent 4

Respondent 4 is a HOD computers and draws attention to the financial impact of an IT infrastructure with the comment "Quite expensive." The school that this HOD Computer is at does not have a full-time network administrator and a teacher acts as the network administrator. None of this school's server maintenance is outsourced which could be due to financial constraints, as attention was drawn to the financial implications by the respondent's comment.

The network at this school appears to be in a good condition as all new software is thoroughly checked to ensure value to teaching and also because hardware and software are tested before staff or learners use it. Anti-virus software is updated at least once a week on all the computers and the internet is not often down.

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Users have a definite procedure to report IT incidents and students are brought before disciplinary committees for computer related offences although I find a paradox here as there isn't an acceptable usage policy for staff at this school. The teaching staff of this school is confident to use ICT in their lessons.

Even though this HOD Computer is happy with the way their school's network is being maintained, he/she does not find it easy to deal with the day to day ICT/IT department issues. Taking into consideration the comment made financial constraints could be the reason why it is difficult to deal with the day to day ICT/IT department issues. Having more human resources, such as a full time network administrator to take over the bulk of the workload with regards to the network maintenance could make a difference.

4.3.8   Discussion around respondent 16

This HOD computers comment "Schools are generally more inclined to spend money on hardware than human capital, especially with ICT moving from a 'lab' set-up and into the classroom," is reflecting on the movement of school networks to facilitate BYOD (bring your own device). As school networks are moving into a service provider role, more research and input from network administrators will be required. The fact that their internet is down more than twice a term is a serious stumbling block for adequate BYOD infrastructure.

Some of this school's server maintenance is outsourced and hardware and software are tested before staff or learners use it. All new software is thoroughly checked to ensure value to teaching and anti-virus software is updated at least once a week on all the computers. Users have a definite procedure to report IT incidents and students are brought before disciplinary committees for computer related offences however there do not have an acceptable usage policy for staff members. Teaching staff members are confident to use ICT in their lessons.

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Even though this school has a full-time on site network administrator and some of their server maintenance is outsourced, he/she is not happy with the way the school's network is being maintained nor does he/she find it easy to deal with the day to day ICT/IT department issues.

4.3.9   Discussion around respondent 41

The comment made my respondent 41: "We have a supportive governing body who replaces, upgrades and maintains our technology on an on-going basis," underlines the importance of senior management providing correct infrastructure support and the way it positively influences staff.

This school does not have a full-time network administrator as a teacher acts as the network administrator. Some of their server maintenance is outsourced and hardware and software are tested before staff or learners use it. Unfortunately teaching staff are not confident to use ICT in their lessons and the HOD is not sure whether all new software is thoroughly checked to ensure value to teaching,

Users do have a definite procedure to report IT incidents and students are brought before disciplinary committees for computer related offences. There is also an acceptable usage policy for staff. The HOD is happy with the way their school's network is being maintained and their internet access is reliable since it isn't down more than twice a term.   Having said this, he/she does not find it easy to deal with the day to day IT/ICT department issues.

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4.3.9   Discussion around respondent 46

Only one comment was made by a deputy principal and his/her comment highlights the importance of teaching staff being confident to use ICT in their teaching. "Some staff are very confident, others completely phobic. All have to use the network for admin, many use it for teaching"

This school has a full time on site administrator and therefore a teacher does not need to act as a network administrator. This could be part of the reason that he/she is happy with the way the school's network is being maintained and why it is easy to deal with ICT/IT departments on a day to day basis.

Some of this school's server maintenance is outsourced and the internet is seldom, if ever down during a term. All new software is thoroughly checked to ensure value to teaching and their anti-virus software is updated at least once a week on all computers.

All users have a definite procedure to report IT incidents and students are brought before disciplinary committees for computer related offences. There is also an acceptable usage policy for staff members of this school.

As this principal has such a well maintained school network, it is encouraging to see that some of the teaching staff is confident in using ICT in their teaching. From this I would infer that the principal has focused some of their time on the personal development of teaching staff on IT training.

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CHAPTER 5: FINDINGS, RECOMMENDATIONS AND SUMMARY OF STUDY

5.1   INTRODUCTION

The driving force for effective IT infrastructure management has always been students learning as well as teaching staff's functionality. IT infrastructure management is most effective when it is most invisible. The strive for invisibleness has proven to be a very challenging task for both senior management teams as well as members of staff who directly deal with their schools' computer network. Effective IT infrastructure management is defined by optimal network usage, monitoring usage, updated anti-virus software, permanent internet connection, well defined user profiles, secure data and effective updating of technologies. Job satisfaction, structured user policies, clear job descriptions, minimal staff turnover, reasonable overtime wages, competitive salaries and good work environment also define effective IT infrastructure management.

In this final chapter the researcher provides a summarised review from the analysis of the quantitative research data with regards to the important aspects of the preceding chapters. Limitations to the study are discussed and any recommendations for further studies are provided. Finally the researcher provides her personal experiences regarding this study.

5.2   LIMITATIONS TO THE STUDY

The limitations of this study were identified as features of the design or methodology that impacted or influenced the application and/or interpretation of the results of this research. They were the constraints on generalising and a utility of findings that are the result of the ways in which the researcher selected to design the study and the method used to establish internal and external validity. Planning and the use of an online survey enabled the researcher to avoid limitations such as sample size and the lack of available and reliable data. (USC University of Southern California; 2012)

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5.2.1   Measures used to collecting the data

Three requests for the online survey completion were sent out. The researcher would have preferred to only send out two requests, one to each of the two chosen mailing lists.   There was a considerable delay between the first two survey requests and the last. The reason for the delay was that permission had to be obtained from the administrator of the school mailing list.   This delay could have negatively impacted the participation in the survey.

The introduction to the online survey sent out to the WCED mailing list clearly stated that participants must be from secondary schools, however the researcher was not able to prevent participations from primary schools because the participation was anonymous. The researcher was not allowed access to the email addresses for the WCED, which would have made it possible to isolate secondary school's email addresses from primary school's email addresses. The online survey that was sent out to the WCED Computer Studies mailing list was vulnerable to private schools participating in the online survey even though this survey's introduction stated that participants must be staff members of government secondary schools in the WCED.

5.2.2   Self-reported data

The online questionnaire relied on self-reported data, and self-reported data is limited by the fact that it can rarely be independently verified. The researcher had to take the responses selected on the questionnaire at face value. One of the limitations of self-reported data is selective memory which affects participants in that they may or may not remember their experiences of events that occurred at some point in the past. Another limitation of self-reported data is telescoping or recalling events that occurred at one time as if they occurred at another time, and could not be independently verified.

Attribution or in other words the act of attributing positive events and outcomes to one's own agency but attributing negative events and outcomes to external forces might also have played a role in the way that participants

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responded to questions. (USC University of Southern California; 2012) Since empirical research was used as a means of gaining knowledge the use of empirical evidence annulled the effect of personal (subjective) experiences by the researcher. Furthermore quantitative research methodology was used as it lent itself for data to be represented statistically. This method maximized generalisation of research and also allowed the researcher to establish relationships between responses, based on the positions that respondents held at schools.

5.2.3   Web based survey

Although the researcher clearly stated that the survey was for employees of secondary schools in the WCED, the researcher had no control over who completed the questionnaire since anonymous participation was assured. Having the survey available on restricted mailing lists allowed the sample population to be reached and also reduced the possibility of participants not being in secondary schools in the WCED.

It was not possible to give assistance to participants, and the researcher had to rely on the online software to be user friendly for all participants. Incomplete questionnaires posed problems, although the number of incomplete questionnaires was considerably lower than originally anticipated. The impact of incomplete questionnaires was reduced by putting the most important questions first, and by providing participants with incentives to complete the survey.

Respondents also needed to have basic internet knowledge in order to complete the online questionnaire. If the respondents' internet connection was slow or there were constant connection problems, respondents could have become discouraged and not completed the questionnaire. This could mean that better responses from schools with well-maintained networks were received. One of the ways that the impact of slow internet connection could be minimised by participants was to use the 'save and return to survey later' option that eSurveypro made provision for.

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5.3   FINDINGS FROM THE STUDY

5.3.1   Findings with regards to the research objectives

The use of descriptive research allowed the researcher to focus on current attitudes, behaviours and characteristics of secondary schools in the WCED. Facts form the basis for generalisation and therefore the researcher needed to look at how secondary schools in the WCED manage their IT infrastructure. Once the phenomenon was described adequately, relationship questions could be addressed (McMillan & Schumacher, 2001:284).

Analysis of the data collected from the online survey concentrated on the frequency of answers. From the 46 responses to the opening question the researcher was able to categorise the respondents into their different school positions. The respondents were made up of 4 network administrators, 24 teachers, and 13 heads of department computers (HOD computers). There were also 2 principals and 3 deputy principals.

The researcher also pointed out that the demography of the participant's positions at the different schools resembles that of a single school. Therefore most of the participants were teachers (52%), then HOD computers (28%), thereafter network administrators (9%), deputy principals (7%) and finally principals (4%). In order to draw meaningful analysis, the general results of each question was examined as well as a comparison between the positions of the respondents and how their answers differed in relation to the research problems.

