Efficacy of Internship Component of the Software Engineering Sector in the Western Cape

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Declaration

I, Tendai Marambire, declare that the contents of this dissertation represent my own unaided work and that the dissertation has not previously been submitted for academic examination towards any qualification. Furthermore, it represents my own opinions and not necessarily those of participants.

Signed --------------------   Date ----------------

Abstract

With the software sector being central to economic growth, it was important for the study to analyse the adequacy of skills in the sector. The provincial government of the Western Cape, the industry and tertiary institutions are collaboratively developing relevant Software Engineering (SE) skills. However, it was unclear whether the joint efforts are achieving the intended outcomes. The risk with uncertainty is that emphases may be placed on aspects that do not accurately address the objective of the initiative. Other SE skills shortage risks may include: failure by the region to improve productivity, innovations, exports, and the risk of failing to reduce high unemployment. It is important therefore, that the efforts to address SE skills shortage in the Western Cape succeed.

This research made extensive use of relevant literature. Interviews were conducted with employers from chosen companies in Cape Town, South Africa, with an HR representative, HOD from the faculty of Computer Science from Universities and with SE interns. Within the interpretive epistemology, a qualitative inductive methodology was applied. In this respect, a non-probability purposive sampling was used to approach only members of the population ready and willing to give the required data. Despite internship programs being in full operation, findings highlighted the SE technical skills in short supply in the Western Cape and these include Java, dot Net and database skills. The high shortage of SE skilled personnel is pointed out to be a result of few SE graduates from SE tertiary institutions which is blamed on few Universities enrolments. Furthermore, Universities indicated poor mathematics pass rates at matric level as the main reason for having low SE enrolment levels since mathematics is a prerequisite to the SE course. Adding on to that, findings confirm that high SE skills shortage are a result of the imbalances of theoretical and practical aspect of SE courses at Universities. The main reason for the imbalances is that there is no communication between SE industry and Universities. It would be beneficial if companies were consulted by universities when syllabi are prepared. This way, affected parties could forge a common ground to close the skills gap. It may also help tertiary institutions to review and change their syllabus at the right time, in order to focus on what are current imperatives in the SE industry.

Findings also reflect that the main reason for SE internships is the need to build up the SE technical skills of interns through work related learning in the SE industry. These internships have been successful in alleviating the problem but not high enough to solve the SE skills shortage in the province. This implies these Internship programs could positively contribute to the alleviation of SE skills shortage in Cape Town if more is done to improve the programs. A greater focus on enhancing such programs would provide benefits in the SE field. Consultative collaborations between the tertiary sector and the industry on curricula matters are recommended. Thus, a need for a more solid relationship between SE tertiary institutions and the SE field of operation needs further investigation. Students on the other hand need to be proactive by collaborating with other relevant SE related affiliations for knowledge sharing seminars especially on the current technologies in use in the SE industry.

Key words: Efficacy, Software, Software Engineering, Intern, SE Internship, Internship Organisation, SE Training institution, Status of SE skills.

List of Abbreviations

ANT	-	Actor Network Theory
HODs	-	Head of Departments
HR	-	Human Resource
ICT	-	Information Communication Technology
IT	-	Information Technology
JCSE	-	Johannesburg Centre of Software Engineering
KZN	-	KwaZulu-Natal
SETA	-	Sector Education and Training Authority.
OPP	-	Obligatory passage point
PC	-	Personal Computer
S/W	-	Software
SE	-	Software Engineering
S.A	-	South Africa
UTC	-	University Technical College
WC	-	Western Cape

Dedication

Special dedication goes to my parents, Mr and Mrs Marambire, for all the encouragements and motivations to keep studying, and to my husband for all the prayers and support during my studies. It was not an easy road. Thank you!

Table of Contents

List of Figures:

List of Tables

CHAPTER 1: INTRODUCTION

1.1   Introduction

Many researchers examined the benefits internship programmes offered to students and employers (Weible, 2009). However, very few have focused on how such initiatives are contributing towards the redress of Software Engineering (SE) skills shortage in South Africa and the Western Cape (WC), in particular. According to some researches done, a wide range of student benefits exists some of them include quicker job offer, better career preparation and improved creative (Gault et al, 2008).On the other hand some of employer benefits include first choice of best students, best selection of future employees and receiving help (Coco, 2000). On the institutions that offer internships, benefits include new scholarships, other forms of funding and improved reputation (Thiel & Hartley, 1997).

This research examines the contribution of current SE internships towards SE skills gap reduction in the in WC region. Thus focus is in the relationship between SE internships and the SE skills shortage problem.

Roadmap to this chapter is outlined in Figure 1: Chapter 1 Roadmap below:
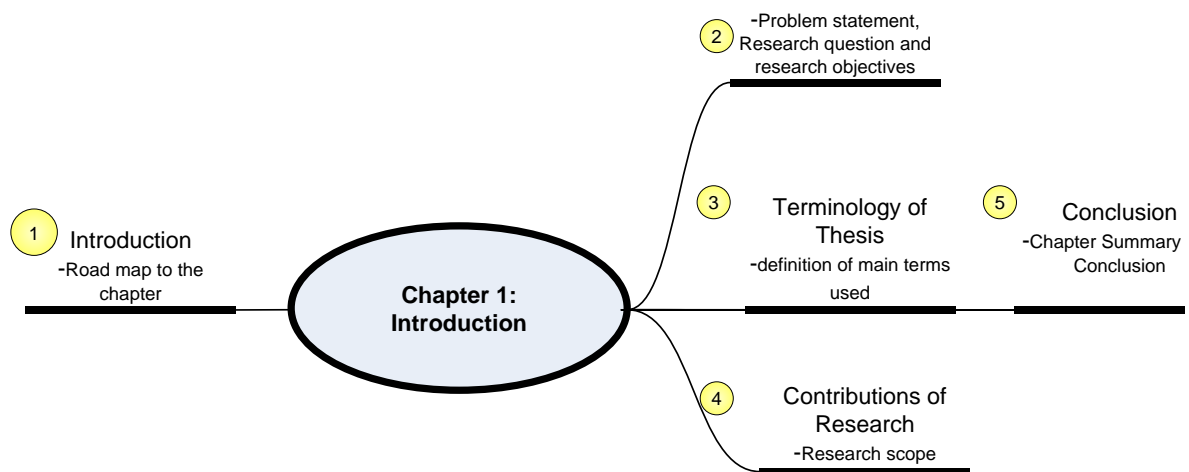
Figure 1: Chapter 1 Roadmap

1.2   Background of Research Problem

Software Engineering (SE) is central to the evolution of software which drives the efficiencies in any industry, and ultimately, a catalyst for economic growth (Cagiltay, 2007). Therefore, SE is the main driver for innovative productions and economic competitiveness across the world, particularly for developing economies like South Africa (SA). Without skilled SE personnel however, it is difficult for the SE industry and different economic sectors to

achieve growth. However, the problem in South Africa is that there is a shortage of specialized technical skills generally, and Software Engineering in particular, being the most affected domain (Govender, 2011). The Western Cape is the third largest economy in SA, after Gauteng and Durban (in KZN) (Lehohla, 2011). With the software sector being central to economic growth, it was only logical for the region to prioritize the development of its SE sector, if it were to be in par with or even to leapfrog into an economic leadership position economy nationally. For this reason, the provincial government of the Western Cape together with the industrial Sector and tertiary Institutions are taking collaborative efforts to develop relevant SE skills through structured curricula with a balance between theory and practice through internship programs.

1.2.1 Problem Statement

The problem in this dissertation however, is that it is not known whether the joint efforts of the Western Cape Government, its industry and tertiary partners, are achieving intended outcomes. Without clarity on this aspect, the risk is that emphasis may be placed on aspects that do not accurately address the objective of the initiative. Unless the problem of SE skills shortage is addressed, the risk of the region failing to improve productivity, innovations, exports, and to reduce unemployment remains high. It would also be difficult to identify areas of improvement, and corrective measures where necessary. It is important therefore, that the efforts to address SE skills shortage in the region succeed.

1.2.2 Research Objective

Given the research problem, the aim of this study was to understand whether SE related skills development initiatives are effective and efficient. In this respect, emphasis was placed on internship programs as developed by the government, industry and tertiary institutions in the Western Cape. The idea was to explore the structure of the internship programs, to gain a full insight into the benefits of such initiatives, so as to identify   any shortcomings there may be, and ultimately, to inform those institutions involved of any improvements that could be made. The end goal therefore, was to understand whether, after having completed an internship program, graduates in tertiary institutions are groomed to the industry's expectations for entry level careers in the software engineering field, in such a way that they can contribute towards the reduction of the skills gap in the industry.

1.3 Research Question

What is the efficacy of the internship component of the Software Engineering (SE) sector in the Western Cape?

1.3.1   Research Sub questions

i. How effective and efficient are the Software engineering Internship programs in alleviating SE skills shortage in the Western Cape Province?

ii. Are Software Engineering graduates in tertiary institutions groomed to the industry's expectations for entry level careers in the software engineering field?

1.4   Terminology of the Thesis

A number of vocabularies are used in this thesis and it is important for the reader to understand the intended meaning. Clarification of dominant terms in this thesis simplifies a reader's understanding of the research and enhances engagement with the content of the paper. These terms are defined for the reader in the following sections. These terms are Efficacy, Software, Software Engineering, Intern, Internship, Internship Organisation, SE Training Organisation, and Status of SE Skills.

1.4.1   Efficacy

According to the Cambridge learner's dictionary (2011), efficacy refers to the quality of being successful in achieving an intended result. In this research, it refers to how close the program gets to achieving the intended goals for an ideal SE internship. An ideal SE internship program in the Western Cape would be one which contributes to the solving of the problems which arise from the SE skills shortage.

1.4.2   Software

Software refers to a set of programs, instructions and rules designed to make computer programs operate correctly (Blum, 1992) and (Sommerville, 2001). The Webster dictionary (1992) supports the definition by looking at software as the programs and programming support necessary to put a computer through its assigned tasks (Pratap, 2010).

For the purposes of this thesis, the same understanding and concept is used and software referred to is not limited to a specific industry. All computer machinery in any field or industry that use some form of mechanism is included in this thesis. The embedded intelligence in such machinery that gives instructions to the machinery is what is being referred to as Software in this thesis

1.4.3   Software Engineering

The concept of software engineering can be described from the context of the words ' software' and 'engineering' that constitutes it. Whilst engineering is described as any systematic, disciplined, quantifiable approach based on specialised knowledge, skill and judgment to the invention (Davis, 2011), development, operation, and maintenance of useful technical objects (ibid), Software is a set of programs, instructions and a set of rules

embedded, interpreted and executed in some kind of computing machinery (Leach, 2000). In the form of algorithmic descriptions and instructions, these sets of rules are written in detail to facilitate the executable computational steps, telling a computer precisely 'what to do' (ibid).

With this background, Software engineering is seen, in this thesis, as a systematic and disciplined approach for process/es of inventing, developing or maintaining a non-tangible (Pressman, 2010) set of programs and rules for execution by computing machinery and systems. Therefore in this research SE refers to the application of engineering techniques for solving variety of software problems in any possible way (Leach, 2000)

1.4.4 Intern

An intern is someone working in a temporary position with an emphasis on education rather than employment (Weible, 2009). In this research, interns are referred to as learners, undergraduates and graduates, undertaking practical work learning experiences in the SE field under the supervision of employers and academic institutes, before they are considered for junior level positions in the SE field of operation.

1.4.5 SE Internship

Internship refers to work integrated learning performed in the field of operation (Weible, 2009), usually for undergraduate education with structured supervision (Dell, 2011). Internships give students practical learning experience in their field of study (Weible, 2009) and usually last for three months up to a year (Dell, 2011). They focus more on hands-on experience rather than theories and philosophies, giving interns a foundation for the intended job (Dell, 2011). As used in this study, SE Internship will thus refer to the SE practical work learning opportunity given to interns as they gain knowledge and the required skills in the SE discipline (Levine, 2010). Moreover, the practical learning is done in a professional setting in the field of SE.

1.4.6 Internship Organisation

Internship Organisation is made up of two words (which are Internship and Organisation). Internship has been defined in section 1.4.5 above and according to the online business dictionary (2012), the word organisation refers to a group of people that is structured and managed to meet a need or to pursue collective goals.

For the purpose of this study Internship organisation refers to a unit of people that is structured and managed to offer SE internships to graduates. This specifically refers to committees or departments whose purpose is to administer SE work integrated learning. The main purpose of such administrative organisations is to up skill interns in IT areas that are in

short supply in the Western Cape Province of South Africa. Such organisations include CapaCITi 1000 and SETA.

1.4.7 SE Training Organisation

Training and teaching can be used interchangeably. According to Schoenfeld (1998) teaching is a process of knowledge transfer and construction. It is knowledge transfer using various methods shaped by the surrounding environment (Kincheloe, 2008). In this thesis SE training is the transfer of knowledge of SE using various methods as structured by the offering organisation, such as IT tertiary institutions. As for the term SE training organisation, reference is made to the organisations (defined in 1.4.6) that promote transfer of SE knowledge and construction to enrolled learners to equip them with knowledge and skills, in order to be productive in their future IT careers (Cagiltay, 2007).

1.4.8 Status of SE Skills

According to online dictionary status is a condition of varying degrees of position such as low or high. In this research status of SE skill refers to a state, or condition; the adequacy and extent to which SE resources possess engineering skills that are relevant in the field of operation. Since a skill is a learned ability to practice in a work related environment (Weible, 2010), this research refers to the expertise acquired at tertiary institutions, which ranges from junior, through intermediate, to skilled levels.

1.5   Contribution of the Research

As a contribution to the body of knowledge this thesis aims to provide a theory based conceptual framework for the maintenance and improvements of skills development initiatives in the Western Cape and beyond. For this reason, publication in academic journals is anticipated, so that the output is readily available for broader public consumption. This research is also expected to give useful insight to the internship planners, Universities and employers, on what needs to be maintained and improved in the internship programmes. This may help in shaping the structure and curriculum of the program according to industry expectations.

1.6 Delineation of Research

The study only focuses on the efficacy of the Internship Component of Software Engineering in the Western Cape. Sources of data were limited to a sample of IT companies in Cape Town and the three Universities in Cape Town, the University of Cape Town, the Cape Peninsula University of Technology and the University of Western Cape. The SE skills referred to in this research are technical skills used in the industry, therefore business IT skills are not dwelt on much in this study. Some tertiary institutions are like private training

institutions that offer IT qualifications on behalf of other external universities. These were not considered in this research.

1.7 Structure of Research

This thesis is divided into five main sections called chapters. Each chapter is comprised of an introduction, sub sections and a conclusion. Further highlights on what to expect in each chapter are described below.

1.7.1 Chapter 1

Chapter one is the introduction which highlights the importance of Software Engineering in the modern world and the importance of the people that engineer the software, which are the Software Engineers . First, the chapter states the background of the research problem, the research problem, and the aims and objectives. It highlights the research question, the sub-questions guiding the research, the definition of terms and the delineation of the research. it gives definitions of key terms, and key concepts in relation to this study are stated. The main terms are defined according to an ordinary understanding, and mapped to the meanings used in this study.

1.7.2 Chapter 2

Following the introductory chapter (Chapter 1), chapter 2 is a review of the related literature. The Literature clarifies the characteristics, purpose and intention of an ideal SE internship program. In this chapter it is clearly stated that South Africa, in particular, the Western Cape Province, has a SE skill shortage problem, which has resulted in the region performing less well than other regions, such as Gauteng and Durban. Chapter 2 also stresses on the importance of SE internship programs amongst other potential solutions to solve the SE skills crisis is region. Furthermore, chapter 2 dwells a little on the theories.

1.7.3 Chapter 3

The third chapter outlines the methodology, theories, sampling and data collection methods that the researcher used to conduct this research. The interpretive-qualitative approach is examined. The way this approach has influenced the researcher, and the reasons for following it, are the main discussion points in chapter 3. The chapter further discusses the sampling method, the units of analysis and of observation that were used for this thesis. The reasons for selecting specific units of analysis are justified in this section. The manner in which data was analysed is part of the discussion in this chapter.

1.7.4 Chapter 4

Chapter 4 mainly focuses on raw data collected from interviews with different units of observation. Analysis and interpretation of this data is also covered in this chapter leading to the discussion and summaries of findings of the research.

1.7.5 Chapter 5

The final chapter (Chapter 5) concludes the findings. It also encompasses recommendation to various stakeholders on SE internship program improvements and maintenance, for the future success and provision of ideal Internship programs. The contributions made by this study are also pointed out in this chapter.

1.8 Chapter Summary

This first chapter gave the background to the research problem in this thesis. From this background the importance of SE skills in the Western Cape Province in South Africa is highlighted. The research problem was introduced; the objectives were discussed in the chapter. The research questions and sub-questions that guided the research are part of the core topics in this chapter. This chapter also composed a definition of key terms used in the rest of the thesis, giving the reader a better understanding of the topic being studied. The chapter also gave a structural overview of the thesis layout, clearly identifying what the reader can expect in each chapter.

1.9 Conclusion

Chapter 1 gives an insight into what this research is aiming to investigate. The main reason for carrying out this research, as stipulated in the introductory section, is that many pieces of research have been done regarding SE skills development initiatives and skills shortages, but very few have investigated the efficacy of SE skills development initiatives in the Western Cape region. The introduction to the chapter pointed out that the main objective of this research is to examine the contribution that current SE internships are making to the reduction of the SE skills gap in the WC region.

This chapter gave a background to the research problem of this thesis. From this background the importance of SE skills in the Western Cape Province of South Africa were highlighted. The research problem introduced the objectives discussed in the chapter. The research questions and sub-questions that guided the research are part of the core topics in this chapter. This chapter also composed definitions of key terms used in the rest of the thesis, giving the reader a better understanding of the research. The chapter concluded with a structured overview of the thesis layout, clearly identifying what to expect in each chapter.

CHAPTER 2: Literature Review

2.1   Introduction

Whilst Chapter 1 gives the background and an outline to this research, this chapter (chapter 2) gives a review of the related literature, concepts of internship programs in South Africa and some theories related to the study.

A roadmap to this chapter is outlined in Figure 2 below:
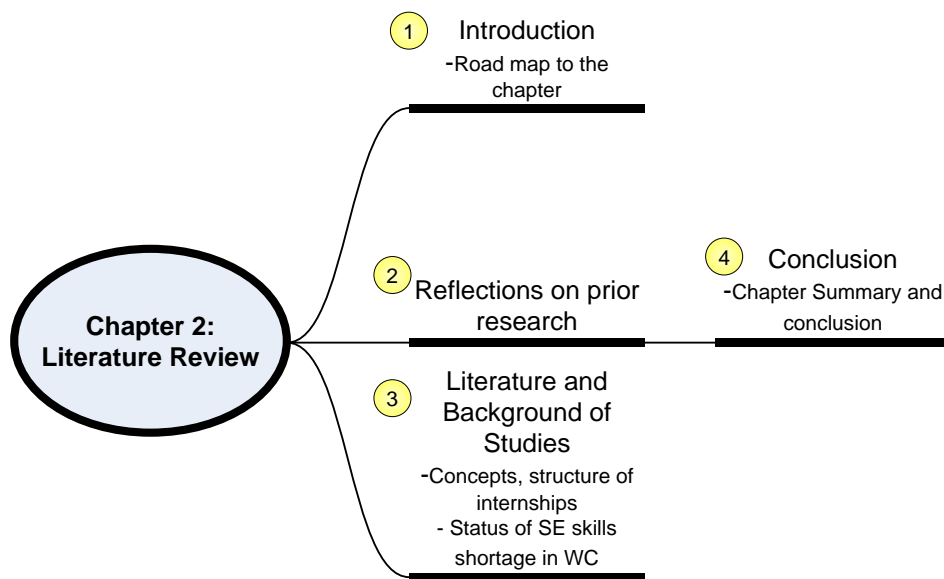
Figure 2: Chapter 2 Roadmap

The chapter is divided into nine sections. As reflected in Figure 2, the chapter opens with an introduction which gives a roadmap to the chapter, followed by reflections on prior researches which are in sections 2.2 to 2.7 and finally a chapter summary in the conclusion which is section 2.8.

2.1.1   Status of Research in the Field

In the background section of this thesis, Software Engineering (SE) is described as any systematic, disciplined, quantifiable approach based on specialised knowledge, skill and judgment to the invention development, operation, and maintenance of useful technical objects (Davis, 2011).

The skills factor is central to this account, as there would be no software engineering without software engineers, and no software engineers without the necessary programming and engineering skills. Research in the field is equally significant, in that it contributes to the

development of new ideas that facilitate technical innovations (ibid). However, whilst there is a wealth of work written on the subject of SE skills in South Africa, publications on SE skills and the internship component which is the focus of this study – remain extremely limited. As reflected in Figure 3 below, there is even less work published on the internship component of SE skills in the Western Cape

The metrics in figure 3, 4, 5 and 6 below were generated from the Academic Search Premier using keyword search. The key words were Software, Software Engineering (SE), Skills and SE Skills in South Africa. The total result search was grouped into scientific and non-scientific publications which include Academic Journals, Magazines, Newspapers, Trade Publication and Peer Reviews. These were the only categories employed to reach the total number of publications relevant to Software Engineering in South Africa. Abstract for a few of the returned results were perused to verify if the search returned a desired outcome.
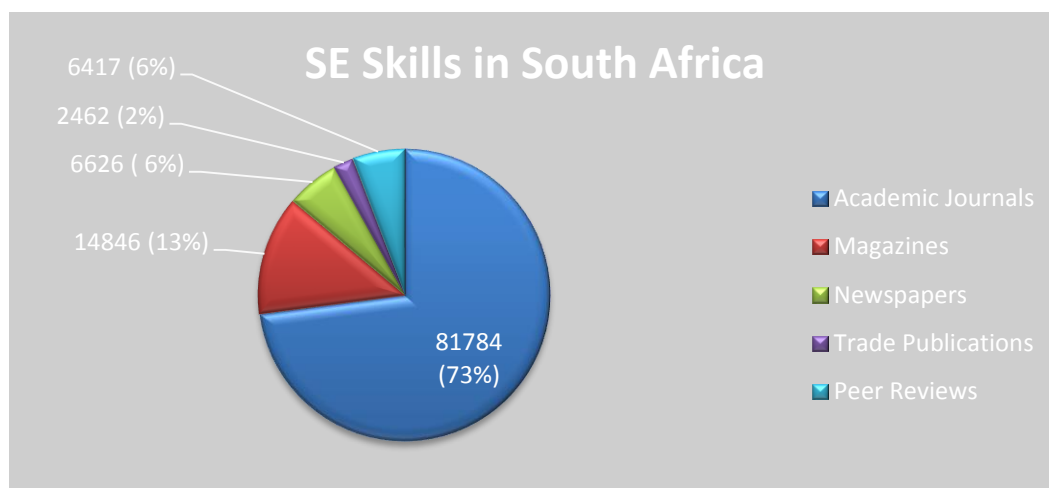
Figure 3: Publications of SE skills in South Africa