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5.3.1.1 Survey findings with regards to the objectives: What is the current characteristics and behaviour with regards to IT infrastructure and whether there is a need for best practice

The first objective with regards to the research aim of studying the nature/state of IT infrastructure at secondary schools in the WCED was: What is the current characteristics and behaviour with regards to IT infrastructure at secondary schools in the WCED. Statements from the online survey that were aimed at describing the current characteristics and behaviour with regards to IT infrastructure at secondary schools in the WCED were:

- We have a full time on site network administrator
- A teacher acts as a network administrator
- Some of our server maintenance is outsourced
- All new software is thoroughly checked to ensure value to teaching
- Users have a definite procedure to report IT incidents
- Hardware and software are tested before staff or learners use it
- Students are brought before disciplinary committees for computer related offences
- Antivirus software is updated at least once a week on all computers
- There is an acceptable usage policy for staff

The response to the statement: We have a full time on site network administrator, was varied and provided the basis for other questions. Altogether 41% (19/46) agreed with the statement and 59% (27/46) indicated that they did not have a full time network administrator at their school. This high number of disagreement indicates that there is a need for best practice for IT infrastructure management.

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To the statement: A teacher acts as the network administrator altogether 46% (21/46) responded yes. Such a large number of respondents, who indicated that a teacher acts as a network administrator, are alarming and underpin the urgent need for best practice at secondary schools in the WCED. One principal did not answer this question and could possibly have missed this question. However another possibility is that he/she did not want to answer the question. In either case it highlights the important role that these teachers fulfil when they are both network administrator and teacher. There are considerable financial advantages for a school having a teacher act as a network administrator which could be the reason that there are so many teachers who take on both roles.

With the statement: Some of our server maintenance is outsourced, the response proved to be considerably different between network administrators and the other respondents. 75% (3/4) of the network administrator indicated that none of their server maintenance is outsourced. At the schools where there are dedicated network administrators, server maintenance was not outsourced and 79% (19/24) of teachers agreed with this statement which is similar to the responses of HOD computers which was 77% (10/13). All three deputy principals indicated that their school's server maintenance was being outsourced. One network administrator did not know whether some of the server maintenance at his/her school is outsourced. This could be a reflection on the professional expertise level of this administrator. It was the intention of the researcher to refer to "outsourcing" as obtaining outside contractors to provide hardware and/or software maintenance on servers.

The rationale for the statement: All new software is thoroughly checked to ensure value to teaching, was to establish to what extent software roll-out at schools are tested. The high number of respondents who agreed with this statement indicates that top management in schools realise the importance of managing what software is being installed on their school network. There were 8 teachers who felt that software is not tested and this should not be ignored. Testing software is a very time consuming process and not all schools have the staff to do this task.

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Users have a definite procedure to report IT incidents, revealed a high correlation between the different respondents' in their school positions. All network administrators and deputy principals (100%) stated that there were definite procedures in place for IT incidents. This is followed closely by HOD computers where 92% (12/13) and one HOD computers who was not sure. Overall 82% of participants felt that there was a definite procedure to follow when reporting IT incidents. This is a high number and an indication that most schools had made staff aware of the procedures to follow when IT incidents occur. The initiative for reporting IT incidents usually originate from network administrators and the high number of respondents who agreed with the statement indicates that staff is aware of these procedures.

All network administrators and all principals felt that all hardware and software is tested before staff or learners can utilise it. This view is however not shared by all participants. The responses of teacher, HOD computers, and deputy principal's correspond to within 10% of each other. 71% (17/24) of teachers, 77% (10/13) of HOD computers, and 67% (2/3) of deputy principals stated that hardware and software are tested before staff or learners use it. Installing software is time consuming and maintaining IT infrastructure is expensive which could be the driving force for ensuring that all hardware and software is tested before use. Schools need to make 100% sure that they have the right product before they purchase it, otherwise it would result in funds being wasted. This would also result in delays before correct hardware and suitable software is purchased.

Overall a high number (74%) of participants agreed with the statement that students are brought before disciplinary committees at their school. Of these results the highest agreement with this statement was 100% by the two principals and 100% by the three deputy principals. Some network administrators, teachers, and HOD computers disagreed and the greatest disagreement came from HOD computers namely 31% (4/13) followed by 25% (1/4) network administrators. In order for a schools' computer network to be effective, the students need to know that they will be held responsible in how they use their schools network. With social media becoming more and more

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intertwined with school life, active awareness campaigns need to be initiated within schools.

A very high number of respondents 80% (37/46) agreed with the statement that anti-virus software is updated at least once a week on all computers. Only 13% (6/46) disagreed with this statement, and 7% (3/46) were unsure whether anti-virus software was updated at least once a week on all computers. The updating of anti-virus software is critical for the maintaining of an effective network. Network administrators fully understand that the negligence of anti-virus software updates could result in considerable time wasted in solving virus related problems and infections. Updating anti-virus software and staying prepared for any network security issues demands substantial time in order to ensure optimal network performance.

All four the network administrators agreed with the statement that there is an acceptable usage policy for staff at their schools while 54% (13/24) teachers, 54% (7/13) HOD computers and 67% (2/3) deputy principals agreed. It is imperative that all school staff members should be aware of an acceptable school network usage policy. The same diligence shown towards enforcing school computer network usage policies on students should be enforced for staff members. Having one of the principals and one of the deputy principles not answer this question could be an indication that the issue of an acceptable usage policy for staff has not being addressed. The initiation and implementation of such a policy needs to come from senior management. With increased internet usage and online visibility it is important for schools to minimise liabilities from any illegal activity that staff may participate in.

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5.3.1.2 Findings from comments regarding the objective: What is the current characteristics and behaviour with regards to IT infrastructure and whether there is a need for best practice

Respondent 24, made a positive comment: "We are fortunate at our school in that we have suitably skilled individuals that can assist with network maintenance." At this school they do not have a full time on site network administrator since a teacher acts as a network administrator. None of their server maintenance is outsourced and users have a definite procedure to report IT incidents, and students are brought before disciplinary committees for computer related offences. It is easy for this teacher to deal with the day to day ICT/IT department issues and hardware and software are tested before staff or learners use it. The internet isn't down more than twice a term. However this teacher isn't sure whether or not he/she is happy with the way that the school network is being maintained. This respondent realises the importance of having a skilled person manage their network.

Participant 31 commented on time management and workload: "Time to do things properly remains a constant problem." There is a possibility that this teacher is also the network administrator since he/she states that a teacher acts as a network administrator, there isn't a full time network administrator, and some of their server maintenance is outsourced. Due to time constraints new software isn't thoroughly checked to ensure value to teaching and they do not have an acceptable usage policy for staff. It cannot be easy for this teacher to deal with the day to day ICT/IT department issues and he/she isn't happy with the way the school network is being maintained.

Respondent 35, a teacher commented: "It consumes a lot of time to keep everything working, and having to teach as well does put a lot of stress on a teacher. Hardware maintenance and software support consumes huge chunks of time and some teachers who are older do not want to use ICT in their lessons which the IT teacher / administrator cannot control." This respondent is overwhelmed by the workload and the time that it takes to maintain their school computer network. From the responses of this

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teacher/network administrator their school network is in a very good condition. Some of their server maintenance is outsourced and all new software is thoroughly checked. Users have a definite procedure to report IT incidents, hardware and software are tested before staff or learners use it. Students are brought before disciplinary committees for computer related offences, and the internet isn't down more than twice a term. Anti-virus software is updated at least once a week on all the computers and there is an acceptable usage policy for staff. He/she is also happy with the way the network is being maintained which indicates work satisfaction.

Respondent 43 commented: "I am the IT technician, Teacher and LAN Administrator" As stated in this teacher's comment, there isn't a full time network administrator at their school, and he/she takes on three roles namely IT technician, network administrator and teacher. Understandably some of the server maintenance is outsourced. He/she ensures that all new software is thoroughly checked and anti-virus software is updated at least once a week on all computers. Users have a definite process to report IT incidents and their hardware and software are tested before staff or learners use it. Students are brought before disciplinary committees for computer related offences and there is an acceptable usage policy for staff. He is happy with the way his/her network is being maintained. This teacher isn't sure whether or not the internet is down more than twice a term or whether teaching staff members are confident in using ICT in their lessons. Importantly he/she does not find it easy to deal with the day to day ICT/IT department issues and this could therefore be due to the work load.

Attention is drawn to the financial impact of an IT infrastructure with respondent 4 commenting: "Quite expensive." The school that this HOD computers is at does not have a full-time network administrator as a teacher assumes the role of the network administrator. None of this school's server maintenance is outsourced which could be due to financial constraints. This could be interpreted as the reason why he/she is finding it difficult to deal with the day to day ICT/IT departmental issues. Having more human resources,

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such as a full time network administrator to take over the bulk of the workload with regards to the network maintenance could make a significant difference.

The HOD computers comments "Schools are generally more inclined to spend money on hardware than human capital, especially with ICT moving from a 'lab' set-up and into the 'classroom' is reflecting on the movement of school networks to facilitate BYOD (bring your own device). As school networks are moving into a service provider role, much more research and input from network administrators will be required. This school does not having reliable internet access due to the fact that their internet is down more than twice a term and this is a serious stumbling block for adequate BYOD infrastructure. Even though this school has a full-time on site network administrator and some of their server maintenance is outsourced, he/she isn't happy with the way the school's network is being maintained, and neither does he/she find it easy to deal with the day to day ICT/IT department issues.