Source: Academic Search Premier, 2014

Figure 3 gives a synopsis of articles of SE skills in South Africa (SA). A review of these publications in the Academic Search premier, which is the most commonly used scientific journal database, reflected a minimum total of 133 365 publications of which, 81 784 (73%) were in scientific journals, 14 846 (13%) were in Magazines, 6 626 (6%) in Newspapers, 6 417 (6%) in Peer Review Commentaries, and 2 462 (2%) articles in Trade Publications (Figure 3). Whilst the numbers would be much higher if all scientific journal databases were observed, the current synopsis of the popular sources give a useful estimate of current publications in the field. Whilst the number of publications in the sector is impressive much less work is written on the subject of SE skills shortages in SA. For example Figure 4 shows the total number of publications in scientific journals on SE skills shortages in SA.
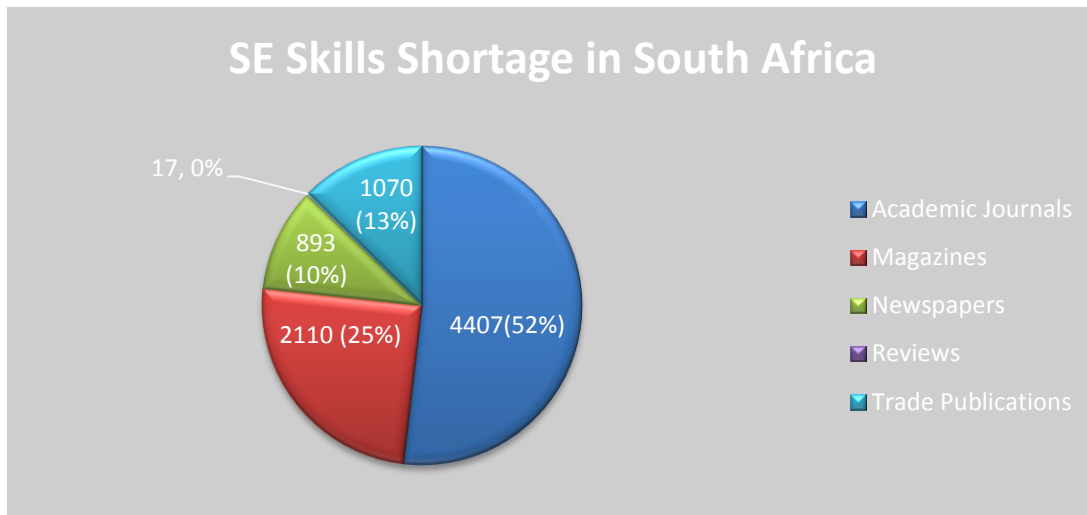
Figure 4: SE Skills Shortage in South Africa

Source: Academic Search Premier, 2014
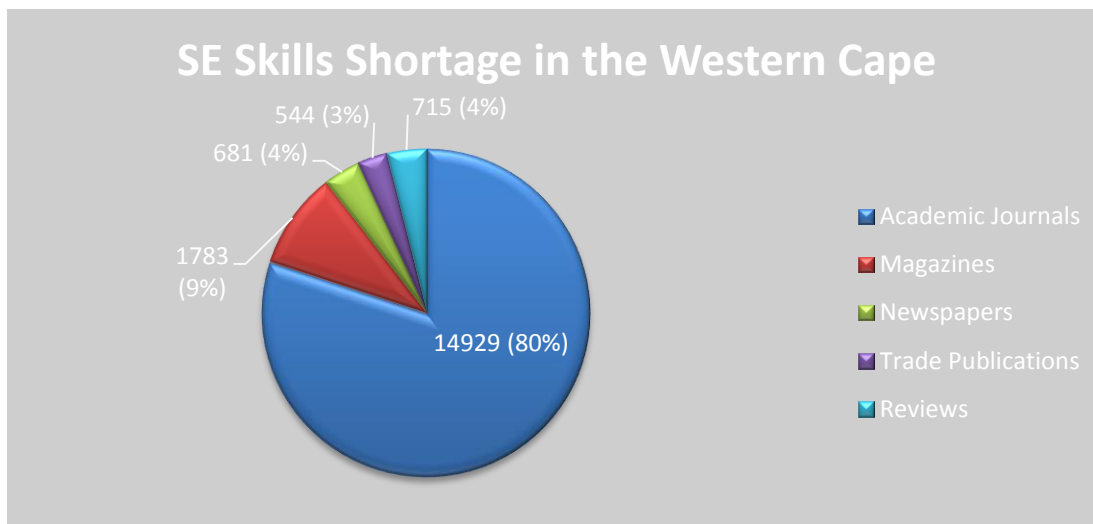
Figure 5: SE Skills Shortage in the Western Cape

Source: Academic Search Premier, 2014

Out of this number, Figure 5 shows a combination of 18 766 publications on this subject that have been published within the WC context, and only 14 929 (80%) were in scientific journals.

Despite this impressive quantity of research work published in this field, it is clear in Figure 6 that there are not enough written on SE skills and the internship component in the region of the Western Cape, which is the area of analysis in this study
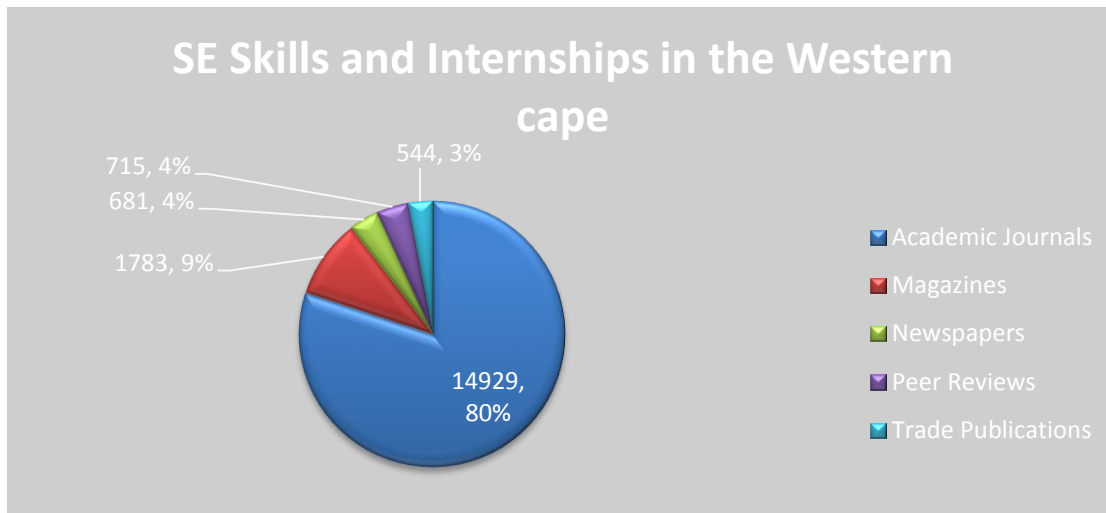
Figure 6: SE Skills shortage in the Western Cape

Source: Academic Search Premier, 2014

However, from an examination of the existing literature on SE internships in the Western Cape, less focus is in the efficacy of internships in the region. Most articles concentrate on the Skills shortage factors and not much on the efficacy of the internship component. Thus in all published literature, little focus has been placed on the efficacy of Software Engineering skills development initiatives. This shows the need for a study of this nature to be conducted.

2.2   Software Engineering as a field of operation

Software engineering as an area of operation is when knowledge and expertise acquired during academic years at tertiary institutions is now put into practice (Cagiltay, 2007). It is at this stage that software engineering is considered a profession (Bott et el, 1991). Real world problems of different complexities are presented to professionals for solutions within specified time frames depending on the business needs. These are solved by applying the concepts learnt during academic periods (Mills & Treagust, 2004) in the business set up instead of a classroom setup.

Furthermore, the skill set involves knowledge and enquiry, as well as the development of software outputs for innovative technical applications across different industries (Cagiltay, 2007). For example in the banking sector, the use of remote automated tellers and the use of plastic card for all money transfers and payments are all results of an engineered software artefact (Charette, 1987). The introduction of Internet banking applications has enabled banks to reach its customers from anywhere in the world making banking much easier (Gurau, 2005). Innovation in the banking sector has seen the industry making profits due to the introduction of Internet banking, mobile banking, Cell phone banking and the use of virtual money and e-payments (Hadidi, 2003; Isarescu, 2001).

2.2.1 Software Engineering in the Banking Sector

As the banking sector deals with money and important personal information of customers, security is a major concern (Lee, 2005). High security measures need to be in place to protect data and several methods such as encryption of customer information are in use (Martin, 1998). As discovered in other pieces of research, sustainable profitability in the banking sector largely depends on managing and integrating customer relationships across channels by making use of complex data and communications technologies (Kirkby, 2001). All these technologies require well developed software that can manage complex systems and promote high levels of security (Callahan, 2003), hence the importance of specialized software engineering skills in the banking sector.

2.2.2 Software Engineering in Farming

The same applies to farmers; weather forecasting technologies help farmers to make decisions on what to plan when. Natural disasters like tornados, hurricanes, cyclones and floods can be forecasted (List, 2004) and precautionary measures are taken care of in advance. For example in 2002 China and Europe were exposed to weather effects of which they had no prior warning, and were thus unaware (Edrich, 2003). Precautionary measures would have been in place if great technology in the meteorological field had been sufficiently advanced. Weather forecast technology is used to monitor the atmosphere on a daily basis (Peng, 1998) so as to know more about possible weather changes.

2.2.3 Software Engineering in Education Sector

Software Engineering is also important in the educational sector. Software programs for example, are an integral part of almost all computer-based teaching and learning programs (Lovell& Philips, 2009). The 'Text-to-Speech' software embedded in lecture slides to simulate a real lecture environment (Santally, 2009) or the Braille tutor software that assists the visually impaired with reading from online documents (Brewer, 2009) are two useful examples. Software in electronic and mobile learning devices also makes it easier for students to learn independently, anytime and at any place (Jolliffe et el, 2001).

2.2.4 Software Engineering and Economic growth

As the software engineering discipline is an innovative area where new ideas and new artefacts are engineered, it contributes widely to the economic growth of a country (Cagiltay, 2007). As per conclusions made at the Global innovation Barometer, 92% of executives who participated are of the view that innovation is the key to a competitive economy (Burrus,

2012). Between 1995 and 2003 India increased its exports of business and software engineering services at an average annual rate of 27% (Arora, 2009). The same applies for Ireland (1995-2004) and the same speedy growth for Brazil, China and Israel (ibid). The increase of newly effective software technologies has seen higher productivity gains and increased exports (Dimelis & Papaioannou, 2010). In the farming sector, for example, cloud seeding has seen some farmers yielding harvests despite a lack of natural rainfall (List, 2004).

As technical products, services, tools and an area of operation, IT, such as software items and services become even more important, in that demand for these services cuts across every aspect of modern living and the economy as whole. Software engineering in particular, is an important discipline with very specialized expertise without which, none of the software products and services can be produced. A lack of skilled software engineers therefore, would cripple innovations, inventions and productivity in the sector, with negative socio-economic and development implications (Roman, 2010).