The comment made by respondent 41: "We have a supportive governing body who replace, upgrade and maintain our technology on an on-going basis," underlines the importance of senior management providing correct infrastructure support and the way it positively influences staff.

The comments made by respondents reinforce the need for standardise guidelines in order to reduce stress that staff experience with regards to ICT/IT issues. Issues that best practice would address are work load, work allocation and time management.

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5.3.1.3 Findings from survey statements and comments with regards to the objective: staff's experience with regards to IT infrastructures and whether there is a need for best practice

These findings concentrate on whether staff members are experiencing any problems with regards to IT infrastructure at secondary schools in the WCED and if so what were these problems. The presence of problems would therefore point to a need for guidelines regarding best practice.

Statements that were taken into consideration where:

- It is easy to deal with the day to day ICT/IT department issues.
- I am happy with the way our school network is being maintained
- Internet is down more than twice a term
- Teaching staff are confident to use ICT in their lessons

Although it appears as if there is a high number of participants who agree with the statement that it is easy to deal with the day to day ICT/IT department issues, comments with regards to ICT/IT infrastructure also needs to be kept in mind. 52% (24/46) of the participants agreed, 39% (18/46) disagreed, and 9% (4/46) were unsure. Network administrators had the highest agreement with the statement while 38% (9/24) teachers disagreed and the remaining 13% (3/24) were unsure on whether or not it was easy to deal with the day to day ICT/IT department issues. HOD computers were almost evenly split on whether they agree or disagree while 67% (2/3) of the deputy principals agreed with the statement and the remaining principal (33%) disagreed. 39% (18/46) of all the respondents who disagreed were teachers, HOD computers, deputy principals and principals. The reason for this can range from hardware to software, security issues and implementation of protocols. More and more attention is given to the use of social media sites from top management since it influences school matters. The fact that there were staff members who felt unhappy with the way their IT department is functioning points to the need for standardise guidelines to minimise dissatisfaction among staff members.

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To the statement: I am happy with the way our school network is being maintained, 59% of participants agreed with, 30% disagreed and 11% were unsure. All network administrators indicated that they were happy with the way that their school networks were being maintained. This high level of agreement was not shared by everyone, since 38% (9/24) of the teachers, 23% (3/13) of HOD computers, 33% (1/3) deputy principals, disagreed. Only 46% (11/24) of the teachers felt that they were happy with their schools network. The majority of network users did not agree with the network administrator. This question reflects on the work quality that network administrators deliver and all users of school computer networks showed varying degrees of dissatisfaction. Teachers who act as network administrators are not able to keep up with all the demands that an effective network requires and this can also lead to maintenance problems.

37% of participants agreed with the statement that the internet is down more than twice a term indicating that school networks are not as reliable as one would expect. 52% (24/46) disagreed with this statement and 9% (4/46) were not sure whether or not the internet was down more than twice a term. Unreliable access to the internet is an indication that a schools network is not functioning effectively for all teaching purposes. The 42% (10/24) of teachers who disagreed with the statement is noteworthy. More and more teachers rely on accessing the internet in order to accomplish the required teaching outcomes. Teachers feel frustrated when the internet isn't accessible and there could be many reasons why internet access at schools is unreliable. Problems with the internet service provider can also contribute to unreliable internet access.

All four the network administrators agreed with the statement: Teaching staff were confident to use ICT in their lessons which represented the highest number in agreement. 29% (7/24) of teachers, 46% (6/13) of HOD computers, 33% (1/3) deputy principals, and one of the two principals also agreed. The question did not distinguish between staff who made use of the schools computer network for teaching purposes, and those who do not make use of it. Staff members who may not have had access to the school computer labs

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would not feel as confident as those who use the school network on a daily basis. Teaching staff who often make use of computers would find the transition to a system where BYOD (bring your own device) are implemented easier. Although there are many factors involved, most teaching staff who are comfortable with different technologies and applications would welcome such a move at their school.

The comments from a teacher and deputy principal were taken into consideration for staff member's experience regarding IT infrastructure and whether there is a need for best practice guidelines.   Comments by respondent 5 were: "I am the Librarian; I only manage the Library system and am busy completing the ICDL course." This teacher makes use of the school network system during her normal day to day activities. They do not have a full time network administrator at this school and a teacher does not act as a network administrator and it is therefore not surprising that respondent 5 does not find it easy to deal with the day to day ICT/IT department issues even though their hardware and software has been 'tested' before staff or learners use it. The fact that a school network user is experiencing difficulties and there isn't a full time network administrator at this school points to the need for best practice.

Respondent 11 has neither a full time network administrator nor a teacher acting as a network administrator, and some of their server maintenance is outsourced. This correlates with his/her comment: "The ICT equipment and infrastructure are maintained by a part time person who comes to the school once a week for two hours."   Respondent 11 isn't happy with the way his/her schools network is being maintained.   The users don't have a definite procedure to report IT incidents and their hardware or software isn't tested before staff or learners use it. Software isn't thoroughly checked before use to ensure value to teaching and furthermore the internet connection fails more than twice a term. There isn't an acceptable usage policy for staff nor are teaching staff confident to use ICT in their lessons. It is clear that the lack of having a dedicated person to manage the IT infrastructure is leading to frustrations and stress.

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The comment made by the deputy principal highlights the importance of teaching staff being confident to use ICT in their teaching. "Some staff are very confident, others completely phobic. All have to use the network for admin, many use it for teaching." This school has a full time on site administrator and therefore a teacher does not need to fulfil this role. This could be part of the reason why he/she is content with the way the schools' network is being maintained and why it is easy to deal with the day to day ICT/IT departments. Some of this schools' server maintenance is outsourced and the internet is seldom, if ever down during a term. All new software is thoroughly checked to ensure value to teaching and anti-virus software is updated at least once a week on all computers. There is also an acceptable usage policy for staff members of this school and users have a definite procedure to report IT incidents. Students are brought before disciplinary committees for computer related offences. It is encouraging to see that this principal can focus most of his attention on personal development of teaching staff because he/she has such a well maintained school network.

It is clear that staff members are experiencing stress when it comes to dealing with their schools ICT/IT department. Once again having an invisible network would result in less stressful environment. Standardise guidelines would make it easier for management to avoid any pitfalls associated with IT infrastructure management.

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5.3.6   Conclusion

This research focused on evaluating IT infrastructure management at secondary schools in the WCED, identifying problem areas within IT infrastructure management and to determine if there is a need for best practice guidelines and discovering where these guidelines can be found.

Both literature review and research revealed that the management of IT infrastructure at secondary schools within the WCED differs widely from school to school, and its functionality depends on many factors. Once the full scope of IT infrastructure was defined problem areas were identified. These included if there was a full time network administrator at a school, structures, work load, and stress. The literature review also looked at how effective IT infrastructure can be managed which includes; the licensing of software, policies, security, staff management and BYOD (bring your own device).

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5.4 RECOMMENDATIONS FROM THE STUDY

5.4.1 Recommendation with regards to conceptualising the management of an IT infrastructure

Basic requirements with regards to components set out for practical examination for the subjects Computer Application Technology (CAT) and Information Technology (IT) was the departure point for the planning and maintenance of an IT infrastructure at secondary schools in the WCED. Five basic components namely: hardware, software, data, procedures, and people were discussed and the researcher emphasised that failure in any of these five basic components would mean that technology would become visible. Visible IT infrastructure means that the users become aware of it because it is not working effectively. Factors that can lead to IT infrastructure becoming visible are poor leadership, inadequate computer infrastructure, and a lack of technical support. Therefore planning the IT infrastructure should be an ongoing process and the allure of an easy methodology should be avoided. When acquiring software or hardware schools need to consider open standards since it would affect compatibility. Examples of products that schools need to choose from are Microsoft or Apple products.

Outsourcing tasks to companies, and the roles that these companies play in a schools' infrastructure needs to be carefully considered. Often outsourcing failures are caused by a misalignment between the schools need and the outsource service agreement of the related management plan. External perspectives and expertise are important in ensuring that a school is acquiring a healthy IT infrastructure.

Budgets need to be well planned to ensure that the implementation of new hardware and software are adequately supported. Users need assistance with installation of software, data and program recovery, maintenance of security measures and also training. Budget planning must span over three years which should be updated annually (Spencer & Johnston, 2003: 149; Wierschen & Ginther, 2002: 57). The budget must include labour fees, hardware, networks and internet connection, software and the maintenance costs of hardware items such as PC's (Wierschen and Ginther, 2002:57). Furthermore it should also

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include anticipated expansion, upgrading applications and targeting areas where future training will be needed (Spencer & Johnston, 2003: 149).

When going into a contract with a vendor the schools' management team must build a relationship with the vendor in order to improve service delivery as contracts can easily become impersonal. Many IT activities centre on purchasing, maintenance, licensing, and infrastructure support. It is important to centralise these activities in order to minimise cost. By insisting on a master agreement for the entire school, inconsistencies can be avoided. A principal can ask for a list of customers similar to their school, who have terminated their relationship with the vendor during the past three to five years. By comparing the vendor's explanation of the circumstances to the explanations of former customers can reveal a great deal about a company. Principals need to let vendors know that his/her opinion has credence within the community. A vendor, who understands the structure and needs of a school, is more able to assist the school in implementing the correct hardware and software. One way to get vendors involved is to set up meetings between all staff involved and the vendor themselves. Vendor scorecards can also be implemented in order to establish the quality of service delivery for different vendors, which will assist management teams in getting the right vendor for their school and continued effective maintenance.