2.3   Software Engineering and the Skills Factor

Software Engineers are vital to the Software Engineering Organisations and the demand for Software Engineering is growing (Jennings, et el, 2013). Central to the modern business environment is the availability of key technical skills that drives various aspects of innovative processes. Companies in London and the South east are having difficulties to attract the technical skills needed like skilled developers required (ibid). Sam Gordon, director of recruitment specialist, La Fosse Associates, also revealed that there is a high demand of skilled Software developers. To try and alleviate the SE skills shortage problem in the UK, a new college University Technical College (UTC) was created to deal with huge Software Engineering skills shortage which is a global issue (Baldwin, 2014). Furthermore in the Computer Weekly, European Union Commission estimates a demand of 900 000 Software Engineering Jobs that will need to be filled by 2020 across the European Union (Glick, 2014).

On the contrary, Software Engineering skills shortage is a common challenge in global knowledge-based economies (Gordon, 2009), with a slowing effect on economic growth in most countries (Roodt & Patterson, 2008). The new era in the world is characterized by new technological inventions and innovations. Hence, many businesses and organizations rely on the new technologies to run their day to day operations, especially the demand for specific areas such as Web 2.0 (Hoffman, 2008). Likewise, South Africa is no exception in facing the challenges of the Software Engineering skills shortage problem.

2.4 SE Skills Shortage and the South African Context

Modern business environment is demanding specialized, experienced and skilled Software Engineers to combat the ever-changing globalised economy. According to Doyle (2015) in ITWeb, an online newspaper, Software Engineering skills shortage hampers SA's ability to compete internationally. In addition, the press release issued by IT public relations on ITWeb in November 2014 states that organisations are having a huge challenge with mobile backlog and are failing to cope with business demands. Furthermore, information shared by the IT Public relations revealed that 85% of companies struggle with mobile backlog and this has increased the demand for Software Engineers specializing in mobile apps development. The business demands for the new mobile application initiatives is to generate revenue, hence lack of skilled human resources result in loss of revenue.

According to research done by Career Junction, an online recruitment Company, December 2014 career Junction Index reflect that yearly job demand for Software Engineers surged by 18%. This is an indication of the increase in demand on skilled Software Engineers in South Africa. The 2015 MICT SETA priority skills list shows Software Engineering skills which include Software Developers, Computer networks and Systems Engineer, Quality Assurance Engineer are amongst the scarce skills in South Africa. The scarcity of these skills was determined by difficulties faced by employers to recruit qualified human resources in the mentioned fields (ibid).

Adding on to that the South African (SA) government declares a continuing need for software engineers (Manuel, 2007); (Fraser-Moleketi, 2006). The rising need for internet services such as online banking and mobile banking applications through the use of web channels, has fuelled the demand for web developer skills (Hill, 2006). For instance, more than a quarter of unbanked[1] adults in SA have access to a phone and 26% perform money transfers to relatives (Tubbs, 2012), hence there is an increased demand for mobile banking solutions. On this point, ABSA[2] bank has 1.25 million online users (ITWeb, 2012) and this calls for a secure and well developed online applications. The development of mobile applications on Android platform has also increased the demand for Java developers to develop applications for this growing market (Schofiled, 2010). At the same time, the increase in cyber-crime, cyber intrusion and hacking also calls for more software systems' security skills in SA (Roodt&Patterson, 2008). For example banks are frequently warning customers about email scams that usually try to deceive clients by persuading them to divulge their secret banking details. This often results in online identity theft (FNB, 2010).

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[1] People with no bank accounts.

[2] ABSA is this thesis is an abbreviation for Amalgamated Banks of South Africa.

According to the media report, the SA Post Office Bank (Post Bank) lost R42 million through the exploitation of employees usernames and passwords in 2011 (Eardly, 2012). These instances prove a need for security consciousness, and for information security experts to develop more secure banking applications (Hill, 2006). An increase in user identity fraud on social networks has also been reported, where Twitter usernames and passwords are hacked and posted on the Internet (ITWeb, 2012). Recently, Cnet news reported that 6.5 million LinkedIn Passwords were leaked in June 2012 thereby compromising people's privacy (Tam, 2012). With the increase in Internet usage these scenarios emphasize a need for highly skilled software engineers who can mitigate the risks of information being compromised on the Internet.

Estimates are that there would be 275 exabytes[3] per day of data being sent across the Internet by 2020, with a forecast of over 200 billion intelligent devices expected to be in circulation by 2015 (Comline, 2012). This clearly implies a need for skilled software engineers. All these shortages are blamed mainly on there being too few skilled entrants going into the industry from tertiary institutions.

Software Engineering skills shortage in South Africa has been blamed partly on a decline in matric mathematic results. This is because only 28% of registered students who write the matric mathematics examination actually pass (SAQA, 2008). This creates a shortfall in the number of students who qualify to enter tertiary institutes to major in technology courses, as mathematics is a prerequisite to the study of technical subjects. Given that mathematics is a prerequisite to embark upon a SE degree at universities, poor mathematics results imply that few students are qualified to enter SE courses at universities, a situation which fuels further shortages of software engineers in South Africa.

Several initiatives to solve the SE skills shortage have been in place across the country since the Skills Development Act of 1998 (SkillsDevelopmentAct, 1998). There are four main internship schemes that are used. The first is the SETA, Sector Education and Training Authority. The second one is where companies concentrate on developing their people in order to build the talented, high skill workforce required at work place for growth (Neuman, 2008). The third is the learner ship/ Internship program where students acquire skills through an academic program at tertiary institutions, and are awarded a degree or diploma in that particular area of study (Skills Development Act (No 97 of 1998). The fourth is skills acquisition through experience, where graduates and other employees gain experience on the job supported by short courses that lead to certifications. This is yet another way of

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[3] An exabyte (EB) is a large unit of information equivalent to one quintillion (Green et el, 2005)

closing the skills shortage gap (Schofiled, 2010). According to CareerJunction, SE skills shortage is seen mainly in the regions of Gauteng and the Western Cape (Nthoiwa, 2011.

2.5   SE skills Shortage in the Western Cape Region

The Western Cape Province is one of South Africa's strategically located provinces that contribute towards the nation's economic growth (City of Cape Town, 2012). However this province has a potential to perform far better, were it not for the challenge of a SE skills shortage (Govender, 2011). Since SE is the main driver for economic growth, the Western Cape economic growth is slowed down by these shortages (Winde, 2009). What complicates matters even more is that out of the few graduates and skilled SE personnel that there are, only a few stay to work in the area, while many of them migrate to other areas for higher paying jobs. As a result of few skilled personnel in the province, companies also face a problem of staff retention as employees 'job trot' from one company to another as companies scramble for skilled people (ITWeb, 2011).

2.6   SE Internships in South Africa

Skills development initiatives are a sound business investment to add technical skills needed in the Software Engineering industry (Baldwin, 2013). These SE Skills Development Initiatives in the form of internships avail good chances for Software Engineering companies to teach and nurture interns in specialized skills required in the Organisation (Thakurdas, 2013). Hence, the internship positively impact the Software Engineering industry to gain its competitive advantage. Adding on to that the Institute of Information Technology Professionals in South Africa has indicated that Skills Development is important to the South African economy and there is need to facilitate such initiatives to meet the growth and National development targets of the country.

Furthermore, there is need to focus on the efficacy of the existing internship programs and nurture the successful skills initiatives Doyle (2015). For example, the South African government in partnership with the industry and academia have joined together to combat the Software engineering skills shortage problem in South Africa. To this effect, the JCSE initiated programs focusing on developing skills in Software development for South Africa and the rest of the continent (IITPSA, 2013). This program is called, the MIT's Accelerating Information Technology Innovation (MIT AITI) program, hosted by Wits University and the Johannesburg Centre of Software Engineering (JCSE) to develop skills in mobile technologies, software development, and entrepreneurship (WITS, 2015).

2.7   SE Internship in the Western Cape Region

Since Talent and skills are an issue, several skills development schemes have been initiated to cope with the human capital demand in the software engineering (SE) field since the Skills Development Act of 1998 (SkillsDevelopmentAct, 1998). To drive this initiative government has launched several new mechanisms aimed at Skills Development, which includes amongst others the Skills Development Act and the Skills Development Element of Broad Based Black Economic Empowerment. These are practical programs put in place to develop courses that can spread and promulgate knowledge to the young and unemployed (Hall & Saunderlands, 2009) and referred to as internships. Internships is a combined programme of work related learning which comprise of theory and practicals (Kruss, 2014).The internship programmes are designed to equip graduates with skills needed in the work environment (Kruss, 2014). In this respect, the emphasis by the Provincial government,SE industry and tertiary institutions, is placed on developing skills in the SE sector by educating those who are unemployed and do not hold an SE qualifications (Organisation A, 2009). The learner-ship programs encompass theory and hands on practice in the world of work for school leavers and new unemployed graduates (Murray & Roberts, 2009). This is commonly known as the CAPA Citi 1000 program. According to Career Junction, IT skills shortage is seen mainly in the regions of Gauteng and the Western Cape (Nthoiwa, 2011). However to describe and explain the skills shortage phenomenon in this dissertation, theories are adopted.

2.8   Analytical Framework

An analytical framework is a structure through which an investigation and its analysis can be based (Mlitwa, 2011). Depending on the type of paradigm used, several theories exist in research and these include Structuration Theory (ST), Activity Theory and Actor Network Theory (ANT) (Flynn &Gregory, 2004). Within the interpretive paradigm, the commonly used theory is the Actor Network Theory (ibid).

The importance of theories lies in the fact that if they are tested and proven, they can be relied upon to conduct studies of the same nature. Actor Network Theory is made up of sociology of translation (Gao, 2010) and it emphasises the understanding of the association between human and non-human actors. According to Callon (1986), translation is comprised of four moments which are Problematisation, interessment, enrolment and mobilisation. The potential contributions and applicability of ANT, to evaluations on the efficacy of SE skills development initiatives in the WC, in this study, are further elaborated in chapter 3 under the framework section.

2.9 Conclusion

In this chapter, after an introduction which gave a roadmap to the chapter, discussions were presented on prior research in the SE field. Several publications report studies that were done regarding SE skills in South Africa, SE skills shortage in South Africa, SE skills in the Western Cape in particular and SE skills shortage in the Western Cape, but not on the efficacy of SE skills development initiatives in the Western Cape. This is the main focus of this research.

This chapter has highlighted the fact that Software Engineering is important in all industries be it farming, banking, or educational sector. It is the main driver for economic growth in all countries including South Africa and in particular its provinces like the Western Cape. Due to technological advancements, the main challenge for the economic growth is when there is a lack of these SE skills. Most of the literature has advocated for a drive to increase SE skills in South Africa as a whole, but the need is more pronounced in the Western Cape Province.

Skills shortage has largely been blamed on the low pass rate in matric mathematics and several skills development initiatives have been put in place to try and solve the skills shortage problem, in particular in the Western Cape. These internships include SETA, Sector Education and Training Authority. An investigation into these programs will be made and analysed using the analytical framework and several theories introduced in this research. The research approach and analytical framework for this investigation is elaborated in Chapter three (3).

CHAPTER 3: THEORETICAL FRAMEWORK

3.0 Introduction

A theory is a set of statements used to explain and describe a phenomenon (Kaplan et al, 2004). Theories are also used as a basis for making predictions and they can be used in the deductive and predictive sense, through hypothesis formulation and testing (Mlitwa, 2011). A theory can also be used in a non-predictive, but inductive sense as a lens through which a phenomenon can be viewed and analyzed (ibid).

In deductive reasoning, a theory is used to test a hypothesis. A person can formulate a hypothesis to prove or disprove a theory within the positivist philosophical paradigm. The positivist approach describes (rather than explains) the phenomenon. As a research paradigm, positivism advocates the similarity of, and a need for, a common approach among all scientific disciplines, a model of thinking more pronounced in natural sciences (MIS Quarterly: 2004). However, this study is about the efficacy of SE internship programs. The essence of an investigation is on ascertaining the inter-subjective (rather than the fixed objective) mediating aspects, which does not fall within the deductive positivist paradigm, but inductive approach. Also the goal is not about testing a hypothesis. Instead, the goal is to understand the efficacy of SE internship programs and the environment of the problem as it unfolds. Inductive reasoning allows researchers to use theories as frameworks to better understand and analyze a complex phenomenon. The study requires some explanation of the environment in which SE works and entails the status quo so that there is a foundation from which clear insights can emerge.

This chapter outlines the theoretical framework adopted in this study. A framework is a conceptual structure designed to serve as a support or guide for the building of something that expands the structure into something useful (Rousse, 2005). Frameworks, models and taxonomies are all approaches which help to structure and classify concepts and relationships in a subject. The main difference between a framework and a taxonomy is that whilst a taxonomy is a collection of controlled vocabulary of terms organized into a hierarchical structure, a framework expands that structure into something more useful providing a lens through which an investigation and its analysis can be made. In this respect, a number of theories are used in the socio-technical space, as a basis for theoretical frameworks and lenses through which complex inter-subjective phenomena can be viewed and analyzed. Actor Network Theory (ANT), which is one of the most common theories in the socio-technical space (Mlitwa, 2011), was adopted as an analytical framework for this study.

The relevance of and the motivation for the use of ANT theory, as well as the technique of its application in this dissertation - is presented in this chapter. To this effect, the structure of the chapter is outlined in Figure 7 with the application of theory elaborated in more detail thereafter.
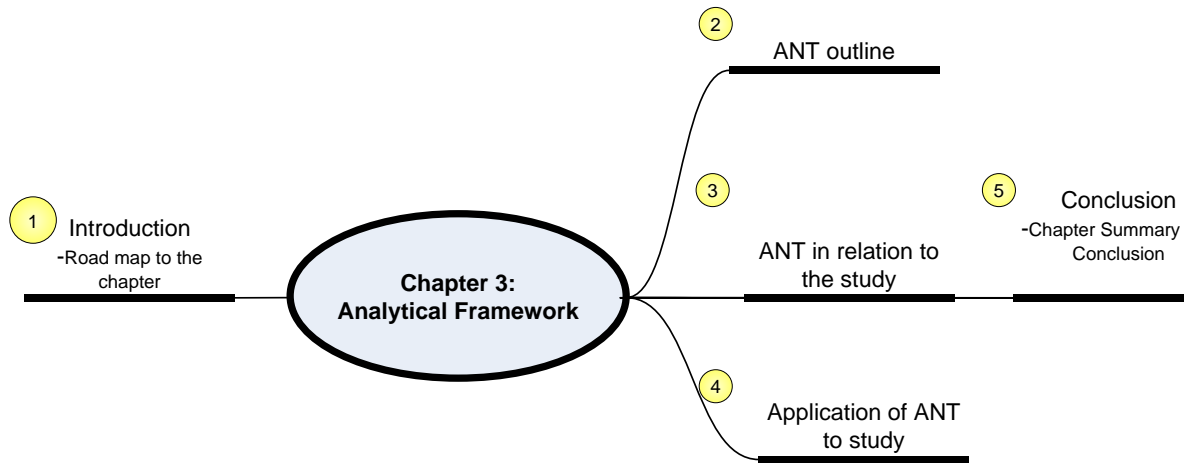
Figure 7: Chapter 3 Roadmap

3.1 Actor Network Theory (ANT)

The Actor Network Theory is a popular theory in Information systems research (Mlitwa & Nonyane, 2008). It was developed by Callon, (1986) and Bruno Latour (Boyne, 2001).This theory is used as a framework and a systematic way to consider the infrastructure surrounding technological achievements (Latour, 1992). The main focus of this theory is on technology and its effect on social processes (Mlitwa, 2011). ANT considers the world as consisting of networks (Law, 1992), and explores ways in which the networks of relations are composed, how they emerge, how they are constructed, maintained, and are made durable overtime (Law, 1999).

The attributes in the network can include humans, things, ideas, concepts and these are called actors in the network (Law, 1992). This theory concentrates mostly on how networks come into being, tracing what associations exists, how actors are enrolled into a network and how they fall apart (Latour, 1992). The most detailed ways of understanding, and the useful means of applying a theory in a study, according to Mlitwa (2011), is to first identify, outline and then clarify the underlying concepts, the key assumptions as well as linkages and their implications. These can be translated and applied to a current phenomenon of an investigation (or its equivalent). In line with this logic, the key terms of ANT are presented in the following passage.

3.1.1   Key Concepts and Underlying Assumptions of ANT

The essence of the Actor Network Theory (ANT) is based on the concepts and the underlying assumptions that constitute it. The meaning and the logic, by which the relevance and usefulness of ANT can be determined, are largely based on the following key terms that are used in the theory: the Problematisation, the Obligatory Passage Point (OPP), process, Interessment, the enrolment, mobilization, the actors, actants, the symmetrical principle as well as the network itself.

- **Problematisation**

Problematisation is the identification of what constitutes a problem to be solved (Walton, 2013). It defines the problem and describes the initial phase of the translation process and the creation of the network (Crotty, 1998). The application of this process in the context of this study is elaborated in section 3.1.3.

At the outset, the researcher wrote down all questions that needed to be answered during the interview process. From the many questions the researcher had, the main question pointing to the problem was: What is the efficacy of the internship component of the Software Engineering (SE) sector in the Western Cape? It was from answers to the sub questions and the main question that the researcher was able to identify all the human actors that formed the network. The actors include SE University Head of Department (HoD), Internship Organisers, Employers and Students. The researcher did not use the same questions for every actor.   The questions were categorised. This process is called problematisation.

The main focus of ANT theory is to identify problems of concern that all actors will be able to address (ibid). In this study all Universities and Internship organisers seek to address the problem of SE skill shortage. The SE industry is also trying to alleviate the problem by enrolling interns whom they train with the SE skills that are required for optimal performance in the field of operation.

- **Obligatory Passage Point (OPP)**

This is the initial phase of the translation process, and important in the formation of a network and an action program (Star, 1995). It defines the roles that are to be played and the way actors relate to each other within the network (Pillay, 2010). The OPP can be a focal actor in the network that shows interest in all the other networks (Callon, 1986). The OPP is important since it is the point of access into this collective action, and it is a necessary element for the formation of a network. In ANT any compulsory action (e.g Studying to get employed in the SE industry, Lecturing to feed into the SE industry), is called an Obligatory

Passage Point. All actors and actants that move through, or to, the OPP, effectively become linked and their network becomes more strong and durable. Without a properly linked network then there is a risk of actors and actants chasing their own interests and this destroys the network. This would produce a diversion from the proper network pointed out in the ANT. The entire project turns around the question of how to alleviate SE skill shortage in the SE industry. The main goal of all actors and actants is to feed well trained personnel into the SE field of operation, and hence the OPP in this research is the SE industry.

Actors and actants become fully functional by passing through the obligatory passage points. According to Callon, 1994 the ideal role of the OPP should be to mediate all interactions between actors in a network and to define the action program. In the context of this study the OPP is the Software Engineering (SE) Industry.

- **Interessment**

Interessment is the stabilization of a network after the problem has been defined and new actors have their tentative roles (Callon 1986). According to Latour (1992), interessment is used to strengthen the network by reinforcing the association between actors, and it supports the structure of the network.

The network presented in this study is comprised of Universities, SE Heads of Departments (HoD), SE Students, Internship Organisers, SE Employers, SE courses, Computers and SE Skills. These human and non-human actors accept characteristics of a network according to strategies of interaction in the ANT. The interaction between these actors and actants should not only be mutually engaging but keep interpreting and aligning everyone's interest with the network's interests (Mlitwa, 2012). Thus actors and actants do not work in their own capacity but in the interest of the network goals.

- **Enrolment**

Enrolment is known as the third stage of translation in the ANT. According to Gao,2010 , enrolment plays a vital role in pointing out tactics in which a main actor tries to define and connect the various roles that permit joining of other actors. It requires the initiator to convince other actors to join in (Macome, 2008) and these actors cannot work outside the network. Thus ANT considers a continuous enrolment of actors into the network (Mlitwa. 2012). Enrolment is important as it binds elements together to maintain a successful network. An ideal network should be well balanced and actors and actants should be willing to take part in ways of thinking and acting that maintains it (Habib, 2012). Enrolment can be seen as a successful outcome of the problematization and interessement processes. (Macome, 2008).

- **Mobilisation**

Mobilisation is the final translation stage. According to Callon, 1986 mobilisation refers to the ways which guarantees that human actors have appropriate speakers to represent them in a more trustable manner. Mobilisation is important in order to organise network resources (human and non-human entities) and to interpret ideas conceived for the benefit of the network. In this study mobilisation is important in that a clear organisation of actors and actants enhances functions of the network. This facilitates the identification of clear roles and responsibilities of actors and actants in the network.

- **Actors**

An actor is any recognizable character who occupies a functional position in relation to events. An Actor is a person or object, meaning that it is something that acts to which activity is granted by others. In this research as shown in the ANT figure 8, actors include Lectures, Employers, Internship Organisers, Students, Software, Universities and Computers. These actors include human actors like employers, lecturers, internship organisers, students and on the other hand none human actors which include lectures, computers, software and Universities. These actors are important in this study for the network to be balanced. If one of the actors is removed from the network, then connections are broken and the network ceases to be complete. This would mean that the purpose of the network cannot be achieved - in this case, there will not be a balance of SE skills in the industry.

- **Actants**

An actant is any participant in an endeavor, whether human or non-human upon which activities by actors unfold. According to Norbet (2011:108) an actant is "any agent, collective or individual that can associate or disassociate with other agents". An actant is defined by what it does, in essence, what function it performs within a discipline. An actant can be anything provided it is granted to be the source of an action (Latour, 1992). It appears through trials such as experiments, tradition, practical application, and once its researchers believe that it performs effectively (through a regularized process, such as peer review, it is admitted to an institution (Jablonski, 2001). Actants are important as they give shape to the balance of the network. For example, in this research the network would not be a network if we had no SE industry. Actors like students, lectures, internship organiser are there to contribute to feeding the SE industry with SE skilled human resources. These are important because the purpose of this research is to have a meaningful problem to be investigated.

- **A Network (of Actors and Actants)**

An actor-network is composed of many entities, actors and actants that form a network. Each actant enrolls the other, that is, finds ways to convince the others to support its own aims. By so doing the network grows bigger and the more actors and actants that are enrolled the stronger and more durable is the network that they form (Clay, 2008).

- **The Symmetrical Principle**

ANT is built on the assumption of heterogeneous formations of actors and actants (Hanseth & Monteiro, 1997). In other words, similar roles are being played by humans and the technology. The principle of symmetry state that humans and technology must be treated equally in the analysis of real-world situations as they both contribute to the goals of a network. This idea was developed by Callon who called it the principle of generalized symmetry. Since then this theory has been in use in Science and Technology Studies. For example, there is no distinction made in the treatment of human and non-human actors such as Software, Computers, Universities, Lecturers and Students, to mention a few, in the ANT diagram presented. The aim is to influence the development of Software Engineering Skills in the SE Industry. The general principle of symmetry is the central ideology of actor network theory in the technical and social worlds. In this research, the principle of general symmetry in actor network theory is taken seriously and the researcher seeks to understand how actors and actants act and the implications of their actions using concepts provided in ANT.