Avoiding internal and external network security problems before they occur are standard procedures as this will lessen the time that network administrators spend on network threats. Policies and procedures need to be in place before students are encouraged to experiment with new technologies such as incorporating social media within their study. Acceptable usage policies that apply to both students and staff should define the use of hardware, software, copyright and communication equipment. Procedures should also be created to prevent the use of pirated software and an acceptable usage policy should be implemented regarding discriminatory activity, harassment and distribution of offensive material.

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Having good systems in place for staff will free principals from managing user profiles. Good systems include corporate vision, objectives, values and standards. The researcher looked at the requirements of a good network administrator and what some of the pitfalls are so that they could be avoided when employing a network administrator or technician. The widening gap between the needs of employees and management can be caused by job mismatch, lack of support or feedback, lack of growth or advancement, favouritism, overwork and stress and also the loss of confidence in leadership.

Some work can only be done after hours and arrangements need to be made for overtime either financially or with time off work. Managers need to look at what are reasonable expectations to solve the problem of overworking IT staff members. A good working environment with reasonable time demands and clear policies allow for legal obligations to be met and expectations to be managed, thereby reducing IT staff stress and turnover. IT staff members also need more client-orientated skills regarding their communication with students and staff and this is becoming an important facet of the IT helpdesk.

There is a current drive for students and staff member to make use of BYOD (bring your own device). A few schools allow and encourage this however it seems that BYOD policies place more strain on network infrastructure and more resistance from network administrators because of the complexity of BYOD systems. To adapt to this change, planning, training and resources are required. The incorporation of cloud computing allows whole communities to publish, present and share information. Devices should not be able to connect solely in response to a specific situation or problem, without considering wider or longer-term learning goals.

Teachers should be encouraged to make use of Google tools and social media to further the learning experience of students. Planning for BYOD should be implemented to allow effective integration of these devices.

The study further looked at the question: Are there sources for standardised guidelines or best practice for an IT infrastructure management at secondary schools in the WCED? The answer to this is the FITS foundation (Framework for

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ICT Technical Support) situated in Great Britain. Their framework is an adaptation from the business world's ITIL (IT Infrastructure Library) framework. Their aims are to provide a resource for senior leaders and practitioners in the education sector, to spearhead the professionalisation of the ICT workforce in the Education sector, to improve the quality of ICT technical support services through the use of a structured service delivery framework and to have a positive impact on teaching and learning experiences and outcomes." (ITIL: 2012)

FITS is most effective in schools where there is a close working relationship between technicians and senior management. Thorough planning is also essential, since a technician needs to have a good understanding of the overall scope of FITS before implementation can start. Enough time must be made available since it can take anything between six months and a year to implement all of the FITS processes successfully. The challenge of introducing a new system to users can be overcome by having a formal launch of FITS. Forming a FITS support group with other schools will enable the sharing of skills and mutual experiences.

There are two main sources for best practice IT infrastructure management. Firstly the ITIL framework that businesses which focus on the evaluation and improvement of IT service delivery but which is unrefined in terms of the specific needs within the education sector. This framework takes into consideration the perspective of both the business and the customers.

Secondly the FITS foundation framework which focuses on school's IT infrastructure management. One of their aims is to provide help for leaders and practitioners in the education sector and lead the way for professionalisation of the ICT workforce in the education sector. They also strive to improve the quality of ICT technical support services through the use of a structured service delivery framework (Greenfield, 2012).

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5.4.2 Recommendation with regards to the research

Recommendations from the literature review and the quantitative research will be given below. The literature review was undertaken for the duration of the study. The quantitative research consisted of an online survey that was made available on two restricted mailing lists of the WCED namely the Computer Studies mailing list and the schools of the WCED mailing list. Recommendations with regards to the quantitative research are aimed at improving IT infrastructures at schools.

5.4.2.1 Employment of a full time network administrators

The first recommendation is for the senior management at secondary schools in the WCED to employ a full time network administrator at their schools. Support for this recommendation is based on the high number of respondents (59%) who indicated that they did not have a full time network administrator as well as the 46% of respondents who indicated that a teacher acts as a network administrator. This recommendation is further supported by comments made by participants such as: "The ICT equipment and infrastructure are maintained by a part time person who comes to the school once a week for two hours. This is hardly enough to maintain not to mention progress the department" and "Time to do things properly remains a constant problem."

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5.4.2.2   Implementation of best practice IT infrastructure management

54% (7/13) of the HOD computers did not find it easy to deal with the day to day IT department issues. This indicates a need for the availability for best practice guidelines for IT infrastructure management.

38% (9/24) of the teachers, 23% (3/13) of HOD computers, 33% (1/3) deputy principals, and 1 of the 2 principals disagreed with the statement that they were happy with the way that their school network was being maintained. These results reflect on the quality of work that network administrators deliver. All users of school computer networks also revealed varying degrees of dissatisfaction with the way that their schools network were being maintained.

Comments made by HOD computers such as "Schools are generally more inclined to spend money on hardware than human capital, especially with ICT moving from a 'lab' set-up and into the classroom" reflects on a need for best practice guidelines. These frameworks can be similar to ITIL (Information Technology Infrastructure Library) that have been successfully developed and implemented by the business environment. In the United Kingdom the FITS foundation (Framework for ICT Technical Support) developed such a framework providing school management teams with best practice guidelines.

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5.5   RECOMMENDATIONS FOR FUTURE STUDIES

With regards to the recommendation that secondary schools in the WCED employ full time network administrators, further research needs to be done to resolve how this can be accomplished. This can include looking at alternative solutions such as the sharing of a network administrator between two adjacent schools, or having department employed network administrators for some schools in the WCED who meet pre-set requirements, such as supporting low socio economic communities.

The advantages for students and staff members to use BYOD (bring your own device) has made it critical for schools to look at the implementation of BYOD infrastructure. A few schools allow and encourage this however it seems that BYOD policies place more strain and resistance on network infrastructure because of the complexity, change, work, planning and resources required to connect and incorporate these devices. Devices should not connect solely in response to a specific situation or problem, without considering wider or long-term learning goals. The incorporation of cloud computing is another useful system, that can have whole communities publish present and share information. Teachers should be encouraged to use Google tools and social media to further the learning experience of students. Planning for BYOD should allow for effective implementation at schools. Further research is needed to effectively implement and maintain BYOD at secondary schools in the WCED. A high percentage of schools outsource their schools' server maintenance which suggests that server maintenance is one factor that has high financial implications for schools.

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5.6   SUMMARY OF THE STUDY

The aim of this section is to provide a summary of the research dissertation. This section will also link the research sub-problems with findings and recommendations from the study. Each chapter focused on the main aims of the study namely to describe IT infrastructure management at secondary schools in the WCED and then to identify problem areas within IT infrastructure management. Further investigation on the possible need for best practice guidelines was undertaken, and also where these guidelines could be found.

Chapter 1 introduced the background to the study that included the concepts of IT infrastructure management. The main research problem for this study was formulated as follows:

How are secondary schools in the WCED managing their IT infrastructure?

This lead to the following four sub-questions:

- What is the current nature/state of IT infrastructure at secondary schools in the WCED?
- What are the problematic areas of IT infrastructure at secondary schools in the WCED?
- Is there a need for standardised guidelines (best practice) for the effective management of IT infrastructure at secondary schools in the WCED?

From the research problem the following aims were identified:

- To examine/study/investigate the nature/state of IT infrastructure at secondary school in WCED.
- To identify some of the problem areas in IT infrastructure at secondary schools in the WCED.
- To identify whether there is a need for standardised guidelines (best practice) for the effective management of IT infrastructures at secondary schools in the WCED.

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With regards to examining the nature/state of IT infrastructure at secondary schools within the WCED the following objectives were formulated:

- o What is the current characteristics and behaviour with regards to IT infrastructure at secondary schools in the WCED
- o What are staff's experience with regards to IT infrastructures at secondary schools in the WCED

The objectives of identifying some of the problem areas in IT infrastructure at secondary schools in the WCED were as follows:

- o Are there any problem areas with regards to current characteristics and behaviour with IT infrastructure at secondary schools in the WCED
- o Are there any problems that staff experience with regards to IT infrastructures at secondary schools in the WCED, and if so what are these problems

The third research aim, namely to determine whether there is a need for standard guidelines (best practice) with regards to IT infrastructure management at secondary schools in the WCED would depend on whether there are any problem areas within IT infrastructures at secondary schools in the WCED. Therefore the research objectives with regards to the need for standard guidelines (best practice) within IT infrastructure management at secondary schools in the WCED were as follows:

- o Is there a need for standardise guidelines(best practice) with regards to current characteristics and behaviour with IT infrastructure at secondary schools in the WCED
- o Is there a need for standardise guidelines (best practice) with regards to problems that staff experience with IT infrastructures at secondary schools in the WCED

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Chapter 2 conceptualised the management of an IT infrastructure and dealt with all the sub problems. Problem areas and possible solutions to these problems were discussed. The literature was mostly in relation to universities and businesses but it must be noted that the literature available on this subject specifically orientated towards secondary education was sparse. With this in mind Chapter 2 revealed how an effective institution would be managed. This highlighted the goal of invisibleness, planning, open standards, outsourcing, budgeting, policies and procedures. The literature review also identified important aspects such as licensing software, copyrighted material, security, staff management, and BYOD (bring your own device) implementation. Chapter 2 also provided a source for guidelines and best practice for IT infrastructure management within a school environment.

Chapter 3 explained and motivated the research methodology. This included the research approach, the population sampling, instrumentation for data collection and the interpretation of the data. How the research data and raw data were used was also provided. This included the raw data from the different online surveys and how they were prepared for analysis. The research design and methodology highlighted the researchers' care in data collection procedures in order to answer the research questions. Credibility was obtained through results that approximated reality and that are dependable and reasonable. The researcher explained that incentives were used to increase questionnaire completion.

Chapter 4 provided the quantitative analysis, interpretation and discussion of all the results from the online survey. Findings with regards to network stability, policies, maintenance, security, and job satisfaction were discussed. The responses concerning the above were compared among technicians, network administrators, teachers, HOD computers, principals and deputy principals and the agreements between the different roles were discussed. This chapter included diagrams and charts to illustrate the findings.

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In chapter 5, the findings were revealed and recommendations were made. This included the structure of IT infrastructure management at secondary schools in the WCED. This chapter also included the discussion on the need for best practice guidelines with regards to IT infrastructure management and where such guidelines can be found.

It was the aim of the researcher to describe characteristics of IT infrastructure management and highlight problem areas to aid school policy making, decision making and to justify decisions between alternatives within the realm of IT infrastructure management.

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5.6.1 Summary of findings and recommendation with regards to conceptualising the management of an IT infrastructure

Encompassing all factors, IT infrastructure must remain invisible, meaning that technology is no longer an end in itself, but rather a means for obtaining other goals. The factors that create a visible IT infrastructure are poor leadership, inadequate infrastructure and technical support. These factors need to be addressed as reflected by Van Wyk in his blog e4Africa (2012:1).

Management needs to pay close attention to accurately aligning the schools' needs to that of the companies that they outsource tasks too. As a rule schools should have full control over issues that directly affect its daily running, but it often makes sense to leave non critical issues to others. (Long, 2000:42).

A strong relationship with vendors will result in better service delivery. A vendor who understands the structure and needs of a school is in a much better position to help that school implement the right hardware and software solutions. One way to get vendors involved is to set up meetings between all school staff involved with IT infrastructure and the vendor themselves. Vendor scorecards can also be implemented in order to establish the quality of service delivery for different vendors, which will assist management teams in getting the right vendor for their school. Centralising all orders can also result in money saved. Kossuth and Ballman (2004:39) state that there must be good inter-departmental communication. If the administration department order their printer cartridges independently from the IT department, vendors can charge different prices even though these printers might all be the same model. By insisting on a master agreement for the entire school these inconsistencies can be avoided.

Internal and external network security problems require standard procedures to avoid network administrators spending considerable time on network threats. Developing an IT policy is a significant undertaking and needs resources that are dedicated to the entire process, from the definition of requirements through to the application of policy and real-life cases. Schools

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that do not make this policy a part of the day-to-day IT procedures, will find it difficult to meet the challenges that they will potentially face under high pressure and media scrutiny (Wada & King, 2001:14). Policies and procedures need to be in place before students are encouraged to experiment with new technologies and incorporating social media within their study. Acceptable usage policies should be in place for staff as well as students and should define the use of hardware, software, copyright and communication equipment. Provision should also be made for the prevention of using pirated software, discriminatory activity, harassment and displaying and or distribution of offensive material.

Management needs to have good systems in place for staff in order to free principals from managing personalities. According to Soteros (2008: 1) managers need to realise: "You are responsible and accountable for your staff's productivity, actions, and behaviour." Good systems include corporate vision, objectives, values and standards. The widening gap caused by job mismatch, lack of support or feedback, lack of growth or advancement, favouritism, overwork, loss of confidence in leadership, and stress between the needs of employees and management needs must be bridged. Considerable amounts of work can only be done after-hours and arrangements need to be made for overtime either financially or time off. Managers need to look at what are reasonable expectations to solve the problem of overworking IT staff members. A good working environment with reasonable time demands and clear policies allow for legal obligations to be met and expectations to be managed thereby reducing IT staff stress and turnover. IT staff members also need more client orientated skills to effectively communicate with students and staff members.

Schools should look at the IT infrastructure frameworks that business use such as ITIL which focus on the evaluation and improvement of IT service delivery. This framework takes into consideration the perspective of both the business and the customers.

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Cartlige (2007: 9) states some of the advantages of ITIL are:

∗ Increased user and customer satisfaction with IT services

∗ Improved service availability, directly leading to increased business profits and revenue

∗ Financial savings from reduced rework, lost time, improved resource management and usage

∗ Improved time to market for new products and services

∗ Improved decision making and optimized risk.

Organisations such as FITS (Framework for ICT Technical Support) provide a customised framework for schools to effectively manage their IT infrastructure. According to Trevor Greenfield CEO of the FITS Foundation (2011:1) their aims are:

• To provide a resource for senior leaders and practitioners in the education sector

• To spearhead the professionalisation of the ICT workforce in the education sector

• To improve the quality of ICT technical support services through the use of a structured service delivery framework

• To have a positive impact on teaching and learning experiences and outcomes" (Greenfield)

Furthermore the accreditation for all those involved in ICT technical support in education would allow for the standardisation of IT infrastructure management at school. For example FITS have two levels of accreditation which have been registered with the Qualifications and Credit Framework (QCF) in Great Britain. They are SQA Level 3 Certificate in ICT Support in Education for Practitioners (QCF) and SQA Level 4 Certificate in ICT Support in Education for Managers (QCF). The WCED can look at forming partnerships in order to have an accreditation framework for network administrators and technicians.

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5.6.1.1 Research sub-questions: What is the current nature/state of IT infrastructure at secondary schools in the WCED?

This research question was addressed in both the literature review as well as in the quantitative study. Chapter 2 looked at the building blocks of an IT infrastructure ranging from hardware, software, data, procedures, network security, vendor contracting, BYOD, work environment and outsourcing.

From the results of the quantitative study the researcher formulated a description of IT infrastructure management which included attitudes, behaviours and characteristics within secondary schools within the WCED. The first question of the online survey identified the role that each participant fulfilled at their school. Results revealed that schools either had a full time network administrator or a teacher that acted in the capacity of a full time network administrator. Other IT infrastructure management frameworks that were dealt with included server maintenance, hardware/software deployment, protocols, policies and policy enforcement, job satisfaction, network security, and the effective use of ICT in teaching.

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5.6.1.2 Research sub-question: What are the problematic areas of IT infrastructure at secondary schools in the WCED?

From the literature review problem areas within the management of IT infrastructure was identified. The researcher emphasised that failure in any of the five basic components namely: hardware, software, data, procedures, and people would mean that technology would become problematic. Planning for IT infrastructure management needs to be an ongoing process to avoid the trap of an easy methodology. Many IT activities centre on purchasing, maintenance, licensing, and infrastructure support and by not having these activities centralised can result in increased running costs. Avoiding internal and external network security problems and spending time on network threats before they occur should be standard procedures and network administrators. Acceptable usage policies that apply to both students and staff should define the use of hardware, software, copyright and communication equipment. Problems arise when good systems such as corporate vision, objectives, values and standards are not in place. The researcher examined what requirements to look for when employing a network administrator or technician.

Problems arise when the needs of employees are not met. This occurs when management creates a job mismatch, lack of support or feedback, lack of growth or advancement, favouritism, overwork, loss of confidence in leadership and stress. Some work can only be done after hours and arrangements need to be made for overtime either financially or with time off work. Managers need to look at what reasonable expectations can be made to solve the problem of overworking IT staff members. A good working environment with reasonable time demands and clear policies allow for legal obligations to be met and expectations to be managed and thereby reducing IT staff stress and turnover. The importance for IT staff members to have more client orientated skills regarding their communication with students and with staff is highlighted.

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Another problem area that needs to be addressed is the drive for students and staff member to make use of BYOD. A few schools allow and encourage this however it seems that BYOD policies place strain on network infrastructure and resistance from network administrators because of the complexity of BYOD systems. To adapt to this change, planning, training and resources are required. The incorporation of cloud computing allows whole communities to publish, present and share information.

Quantitative research highlighted the problem areas within the IT infrastructure management. Overall the high number of respondents (59%) that did not have a full time network administrator at their school is a reason for concern. Furthermore 45% of respondents had a teacher act as a network administrator which could be an underlying cause for many of the problems that schools have. For other statements the lack of agreement between different roles within schools are also a cause for concern. Most of the agreement with positive statements was from network administrators while most disagreement with positive statements was from teachers and HOD computers. This disagreement is problematic since it highlights inconsistencies of different participant's experiences. An example of this is the testing of software. All network administrators and all principals felt that hardware and software is tested before staff or learners can utilise it. This view is however not shared by teachers, HOD computers and deputy principals. 39% of participants did not find it easy to deal with the day to day ICT/IT department issues. 30% of participants were not happy with the way that their schools network was being maintained. The fact that internet at many schools is down also indicates that these schools cannot function at optimum strength.