In ANT, no actor can be viewed to operate on its own separately from other parts of the network (Mlitwa, 2011). If an actor can operate separately then it ceases to be a part of the network because a network is pictured as a mixture of textual, conceptual, social and technical actors (Ritzer, 2004).The actors are all considered to be equal and no level in the network is more important than another (Boyne, 2001). ANT is seen as a heterogeneous network where various social and non-social elements are channeled in such a way that they can work together (Mlitwa, 2011). According to Mlitwa (2011), the symmetrical assumption between human and non-human actors in a network assumes some level of balance between roles and relationships of actors within a network, meaning that a non-human actor is by no means inferior to a human actor.

ANT assumes that technology emerged from social interest and therefore, it can shape social interactions (Prout, 1996). The main components of ANT are actors and actants. The relevance of using the ANT in this study is discussed below.

3.1.2 How is ANT Appropriate for this Study?

The focus of this study is on people (trainers, students, internship coordinators and employers), software, software engineering (SE) and SE skills. More significantly, SE is considered important, but not more important than the skill to use it, and the skill not more important than the curriculum and programme to produce it. There are strong and necessary links between those who seek to develop their skill, those who provide the skill, those who coordinate the internship programme, those who employ the skill and ultimately, those who use the skill to produce outputs. The realisation that these links seem to resemble the heterogeneous symmetrical and interrelated parts of an SE-Skills development network – is clear in this study. In addition, the Actor Network Theory (ANT) has been used by a number of researchers in similar studies, with great success.

(Gao, 2010), applied ANT in analyzing the socio-technological construction of China's strategy for telecommunications market transformation. Harty (2010) also used ANT to trace and unpack interactions occurring around the implementation and use of innovations within construction contexts.

ANT is well suited to inform scholarly inquiry in areas where the relationships between the various elements of investigation are fast-changing and do not easily lend themselves to a clear categorization (Johannesen, 2013; Johannesen, Erstad, & Habib, 2012). In this study various relationships between students, universities, SE courses and SE fields of operation are investigated. The SE field of operation is fast changing as the world of technology we are living in is fast changing. The skill set required by the Software Engineering industry often changes as a result of technological advancements. ANT has also been used in studying," cultural networks of the international students network that they form together with their study programme and the technology in use at their institution" (Habib, 2012). These studies are of a similar nature to this current study and thus, ANT was chosen as the best theory for this study.

3.1.3 Application of ANT to this study

The ANT framework in this study presents a network which is comprised of the OPP, actants, human and non-human actors, as well as translation phases which comprise of problematisation, interessment, enrolment and mobilisation.

A diagram in Figure 8 represents the ANT theory adopted in this study.
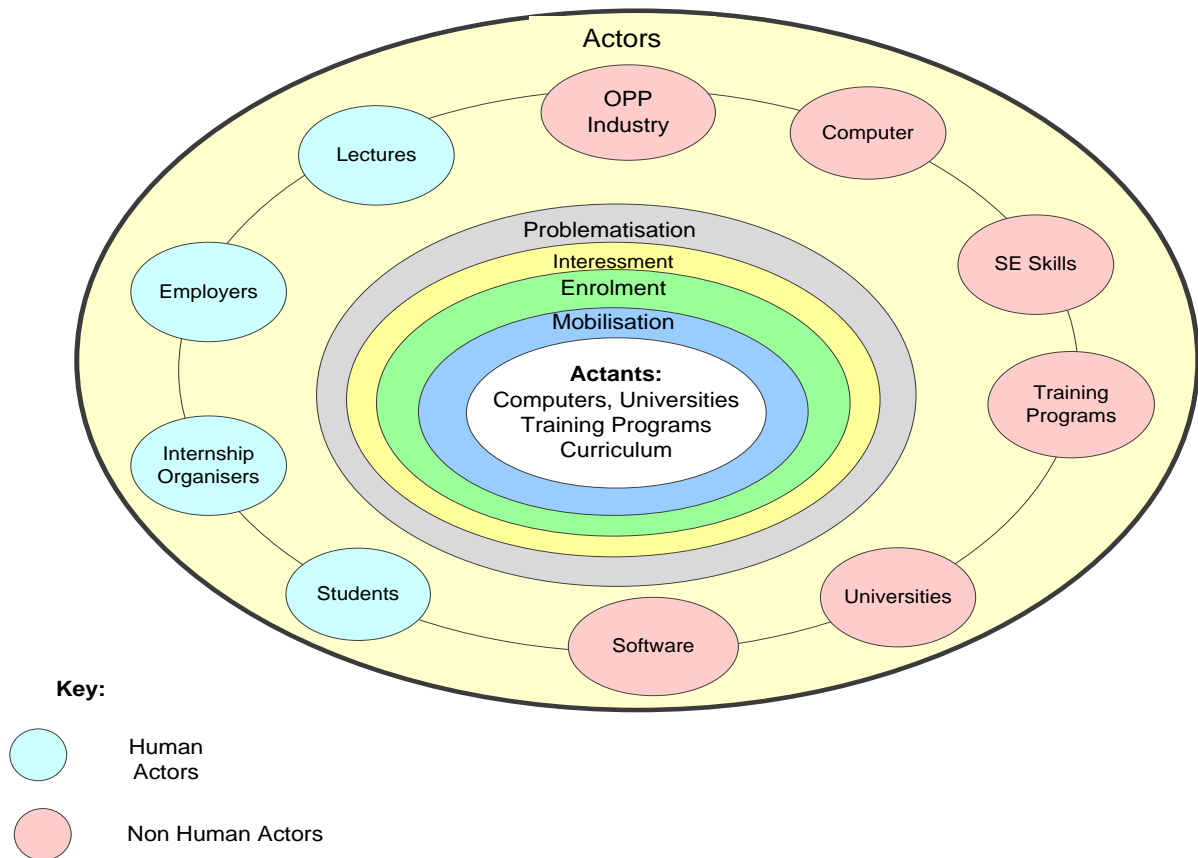
Figure 8: ANT Diagram

3.1.3.1 Actors and Actants

In this study human actors include university lecturers, students, internship organisers and employers. On the other hand non-human actors in this study include objects such as computers, software programs, the SE industry, SE skills and universities. University lecturers and internship organisers are important in the network as they facilitate training programs in universities. Without lecturers, universities cannot run and also without students the network is incomplete. This implies that each actor in the network is as important as any other for the completeness of the network (Mlitwa, 2011).

In Figure 8, employers, interns, internship organisers, universities, training programs, SE skills, as well as software and computers, are identified as human and non-human actors.

As the network phenomenon infers however, the relationship between these aspects defines a network in the context of this study. With an appropriate quality therefore, software programs facilitate the proper functioning of any form of technology. Without properly running software, no production will be possible as every machine is embedded with

software to direct its functioning. As an important actor, software facilitate the running of any form of technology in any industry – be it banking, farming or education. Closely linked to the software component of the network is the human actor – the software developer whose skill determines the quality of the software output, and ultimately, the extent to which the goal of a software development project is (or is not) realised. These software developers need to be produced from the SE tertiary institutions which enrols SE students. In an ideal situation according to the ANT, the fulfilment of the SE Industry should be that Software developers are sufficient to satisfy the SE Industry demands. In this study a balanced network should have adequate SE skilled personnel for the SE industry and this can only be satisfied if there are adequate students to enrol for the SE programs. To this effect, the second set of actors – the training institutions, should play a significant role

Universities are important as they run different SE courses to supply the industry with potential SE skilled resources. Without adequately trained SE lectures and a proper SE curriculum, it is almost impossible for Universities to produce well prepared interns for the SE industry. Further, SE tertiary institutions need regular input from the SE industry on what skills are required. Only then can these skills be incorporated in the University SE curriculum. If this does not happen, the Universities will produce interns that will be inadequately trained and thus less well prepared for the industry, due to the inadequate curriculum. The effect of not having properly skilled resources will be that it will be difficult to run any form of technology in any industry for good production. This situation would result in loss of revenue leading to economic down turn. Universities as SE training institutions need to work closely with the SE Industry, as the industry needs to promote the skills development initiatives by offering SE internship to graduates. In cases where there is a lack of communication between Universities and the SE Industry, then that is where Internship Organisations come in to facilitate. By closing the communication gap between Universities and the SE industry, Internship Organisations augment the SE network; otherwise it ceases to be a properly functioning network. Likewise, if Universities are removed from the network then there is no training and production of interns to feed into the SE industry.

Furthermore, if software is removed from the network, then there will be no point in having SE Industries and any form of organisation that uses software in their day to day operations will be affected financially. This leads to loss of revenue. it is not only the SE Industry that will be affected but interns will have limited job opportunities which will increase unemployment levels. This is something that is already a problem in the South African economy. Internship Organisers cannot exist on their own: they need software and SE Industries. The existence Internship Organisers is largely dependent on the existence of all

the actors named in the ANT diagram. Thus all actors in the network for this study are equally important for the proper functioning of the network.3.2

SE interns are crucial as they are the main focal point of this study. The existence of universities is as a result of a supply of good students. To enrol for SE programs at Universities students need to have a good pass in mathematics in their matric examination. If the number of people who have a good pass in   mathematics at matric is low, it means there is a low level of enrolment of students into the SE programs in Universities. Not only does this affect University enrolment but the end result will be an inadequate supply of SE interns to service the SE Industry. In such a scenario, where adequately prepared interns are in short supply, there is less that the SE industry can do. to support the Internship programs that offer internships to graduates. To this effect an imbalance in the network would exist which is not what is advocated by ANT. If such a situation exists then the SE skills shortage will remain a problem in the field of operation.

The diagram presented, fully supports the idea, as there is no hierarchical order in the framework. The only differences within the network are the roles of the actors. Each role is significant, but equally important, for the proper functioning of the network. Actors and actants are presented in a wide circle and are all joined by a dotted line that symbolizes the symmetrical inter-linkages between the network entities. This follows the principle of similarity of actors and actants in the network. No actor is superior or inferior to another (Mlitwa, 2011). Different colours have been used to distinguish between the human and non-human actors in the framework diagram (Figure 8). Also the position of the actor does not imply any inferiority of one actor to another. All actors are equally important and if one actor is removed from the network then the functioning of the network is affected (ibid).

In a network, different interrelated activities are joined together to achieve the same goal (Law, 1992). In this study computers, software programs, SE industry, SE skills and universities facilitate SE training programs to alleviate SE skills shortage in the field of operation and particularly in Cape Town.

3.1.3.2 Problematization

According to Gao (2010), problematization is the first stage of the translation in the ANT. This stage mainly includes the initiation of the project idea, identification of actors as well as the OPP (ibid), and the associations among the actors (Callon, 1986). In the case of this study, the initiation of the idea refers to the analysis undertaken to allow the project to be started.   This entails planning, analysis and understanding of the problem under investigation and budgeting of the project.

In this study an association between actors and actants in the ANT diagram must be formed in order to deduce clear answers to the problem. Actors in this study are important as the initial phase for the creation of the network and defining the problem (Crotty, 1998) which is represented as problematisation in the framework. The main objective to be achieved by actors and actants in this study is to develop SE skills through education in universities and internship programs in various organisations. The creation of SE skills will help alleviate SE skills shortage which is the main purpose of this study.

Collaborative efforts are made by the provincial government of the Western Cape together with the industrial Sector and tertiary Institutions to develop relevant SE skills through structured curricula, with a balance between theory and practice through internship programs. For example, employers are required to contribute money in the form of a skills levy, to ensure funding is available for skills development, especially for scarce skills, and this money is used by the SETAs. This money is paid back to companies that have internship programs in the form of a grant to employ unemployed people for internships. All this is done to equip unemployed graduates with experiential learning thereby alleviating skills shortage. For a successful network the ideal problematisation process should be when all actors collaborate to address the SE skills shortage problem. In the case of this study, the government, SE industries, Universities, and interns working in different ways to alleviate skills shortage, is problematisation.

3.1.3.3 Obligatory Passage Point (SE Industry)

The Obligatory passage point (OPP) is a point on the network that every actor has to go through for the network to continue. The OPP, which is the focal actor in this study, thus, is the industry (represented by employers). Basically, it controls the resources needed to achieve the actants outcome. The OPP defines the critical skills needed in the SE industry and employers recruit from universities and internship organisations. Interaction between employers and universities encourages the proper preparation of curricula to be taught to students; this enables students not only to be marketable in the SE industry but also ensures successful employment for the interns after graduating. In this study the OPP is considered as the SE Industry as it is this actor that determines what needs to be taught, and the focus for all trainings is to feed the industry.

In this, the SE industry mediates all interactions between actors and actants. The Provincial Government, Tertiary Institutions, Students, Universities and Internship Organisations are all working towards feeding skilled graduates into the SE industry. Thus the SE industry is the focal point for all actors and actants hence making it the OPP. Without the SE Industry, there

would be no need of skilled Software Engineers which implies that there would have been no point for SE Tertiary Institutions, SE Internship Organisations and the Government to work together towards up-skilling Software Engineers. All the efforts made by actors and actants in figure 8, need to satisfy the needs of the SE Industry. Thus the SE industry is the focal point for all actors and actants in this study. For a successful network, the ideal OPP should be to mediate all interactions between actors in a network and to define the action program. The OPP should be the focal point where actors and actants converge to address the SE skills shortage problem. The OPP thereby mediates all interactions between actors in a network and defines the action program and this will be analysed in the findings section to determine if that is the case in the current study.

3.1.3.4 Interessment

Furthermore in ANT, interessment is used to strengthen the association between actors and it supports the structure of the network (Latour, 1992). In this study, universities train students according to their curricula and supply the industry with interns. On the other hand some industries, who work with internship organisers, come up with a set of skills that interns, who will later on be employed in those same industries, need to acquire. This process strengthens the network and supports the ongoing interactions within the network. In short then, for a successful network, the ideal Interessment process should be when Universities strengthen their relationship with interns and the SE Industry. This association between Universities and the SE industry should be facilitated by communication between these actors. Universities should get an input from the SE Industry when preparing their SE curricula. This would eliminate the risk of delivering modules that are not beneficial to the SE Industry, as the SE Industry is dynamic and fast evolving. Further, SE Industries should be willing and readily available to offer hands on experience to well prepared and qualified interns. Provincial government and SE Industry must work together to put structures in place that promote internships. The status of an ideal interessment process in this study will be observed in the findings.

However a network cannot be strengthened when the trained interns do not get enrolled. Thus enrolment is of much importance in the ANT as well as in this study.

3.1.3.5 Enrolment

ANT considers a continuous enrolment of actors into the network to be important. (Mlitwa, 2012). By enrolling into the network, Universities are responsible for offering SE courses for which students can enrol. The main roles of Lecturers and Internship Organisers' are to facilitate the study of SE skills by students. On the other hand, employers are responsible for

employing qualified SE skilled interns in the SE field of operation. Thus, enrolment is a multiparty power process.

Since SE skills are so important in the SE industry, Universities and Internship Organisations have a strong potential to enrol actors and actants. These actors and actants shape their ideas of what reality is about, how reality should be, and how the desired state can be achieved (*Ibid*). Enrolment is important as it binds elements together to maintain a successful network. An ideal network should be well balanced and actors and actants should be willing to take part in ways of thinking and acting that maintains it (Habib, 2012).

For a successful network, an ideal enrolment process should have a balance of actors and actants who interrelate the various roles in the SE industry. In the case of interns, there should be a high pass rate of mathematics at matric level as that increases enrolment levels for potential SE students in tertiary institutions. This can only be successful if there are enough qualified mathematics teachers at matric level who can produce students with a high mark in mathematics. In addition to qualified teachers, there should be adequate University SE lecturers to SE student ratio in tertiary institutions. These SE lectures must be qualified to lecture SE courses at University level. On the other hand, enrolled students must be hardworking and willing to put in an extra effort when studying towards SE programs. Observations will be made in findings to determine status of this in the current study.

Enrolment can be seen as a successful outcome of problematization and the interessement processes (Macome, 2008).

3.1.3.6 Mobilisation

The processes whereby tertiary institutions adopt measures suggested by employers, and include them in university modules, is called mobilisation. According to Thapa (2011), the solutions implemented during problematisation start to operate during mobilisation. Thus ANT is a very practical approach in investigating the efficacy of a skills development initiative in the SE industry, as it attributes equal importance to all actors in the network. The provincial government of the Western Cape in conjunction with employers, interns, universities and internship organisers are all important in the alleviation of the SE skills shortage in the Western Cape region in South Africa. If any of these actors is removed from the network then the SE skills shortage will never cease to be a problem in the region. For a successful network, the ideal mobilisation process in the context of this study should be when tertiary institutions engage with, listen to and adopt feedback from employers. This includes collaborations with structures such as the Computer Society of South Africa (CSSA), SE Industries and interns, so that an SE curriculum directly relevant to the operational needs of the industry can be defined. The provincial government should also be

involved; it should work with all stake holders involved in the internship network to come up with solutions that alleviate the SE skills shortage problem. The findings chapter will discuss the level to which these aims are revealed in the current study.

3.2 Conclusion

In this chapter, the ANT theory is discussed as the most relevant and practical framework for studying the efficacy of SE skills development initiatives in the Western Cape region. The purpose of the theory is to give proper meaning and clarity to how dependant each actor is on others in the network.

As discussed in this chapter, ANT played a significant role in helping break down the different components of the SE skills development and internship initiative in South Africa. For example the breaking down of different actors and actants, identifying the OPP, and the different translation processes, which include problematisation, Interessment, mobilisation and enrolment. Furthermore, it has helped by linking these components together and giving an understanding of the role played by each actor and actant in the technology network discussed in this study.

The ANT has also helped in understanding the assumptions of a network and in making sense of them in the current study. These assumptions include the understanding that each actor and actant in a network plays a vital role in as far as sustaining that network is concerned. An Internship program is viewed as a network that incorporates interns, software programs, software, SE tertiary institutions, Universities, SE employers, Internship Organisations and the SE Industry. All these actors and actants are equality important and the removal of one, or the improper functioning of one, can have a large impact on the proper functioning of the Internship network. In the ANT human and non- human actors do not serve individual goals but they align their interests with the network interest, which, in this study, is the production of skilled SE Interns. Individual goals are not promoted in the ANT.

Further, the collaboration and engagement between different actors and actants in a technological learning environment align with each actor's role in the network. Universities largely depend on the students that enrol into the SE programs and SE industries also depend on the output from SE tertiary institutions. This implies a mutual engagement between various actors inside the internship program network. Thus ANT is a framework that is very relevant to the current study.

All the identified actors are equally important in contributing towards the SE skills required in the SE industry. In the diagram actors depicted in different colours are only a means of representation and by no means refer to the superiority of one actor over another.

The theoretical framework presented in this chapter is used within the interpretivist epistemology, together with a qualitative research approach (including a methodology) as presented in chapter 4. Implications of the theory are then integrated with the key assumptions from the literature, and used as analytical lenses to view the findings in chapter 5.

CHAPTER 4: METHODOLOGY

4.0 Introduction

Building on the ANT as a theoretical framework in chapter 3, this chapter outlines the research approach and the methodology that was used to investigate the efficacy of the internship component of SE in Western Cape.

Out of so many methods and techniques that exist in the field of research, specific methodologies were selected and this is detailed in the sections under this theme. Reasons why such a methodology was selected is explained in relation to the qualitative nature of this study. The composition of this chapter is shown in the chapter Outline, Fig 9 below.
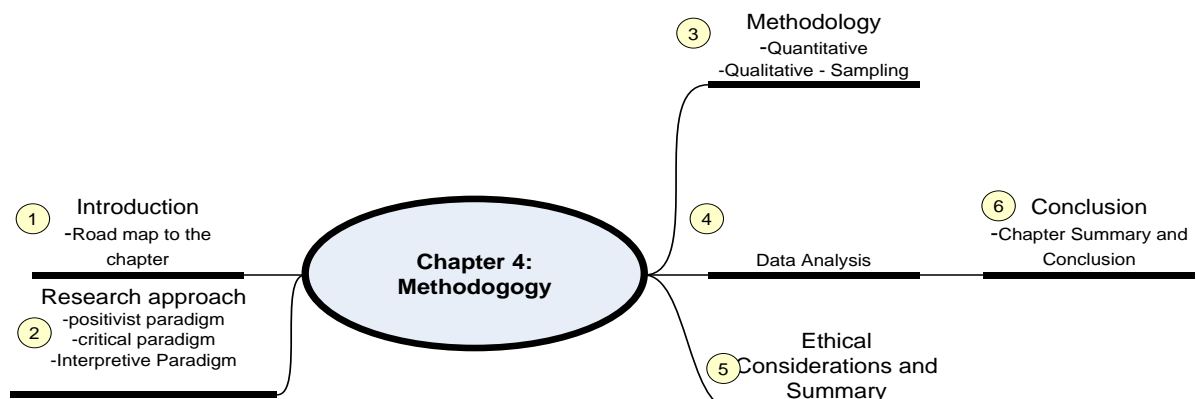
Figure 9: Chapter 4 Roadmap

4.1 Research Approach

When conducting research, there are several theoretical assumptions and philosophical convictions that are adopted (Mlitwa & Van Belle, 2010).These theories and convictions refer to what is known as the Research Approach. This is important in research as it helps to shape ideas and actions in research (MacArthur, 1992). A usual research approach integrates a paradigm, conceptual and theoretical frameworks. (Kuhn, 1996). A paradigm is a way to reflect and share main assumptions and values about a discipline (Burke, 2007). It also includes methods and techniques for the research design, to collect, analyse and interpret data (Kuhn, 1996). There are several paradigms that exist in information systems research and these include Positivist, Critical and Interpretive. These are discussed below; together with why the interpretive paradigm was chosen is explained.

4.1.1 The Positivist Paradigm

This research paradigm supports experimental and quasi-experimental designs using formal and deductive logic rules (Howcroft &Trauth, 2005). In the Positivist paradigm, facts are considered to be measurable and the paradigm emphasizes that real events can be

observed empirically and explained with logical analysis (Burke, 2007). Based on logical analysis, the most suitable use for this is in quantitative research (Babbie &Mouton, 2001), as this type of research focuses on logical analysis. Researches under this paradigm are often involved with hypothesis formulation and the testing of theories (Myers, 1997). As this research has a qualitative nature of explanatory data, a positivist research paradigm will not be suitable for conducting this study. The efficacy of SE skills development initiatives in WC cannot be fully uncovered by using the positivist research paradigm; therefore, the possibility of using the Critical paradigm is explored in the section below.