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5.6.1.3 Research sub-question: Is there a need for standardised guidelines (best practice) for the effective management of IT infrastructure at secondary schools in the WCED?

The response to the statement: We have a full time on site network administrator, was varied and provided the basis for other questions. Altogether 41% (19/46) responded yes and 59% (27/46) indicated that they did not have a full time network administrator at their school. This high disagreement to the statement suggests that there _is_ a need for best practice of IT infrastructure management.

To the statement: A teacher acts as the network administrator altogether 46% (21/46) responded yes. Such a large number of respondents, who indicate that a teacher acts as a network administrator, are alarming and also underline a need for best practice at secondary schools in the WCED. Comments such as "Time to do things properly remains a constant problem" and "It consumes a lot of time to keep everything working and having to teach as well does put a lot of stress son a teacher" indicate that best practice implementation with regards to workload and time management is needed.

5.7 Personal experience

This research was born out of the frustrations for the lack of IT infrastructure management. This suggested an urgent need for best practice guidelines. Casual observations lead to the embarking of an amazing research journey. There were two pivotal points during this study. Firstly the discovery of ITIL made me realise that businesses have been making use of best practice frameworks for a long time. These findings also lead to the FITS foundation, which have taken the ITIL framework and adapted it to the education industry, and specifically to schools.

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5.7.   CONCLUSION

This research conceptualises the nature/state of IT infrastructure management at secondary schools in the WCED and the effective management thereof. This included whether or not secondary schools in the WCED make use of a full time, on-site network administrator or whether a teacher acts as on-site network administrator. This research also looked at network security, internet availability, job satisfaction and the implementation of computer usage policies. Problem areas within IT infrastructure management at secondary schools in the WCED were identified. The need for best practice guidelines with regards to IT infrastructure management was determined in order to improve service delivery. Sources for best practice IT infrastructure management were also provided.

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CHAPTER 6: REFERENCE LIST

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CHAPTER 7:   APPENDICES
Appendix A: Pilot Survey

IT infrastructure management and Best Practices 1
Answers marked with a * are required.

1. Basic information

Hi, my name is Karina Perkins. I am out to answer the question:

"Is there a need for best practice ICT/IT infrastructure management at schools?"

How will this survey benefit you? Each school who participates in the survey will be eligible to receive 10% membership discount from FITS (Framework for ICT technical Support http://www.thefitsfoundation.org). Who is FITS? FITS is a UK non profit organization that specialises in ICT/IT school service management frameworks. Your individual response will remain confidential.

Time frame: 5 minutes

Any questions or feedback can be emailed to: manageSchool.IT@gmail.com

1. Which of the following roles best describe your position at your school? *
◎ IT Technician
◎ Network Administrator
◎ Teacher
◎ Head of Department Computers
◎ Deputy Principal
◎ Principal
  Reset

I am interested in claiming the 10% discount for FITS membership. Yes/No

1.   We have a full time on site network administrator.   Yes/No/Not Sure

2.   A teacher acts as the network administrator.   Yes/No/Not Sure

3.   Some our server maintenance is outsourced.   Yes/No/Not Sure

4.   It staff members feel unhappy about their workload. Yes/No/Not Sure

5.   IT staff members and senior management disagree at least once a week on IT related issues. Yes/No/Not Sure

6.   It is easy to deal with the day to day ICT/IT department issues.   Yes/No/Not Sure

7.   I am happy with the way our school network is being maintained.   Yes/No/Not Sure

8.   Preparing for Computer Practical tests and exams are stressful.   Yes/No/Not Sure

9.   Finance Planning of IT infrastructure is done. Yes/No/Not Sure

10.   All new software is thoroughly checked to ensure value to teaching. Yes/No/Not Sure

11.   Users have a definite procedure to report IT incidents. Yes/No/Not Sure

12.   Hardware and software are tested before staff or learners use it. Yes/No/Not Sure

13.   I am interested in best practice guidelines for ICT/IT infrastructure management for our school.   Yes/No/Not Sure

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Appendix B: Final Survey

IT infrastructure management and Best Practices at Government Secondary Schools in Western Cape
Answers marked with a * are required.

1. Basic information

Hi, my name is Karina Perkins. I am out to answer the question:

"Is there a need for best practice ICT/IT infrastructure management at government secondary schools in the Western Cape?"

How will this survey benefit you? Each school who participates in the survey will be eligible to receive 10% membership discount from FITS (Framework for ICT technical Support http://www.thefitsfoundation.org). Who is FITS? FITS is a UK non profit organization that specialises in ICT/IT school service management frameworks. Your individual response will remain confidential.

Time frame: 5 minutes

Any questions or feedback can be emailed to: manageSchool.IT@gmail.com

1. Which of the following roles best describe your position at your school? *
○ IT Technician
○ Network Administrator
○ Teacher
○ Head of Department Computers
○ Deputy Principal
○ Principal
   Reset

Next

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IT infrastructure management and Best Practices at Government Secondary Schools in Western Cape
Answers marked with a * are required.

For the following statements choose between Yes/No/Not Sure

1. We have a full time on site network administrator.
   ○ Yes   ○ No   ○ Not Sure

2. A teacher acts as the network administrator.
   ○ Yes   ○ No   ○ Not Sure

3. Some of our server maintenance is outsourced.
   ○ Yes   ○ No   ○ Not Sure

4. All new software is thoroughly checked to ensure value to teaching.
   ○ Yes   ○ No   ○ Not Sure

5. Users have a definite procedure to report IT incidents.
   ○ Yes   ○ No   ○ Not Sure

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6. Hardware and software are tested before staff or learners use it.
○ Yes   ○ No   ○ Not Sure

7. Students are brought before disciplinary committees for computer related offences
○ Yes   ○ No   ○ Not Sure

8. It is easy to deal with the day to day ICT/IT department issues.
○ Yes   ○ No   ○ Not Sure

9. I am happy with the way our school network is being maintained
○ Yes   ○ No   ○ Not Sure

10. Internet is down more than twice a term.
○ Yes   ○ No   ○ Not Sure

11. Anti-virus software is updated at least once a week on all the computers
○ Yes   ○ No   ○ Not Sure

12. There is an acceptable usage policy for staff.
○ Yes   ○ No   ○ Not Sure

13. Teaching staff are confident to use ICT in their lessons.
○ Yes   ○ No   ○ Not Sure

Please contact http://www.thefitsfoundation.org/contact-us/ to claim 10% discount. Please state that you completed the best practice survey. Alternatively you can email a request to manageSchool.IT@gmail.com

14. Comments regarding IT/ICT infrastructure management.

[Back]   [Finished]

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Appendix C: Raw data from first survey

Respondents	Which of the following roles best describe your position at your school?	Q1 We have a full time on site network administrator.	Q2 A teacher acts as the network administrator.	Q3 Some of our server maintenance is outsourced.	Q4 All new software is thoroughly checked to ensure value to teaching.	Q5 Users have a definite procedure to report IT incidents.	Q6 Hardware and software are tested before staff or learners use it.	Q7 Students are brought before disciplinary committees for computer related offences	Q8 It is easy to deal with the day to day ICT/IT department issues.	Q9 I am happy with the way our school network is being maintained	Q10 Internet is down more than twice a term.	Q11 Anti-virus software is updated at least once a week on all the computers	Q12 There is an acceptable usage policy for staff.	Q13 Teaching staff are confident to use ICT in their lessons.
1	Principal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	Teacher	Yes	No	No	NS	No	NS	NS	NS	NS	Yes	No	No	NS
3	Teacher	No	No	Yes	NS	Yes	Yes	Yes	No	No	NA	Yes	No	NS
4	Teacher	No	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes
5	HOD Computers	No	Yes	No	Yes	Yes	Yes	Yes	No	Yes	No	Yes	No	Yes
6	Teacher	No	No	Yes	Yes	Yes	Yes	Yes	No	NS	Yes	NS	Yes	Yes
7	Teacher	No	Yes	Yes	No	Yes	Yes	Yes	No	No	No	No	Yes	Yes
8	Teacher	No	Yes	Yes	Yes	Yes	NS	Yes	Yes	Yes	No	Yes	Yes	Yes
9	HOD Computers	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes	Yes	Yes
10	HOD Computers	No	No	Yes	No	Yes	No	Yes	No	No	No	Yes	No	Yes
11	Teacher	Yes	No	No	No	Yes	NS	Yes	Yes	No	Yes	Yes	Yes	NS
12	Teacher	No	No	Yes	No	No	No	Yes	NS	No	Yes	Yes	No	No
13	Teacher	No	Yes	Yes	No	No	No	Yes	No	Yes	No	Yes	No	No
14	Teacher	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
15	HOD Computers	Yes	No	Yes	NS	NS	No	NS	Yes	NS	Yes	Yes	Yes	NS
16	HOD Computers	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
17	Teacher	Yes	No	No	NS	NS	Yes	No	NS	No	Yes	No	No	No
18	HOD Computers	Yes	No	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	No	Yes
19	Teacher	No	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No
20	Network Administrator	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
21	HOD Computers	Yes	No	Yes	Yes	Yes	NA	Yes	No	No	NS	Yes	No	NA

Keys:

NA =Unanswered   NS: Not Sure

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Appendix D: **Raw data from second survey**

Respondents	Which of the following roles best describe your position at your school?	Q1 We have a full time on site network administrator.	Q2 A teacher acts as the network administrator.	Q3 Some of our server maintenance is outsourced.	Q4 All new software is thoroughly checked to ensure value to teaching.	Q5 Users have a definite procedure to report IT incidents.	Q6 Hardware and software are tested before staff or learners use it.	Q7 Students are brought before disciplinary committees for computer	Q8 It is easy to deal with the day to day ICT/IT department issues.	Q9 I am happy with the way our school network is being maintained	Q10 Internet is down more than twice a term.	Q11 Anti-virus software is updated at least once a week on all the computers	Q12 There is an acceptable usage policy for staff.	Q13 Teaching staff are confident to use ICT in their lessons.
1	Teacher	No	No	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes	No	Yes
2	HOD Computers	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No
3	Teacher	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
4	Deputy Principal	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes	No
5	Teacher	No	Yes	No	NA	Yes	Yes	Yes	Yes	NS	No	NS	NA	No
6	Teacher	No	No	Yes	NS	Yes	Yes	Yes	Yes	No	Yes	Yes	NS`	NS
7	HOD Computers	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NS	Yes	Yes	No
8	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
9	Teacher	Yes	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
10	Deputy Principal	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No	Yes	NA	Yes
11	Network Administrator	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
12	Principal	Yes	NA	No	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
13	Teacher	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
14	Teacher	No	Yes	Yes	No	Yes	Yes	NS	No	No	NS	Yes	No	NS
15	Teacher	No	No	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No
16	HOD Computers	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	NS	No	No
17	Teacher	No	No	Yes	No	Yes	No	No	No	No	Yes	No	No	No
18	Teacher	No	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Yes	NS
19	Teacher	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
20	Teacher	No	No	Yes	No	No	Yes	No	Yes	NS	No	Yes	No	NS
21	Teacher	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
22	Teacher	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
23	HOD Computers	No	Yes	Yes	Yes	Yes	Yes	No	No	Yes	No	Yes	No	No
24	Teacher	No	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Yes	No
25	Network Administrator	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
26	Principal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
27	HOD Computers	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Keys:

NA: Unanswered   NS: Not Sure

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Appendix E: Raw data from third survey

Survey 3

	Respondents	Which of the following roles best describe your position at your school?	Q1 We have a full time on site network administrator.	Q2 A teacher acts as the network administrator.	Q3 Some of our server maintenance is outsourced.	Q4 All new software is thoroughly checked to ensure value to teaching.	Q5 Users have a definite procedure to report IT incidents.	Q6 Hardware and software are tested before staff or learners use it.	Q7 Students are brought before disciplinary committees for computer related offences	Q8 It is easy to deal with the day to day ICT/IT department issues.	Q9 I am happy with the way our school network is being maintained	Q10 Internet is down more than twice a term.	Q11 Anti-virus software is updated at least once a week on all the computers	Q12 There is an acceptable usage policy for staff.	Q13 Teaching staff are confident to use ICT in their lessons.
1	HOD Computers		No	Yes	Yes	NS	Yes	Yes	Yes	No	Yes	No	Yes	Yes	No
2	Network Administrator		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3	Teacher		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4	Network Administrator		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5	HOD Computers		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6	Network Administrator		Yes	No	No	NS	Yes	Yes	No	Yes	Yes	No	Yes	Yes	Yes
7	Teacher		No	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	NS	Yes	Yes	NS
8	Network Administrator		No	Yes	NS	Yes	Yes	Yes	Yes	NS	Yes	No	Yes	Yes	Yes
9	Principal		No	Yes	Yes	Yes	No	Yes	Yes	No	No	Yes	No	NA	No
10	Deputy Principal		Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	No

Keys:

NA: Unanswered   NS: Not Sure

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Appendix F: Data with unanswered responses removed

Respondents	Which of the following roles best describe your position at your school?	Q1 We have a full time on site network administrator.	Q2 A teacher acts as the network administrator.	Q3 Some of our server maintenance is outsourced.	Q4 All new software is thoroughly checked to ensure value to teaching.	Q5 Users have a definite procedure to report IT incidents.	Q6 Hardware and software are tested before staff or learners use it.	Q7 Students are brought before disciplinary committees for computer related offences	Q8 It is easy to deal with the day to day ICT/IT department issues.	Q9 I am happy with the way our school network is being maintained	Q10 Internet is down more than twice a term.	Q11 Anti-virus software is updated at least once a week on all the computers	Q12 There is an acceptable usage policy for staff.	Q13 Teaching staff are confident to use ICT in their lessons.
1	Teacher	Yes	No	No	NS	No	NS	NS	NS	NS	Yes	No	No	NS
2	Teacher	No	No	Yes	NS	Yes	Yes	Yes	No	No	NA	Yes	No	NS
3	Teacher	No	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes
4	HOD Computers	No	Yes	No	Yes	Yes	Yes	Yes	No	Yes	No	Yes	No	Yes
5	Teacher	No	No	Yes	Yes	Yes	Yes	Yes	No	NS	Yes	NS	Yes	Yes
6	Teacher	No	Yes	Yes	No	Yes	Yes	Yes	No	No	No	No	Yes	Yes
7	Teacher	No	Yes	Yes	Yes	Yes	NS	Yes	Yes	Yes	No	Yes	Yes	Yes
8	HOD Computers	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes	Yes	Yes
9	HOD Computers	No	No	Yes	No	Yes	No	Yes	No	No	No	Yes	No	Yes
10	Teacher	Yes	No	No	No	Yes	NS	Yes	Yes	No	Yes	Yes	Yes	NS
11	Teacher	No	No	Yes	No	No	No	Yes	NS	No	Yes	Yes	No	No
12	Teacher	No	Yes	Yes	No	No	No	Yes	No	Yes	No	Yes	No	No
13	HOD Computers	Yes	No	Yes	NS	NS	No	NS	Yes	NS	Yes	Yes	Yes	NS
14	HOD Computers	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
15	Teacher	Yes	No	No	NS	NS	Yes	No	NS	No	Yes	No	No	No
16	HOD Computers	Yes	No	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	No	Yes
17	Teacher	No	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No
18	Network Administrator	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
19	HOD Computers	Yes	No	Yes	Yes	Yes	NA	Yes	No	No	NS	Yes	No	NA
20	Teacher	No	No	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes	No	Yes
21	HOD Computers	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No
22	Teacher	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
23	Deputy Principal	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes	No
24	Teacher	No	Yes	No	NA	Yes	Yes	Yes	Yes	NS	No	NS	NA	No
25	Teacher	No	No	Yes	NS	Yes	Yes	Yes	Yes	No	Yes	Yes	NS`	NS

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Respondents	Which of the following roles best describe your position at your school?	Q1 We have a full time on site network administrator.	Q2 A teacher acts as the network administrator.	Q3 Some of our server maintenance is outsourced.	Q4 All new software is thoroughly checked to ensure value to teaching.	Q5 Users have a definite procedure to report IT incidents.	Q6 Hardware and software are tested before staff or learners use it.	Q7 Students are brought before disciplinary committees for computer related offences	Q8 It is easy to deal with the day to day ICT/IT department issues.	Q9 I am happy with the way our school network is being maintained	Q10 Internet is down more than twice a term.	Q11 Anti-virus software is updated at least once a week on all the computers	Q12 There is an acceptable usage policy for staff.	Q13 Teaching staff are confident to use ICT in their lessons.
26	HOD Computers	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NS	Yes	Yes	No
27	Teacher	Yes	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
28	Deputy Principal	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No	Yes	NA	Yes
29	Network Administrator	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
30	Principal	Yes	NA	No	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
31	Teacher	No	Yes	Yes	No	Yes	Yes	NS	No	No	NS	Yes	No	NS
32	Teacher	No	No	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No
33	HOD Computers	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	NS	No	No
34	Teacher	No	No	Yes	No	Yes	No	No	No	No	Yes	No	No	No
35	Teacher	No	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Yes	NS
36	Teacher	No	No	Yes	No	No	Yes	No	Yes	NS	No	Yes	No	NS
37	Teacher	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
38	HOD Computers	No	Yes	Yes	Yes	Yes	Yes	No	No	Yes	No	Yes	No	No
39	Teacher	No	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Yes	No
40	HOD Computers	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
41	HOD Computers	No	Yes	Yes	NS	Yes	Yes	Yes	No	Yes	No	Yes	Yes	No
42	Network Administrator	Yes	No	No	NS	Yes	Yes	No	Yes	Yes	No	Yes	Yes	Yes
43	Teacher	No	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	NS	Yes	Yes	NS
44	Network Administrator	No	Yes	NS	Yes	Yes	Yes	Yes	NS	Yes	No	Yes	Yes	Yes
45	Principal	No	Yes	Yes	Yes	No	Yes	Yes	No	No	Yes	No	NA	No
46	Deputy Principal	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	No

Appendix G: Coded Results

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Coded Results

	Position at school	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13
1	Teacher	1	2	2	3	2	3	3	3	3	1	2	2	3
2	Teacher	2	2	1	3	1	1	1	2	2	4	1	2	3
3	Teacher	2	2	1	1	1	2	1	1	1	2	1	1	1
4	HOD Computers	2	1	2	1	1	1	1	2	1	2	1	2	1
5	Teacher	2	2	1	1	1	1	1	2	3	1	3	1	1
6	Teacher	2	1	1	2	1	1	1	2	2	2	2	1	1
7	Teacher	2	1	1	1	1	3	1	1	1	2	1	1	1
8	HOD Computers	1	1	1	1	1	1	2	1	1	2	1	1	1
9	HOD Computers	2	2	1	2	1	2	1	2	2	2	1	2	1
10	Teacher	1	2	2	2	1	3	1	1	2	1	1	1	3
11	Teacher	2	2	1	2	2	2	1	3	2	1	1	2	2
12	Teacher	2	1	1	2	2	2	1	2	1	2	1	2	2
13	HOD Computers	1	2	1	3	3	2	3	1	3	1	1	1	3
14	HOD Computers	1	2	2	1	1	1	1	1	1	1	1	1	1
15	Teacher	1	2	2	3	3	1	2	3	2	1	2	2	2
16	HOD Computers	1	2	1	1	1	1	2	2	1	1	1	2	1
17	Teacher	2	1	2	1	1	1	1	2	1	1	1	1	2
18	Network Administrator	1	1	2	1	1	1	1	1	1	2	1	1	1
19	HOD Computers	1	2	1	1	1	4	1	2	2	3	1	2	4
20	Teacher	2	2	1	1	1	1	2	1	1	2	1	2	1
21	HOD Computers	1	2	1	1	1	1	2	1	1	2	1	1	2
22	Teacher	2	1	1	1	1	1	1	1	1	1	1	1	2
23	Deputy Principal	2	1	1	1	1	1	1	1	2	2	2	1	2
24	Teacher	2	1	2	4	1	1	1	1	3	2	3	4	2
25	Teacher	2	2	1	3	1	1	1	1	2	1	1	3	3
26	HOD Computers	2	1	1	1	1	1	1	1	1	3	1	1	2
27	Teacher	1	2	1	2	1	1	1	1	1	1	1	1	1
28	Deputy Principal	1	1	1	1	1	1	1	2	1	2	1	4	1
29	Network Administrator	1	2	2	1	1	1	1	1	1	2	1	1	1
30	Principal	1	4	2	1	1	1	1	1	1	2	1	1	1
31	Teacher	2	1	1	2	1	1	3	2	2	3	1	2	3
32	Teacher	2	2	1	1	1	1	1	1	2	1	1	1	2
33	HOD Computers	1	1	1	1	1	1	2	2	1	1	3	2	2
34	Teacher	2	2	1	2	1	2	2	2	2	1	2	2	2
35	Teacher	2	1	1	1	1	1	1	2	1	2	1	1	3
36	Teacher	2	2	1	2	2	1	2	1	3	2	1	2	3
37	Teacher	1	2	1	1	1	1	1	1	1	2	1	1	1
38	HOD Computers	2	1	1	1	1	1	2	2	1	2	1	2	2
39	Teacher	2	1	1	1	2	1	1	1	1	2	1	1	2
40	HOD Computers	1	2	2	1	1	1	1	1	1	1	1	1	1
41	HOD Computers	2	1	1	3	1	1	1	2	1	2	1	1	2
42	Network Administrator	1	2	2	3	1	1	2	1	1	2	1	1	1
43	Teacher	2	1	1	1	1	1	1	2	1	3	1	1	3
44	Network Administrator	2	1	3	1	1	1	1	3	1	2	1	1	1
45	Principal	2	1	1	1	2	1	1	2	2	1	2	4	2
46	Deputy Principal	1	2	1	1	1	2	1	1	1	2	1	1	2

Key: 1-Yes, 2-No, 3-Not Sure, 4-Unanswered

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Appendix H: **Response from Greenfield**

Hello Karina,

Thank you for contacting us at The FITS Foundation. I was interested to see that your work is concerned with best practice processes for ICT infrastructure in secondary schools. Your findings will be of great interest to me, particularly since it centres around secondary schools in South Africa where I don't currently have anyone delivering the FITS training.

If there is anything you would like from me to assist your work please feel free to ask, I'll do what I can to help. I do have training partner organisations outside of the UK but only in Australia and Norway at the moment. I have had a couple of requests from African countries to look at getting training off the ground but nothing has materialised as yet.

regards,

Trevor Greenfield
Chief Executive
21 February 2012
(Greenfield, 2012)

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Appendix I: **First survey request on WCED Computer Studies mailing list**

from:	**Pam Miller** *docpam@gmail.com*
sender time:	*Sent at 07:09 (GMT+02:00). Current time there: 10:09.* ✏
to:	*comp-studies@lists.esn.org.za*
date:	*23 April 2012 07:09*
subject:	*[Comp-studies] Survey for a masters degree on IT infrastructure*
mailing list:	*comp-studies.lists.esn.org.za*

Greetings

Karina Perkins (ex IT teacher and examiner) needs a number of IT people to help her with her data collection for her M.Ed. Would you PLEASE complete this survey.

Please let me know if you managed to do it.
The link is below.

Thanks
Pam

http://www.eSurveysPro.com/Survey.aspx?id=a477c538-90a5-437e-85ec-7f4b89581c9d

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Appendix J: Reply from WCED schools mailing list

from: **schools-bounces@lists.esn.org.za**

to: *manageschool.it@gmail.com*

date: *Fri, May 4, 2012 at 11:04 AM*

subject: *Your message to Schools awaits moderator
approval*

*mailing
list:*   *schools.lists.esn.org.za*

Your mail to 'Schools' with the subject

*Survey regarding IT infrastructure management at secondary schools in
WCED is being held until the list moderator can review it for approval.*

The reason it is being held:

Post by non-member to a members-only list

*Either the message will get posted to the list, or you will receive notification
of the moderator's decision. If you would like to cancel this posting, please
visit the following URL:*

*http://www.esn.org.za/mailman/confirm/schools/c007275b5e4f1befcddec95
5edc6e1430bbf8093*

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Appendix K: **Researchers enquiry on WCED's schools email list**

> *from:* **Manage IT** *manageschool.it@gmail.com*
>
> *to:* *schools-bounces@lists.esn.org.za*
>
> *date:* *Fri, May 11, 2012 at 9:50 PM*
>
> *subject:* *Re: Your message to Schools awaits moderator approval*

To whom it may concern

I am enquiring about the status of my survey request. My research regarding IT infrastructure management has been approved by the education department and you are also welcome to contact Trevor Greenfield <trevor.greenfield@thefitsfoundation.org> from the FITS foundation to confirm the 10% discount for membership. I am anxiously awaiting your reply.

Kind regards
Karina Perkins

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Appendix L: Final enquiry to WCED's schools email list

from:	***Karina Perkins*** *karinaperkins @gmail.com*
sender time:	*Sent at 20:28 (GMT+12:00). Current time there: 21:23.* ✏
to:	*schools @wcape.school.za*
date:	*21 May 2012 20:28*
subject:	*Survey regarding ICT/IT infrastructure management at government secondary schools in the Western Cape*

Dear Colleague

I am enquiring about the status of my survey request. My research regarding IT infrastructure management has been approved by the Western Cape Education Department and you are also welcome to contact Trevor Greenfield <trevor.greenfield@thefitsfoundation.org> from the FITS foundation to confirm the 10% discount for membership. I am anxiously awaiting your reply. Link for survey regarding IT/ICT management at secondary schools in the Western Cape

http://www.eSurveysPro.com/Survey.aspx?id=d3e9e956-0af2-49a4-8beb-60f924fc7a2

Kind regards

Karina Perkins

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Appendix M: **Comments by Teachers**

Question 14: Comments regarding the management of IT/ICT

Respondent 5:   "I am the Librarian; I only manage the Library system and
                     am busy completing the ICDL course." (Teacher)

Respondent 11:   The ICT equipment and infrastructure are maintained by a
                     part time person who comes to the school once a week for
                     two hours. This is hardly enough to maintain not to mention
                     progress in the department. (Teacher)

Respondent 24:   "We are fortunate at our school in that we have suitably
                     skilled individuals that can assist with network
                     maintenance." (Teacher)

Respondent 31:   "Time to do things properly remains a constant problem."
                     (Teacher)

Respondent 35:   "It consumes a lot of time to keep everything working and
                     having to teach as well does put a lot of stress on a
                     teacher. Hardware maintenance and software support
                     consumes huge chunks of time and some teachers who
                     are older do not want to use ICT in their lessons which the IT
                     teacher / administrator cannot control." (Teacher)

Respondent 43:   "I am the IT technician, Teacher and LAN Administrator"
                     (Teacher)

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Appendix N: **Comments by HOD Computers**

Question 14: Comments regarding the management of IT/ICT

Respondent 4:   "Quite expensive" (HOD Computers)

Respondent 16:   "Schools are generally more inclined to spend money on hardware than human capital, especially with ICT moving from a 'lab' set-up and into the classroom" (HOD Computers)

Respondent 41:   "We have a supportive governing body who replace, upgrade and maintain our technology on an on-going basis" (HOD Computers)

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Appendix O: **Comments by Deputy Principal**

Question 14: Comments regarding the management of IT/ICT

Respondent 46:   "Some staff are very confident, others completely phobic.
                      All have to use the network for admin, many use it for
                      teaching" (Deputy Principal)