4.1.2 The Critical Paradigm

The Critical research paradigm is an additional level of analysis that can be added to the Positivist or the Interpretive paradigm (Niehaves &Stahl, 2006). Critical theory focuses on oppositions, conflicts and disagreements in contemporary society (Myers, 2009). It is mostly concerned with evaluating the existing social systems and explores any impediment or repressive social order that may hinder their structure (Orlikowski &Baroudi, 1991). More interest is placed on the way people think, act and how social circumstances influence those thoughts and actions (ibid). However for the purpose of this research, the focus is not on the way people think but on the efficacy of skills development initiatives. The researcher seeks to understand the imbalances existing between skills development initiatives in SE and the demand for skills in industry. These imbalances are not influenced by the way people think but rather by the level of skills training in the SE space. Thus Critical paradigm is not a suitable theory for this research.

4.1.3 The Interpretive Paradigm

Unlike the Positivist Paradigm, the Interpretive Paradigm considers the social context, conventions, norms and standards of a community as important in understanding human behaviour. It relies on multiple realities and multiple perceptions about a single reality (Healy & Perry, 2000), with assumptions that are not objectively determined but which are socially constructed (Husserl, 1965). The Interpretive approach is a research paradigm which lays emphasis on explaining a happening exactly as people see it (Orlikowski W & Baroudi, 1991). It advocates the fact that to understand people's perceptions you should put them in their social context (Willis, 2007). In this approach knowledge is gained, "through emphasis on social constructions such as language, shared meanings, documents, tools and other artifacts" (Kaplan & Maxwell, 1994). This approach is used most in qualitative research to understand phenomena in their context and underlying environments, an approach which is in line with the objectives of this study.

Because of the qualitative nature of explanatory data in this investigation, an interpretive approach to the study is followed. For the purpose of this research knowledge is largely from the literature (secondary data) and direct interviews (primary data) where participants express their experiences pertaining to the IT skills development initiatives in Western Cape. Therefore, the interpretive approach seems most relevant for the purposes of this research.

Details of participants are given in the sampling section.

4.2 Methodology

A research methodology refers to the collection of methods, techniques, assumptions and values and their use in a given research context (Babbie &Mouton, 2001). The most used methodologies in the interpretive research paradigm are quantitative and qualitative research approaches (Neuman, 2006). According to Neuman (2006), a choice of methodology is informed by the research problem, research question, the type of data sources, the format of source answers and the required procedures of analysis. The choice of methodology of this study is further explored in sections below as the two methodologies are discussed.

4.2.1   Quantitative Research

This type of research puts more emphasis on the assigning of numbers (Babbie &Mouton, 2001).It is mainly used when the researcher is working on or researching non-explanatory, factually deductive studies that produce empirically abstract data (Neuman, 2006). The aim of this study was to understand the efficacy of the internship component of SE in the WC from the contextually subjective environment of employers and University HOD of computer science departments. Most data is mainly in words that cannot be converted to numbers. This means that quantitative methodology and techniques would not be appropriate in this study, hence it was decided to adopt a qualitative methodology.

4.2.2   Qualitative Research

While quantitative research mainly focuses on numbers, qualitative research is concerned with the social aspect where data is mainly in the form of words, documents and observations (Neuman, 2006). This research is based on secondary data from the literature (documents) and on the primary data from direct interviews with participants.

Within the qualitative research framework, into which Interpretive studies fall, a number of research methods exist, including the historical, action and case study research techniques. In Case studies units of observation can be individuals (Cooper, 1990) and multiple sources of data (Babbie &Mouton, 2001). In this study data collection was from multiple sources,

which included interns, employers, HODs and intern organisations. Case studies focus on investigating a certain phenomenon in its real life context using many sources of evidence to answer the "how" and "why" questions (Yin, 1994). Since the efficacy of the internship component in SE in the Western Cape is not fully understood, and needs exploration and further analysis, a case study technique is more appropriate than any other research methodology.

The multiple units of analysis and observation used in this study are fully explained in the sampling table.

4.2.2.1 Sampling

Sampling refers to any procedure used to select a unit of observation in a piece of research (Babbie, 2010). Two main techniques, probability and non-probability sampling (Walliman, 2001) can be used in research. Probability sampling is usually aligned with quantitative research, and refers to the process where all members of a research population have an equal chance (probability) of being selected through a random process - into a sample (Neuman, 2008). Non-probability sampling on the other hand, is used in cases where the actual location and numbers of a research population are not known, and cannot enable a random selection process (Erwee, 1994). Non probabilistic sampling includes snow-balling, quota sampling and purposive (judgmental) sampling, among others (Babbie, 2010).

Given the purpose of this research and the type of data sources required, purposive sampling is considered the most appropriate method.

Purposive sampling is a technique used to select a sample from the elements that are most representative of a research population (Mlitwa, 2011). The selection is done purely according to the purpose of the study as shaped by the intentions and discretion (judgment) of the researcher (Babbie, 2010). This method is used when selecting units that are representative of the population (Singleton and Straights, 2005) based on a researcher's opinion. Purposive sampling applies perfectly well when a researcher has "clear characteristics of the participants needed" (Mlitwa, 2011). A small representative sample, possessing such characteristics, is used to gather insight, from which conclusions, about the targeted population, can be drawn (Babbie & Mouton, 2001). This technique allows the researcher to approach only members of the population ready and willing to give the required data (Kumar, 2005). The sampling process followed in this study is outlined in Table Table 1 and discussed in more detail in passages that follow.

Table 1: Sample Selection

Main Question: How efficient is the Internship Component of the Software Engineering Sector in the Western Cape?					
Issue/ Point of Investigation	**Data Source**	**Tool/s**	**Unit of Analysis**	**Unit of Observation**	**No. of Participants**
Background, Methodology & theories	• Literature	• Read, Analyse, Write	• Journals, Internet, books	• Published Journals, Trusted Websites, accredited textbooks	
Status & Magnitude of SE Skills Shortage in WC	• Employers • Internship organisation • Universities	• Interviews • Observations	• Company A, Company B, Company C • Organisation A, Organisation B • University A, University B, University C	• IT Managers (3), HR Managers (3) • IT Internship organisers (2) • University IT HoDs (3)	IT Managers = 3 HR Managers = 3 Internship Organisers = 2 University IT HoDs = 3 IT Interns = 3
Goal/ objective of internship programmes	• Employers • Internship organisation • Universities	• Interviews • Observations	• Company A, Company B, Company C • Organisation A, Organisation B • University A, University B, University C	• IT Managers (3), HR Managers (3) • IT Internship organisers (2) • University IT HoDs (3)	
Structure of internship programmes (insight)	• Employers • Internship organisation • Universities	• Interviews • Observations	• Company A, Company B, Company C • Organisation A, Organisation B • University A, University B, University C	• IT Managers (3), HR Managers (3) • IT Internship organisers (2) • University IT HoDs (3)	
Curricula issues (balance of theory & practice)	• Internship organisation • Universities • IT Students	• Interviews • Observations	• Company A, Company B, Company C • Organisation A, Organisation B • T Interns	• IT Internship organisers (2) • University IT HoDs (3) • IT Interns (3)	
Progress: success & failure aspects of internship programs	• Employers • Internship organisation • Universities • IT Students	• Interviews • Observations	• Company A, Company B, Company C • Organisation A, Organisation B • University A, University B, University C • IT Interns	• IT Managers (3), HR Managers (3) • IT Internship organisers (2) • University IT HoDs (3) • IT Interns (3)	
				Total Participants:	**14**

The sampling table outlines the issues under investigation, the data sources, the units of analysis, the units of observation and the total number of participants for this research.

Firstly, because of the location of computer science, information systems and information technology (IT) faculties in universities, universities were considered appropriate sources of data on the development of software engineering (SE) skills. Hence, three Universities: the University of Western Cape (University B), the University of Cape Town (University C) and the Cape Peninsula University of Technology(University A) were chosen because of their direct location in the Western Cape, which is the region under investigation in this study. They were also selected on the basis of their direct participation in the multi-stakeholder internship programs (Cape IT initiative, 2012). Given the integrated learning approach in the curriculum, where internship takes place prior to graduation at University A, and that the other two universities do not send students to internships before they graduate, a combination of these institutions offers a comparative insight between the respective internship arrangements.

Within these university departments, the heads of departments (HoDs) were the most appropriate units of observation, given their senior roles and their knowledge of various levels of academic information. Key information in this respect includes curriculum planning, student admissions procedures and decisions on internship programmes. HoDs therefore, are relevant interviewees for all questions relating to graduates readiness to enter the IT field of operation, and whether they are adequately skilled to meet the needs of the IT industry and the SE sector. Thus from the three universities only three (3) HoDs were sampled for direct interviews.

Secondly, employers of IT and software engineering graduates would offer relevant insight on skills needs relative to the quality of the available skills supply, including the quality of internship programmes. A good comparison on the performance of graduates who have done the internship program before they graduate and those who come direct from University with no such exposure will be correctly answered by the employers. For this purposes, three companies: Company A, Company B and Company C, all in Cape Town, were selected for the sample. A specialist in Microsoft products and a Microsoft partner in Western Cape

Company C was chosen as an appropriate representative of Microsoft product specialists. Also as one of the major sponsors of the internship program, employing a number of interns, Company C is better positioned than many other companies to offer valuable insights on the needs of the employers and the quality of skills acquisition on existing internship programs.

Company A was also selected on the basis that it is a software development Company that actively supports internship programmes, recruiting and employing IT interns from different universities.

Lastly, Company B, which is an IT Company specializing in Mobile applications, and also one of the Internship sponsors, was selected, to offer additional insight from the Mobile financial applications sector. Within these companies, IT managers and human resource (HR) mangers were selected as the appropriate units of observation, for two reasons. Since the IT managers are responsible for the supervision of interns, and the human resources (HR) managers are responsible for the recruitment of employees, they are better positioned to offer the most relevant insight on skills needs and internship matters which fall directly under their areas of operation. In this respect, IT managers should be well informed on performance related questions whilst HR managers should be knowledgeable about SE recruitment needs and challenges, selection criteria and availability of IT interns. Given the number (3) of companies, the number of officials selected therefore, is one IT and one HR manager in each of the three companies, which brings the total to six (6) units of observation for employers.

The third data source will be the internship organizations. These are more relevant to the research study as they are directly involved with the interns and intern employers. They train the interns by placing them at different IT companies and because of that they know employer demands. Two organisations will be targeted which are Organisation A and Organisation B. These specifically provide IT internship opportunities in the Western Cape and not only for IT graduates but also for non IT academics, proving the need for skilled IT personnel in the region. From the two intern organisations, two organisers were selected as units of observation. These organisers not only interact with the industry to get information on what sort of skills are needed, but they also interact with the universities by training the interns. For example, Organisation A has an initiative to increase the supply of Business Analysts in Cape Town by 1000. University C trains these interns from Organization A in different areas of IT specializations. Interns enrolled at Organization A are trained in Software development, IT applications and Infrastructure Management at University B, and in advanced Java programming at University A (Cape IT initiative, 2012). From the two organizations the number of units of observation therefore is one per each to make a total of two (2).

Finally, interns from the three selected companies were interviewed to get their opinions on the internship programs. It is relevant to interview interns 'from the selected companies as it is appropriate to compare employer and intern expectations from the same companies and

determine whether or not they are similar. Given the three companies (Company A, Company B and Company C), two interns from each Company were interviewed to make a total of six (6) units of observation. From the interns to be interviewed two were from the intern organizations and four from the selected Universities.

These interviews with the all the units of observation in Table 1: Sample selection were conducted during the month of March to June 2014. The process involved included scheduling of interviews through emails and follow up phone calls were done to secure interview dates and confirmation of appointments. The interviews were all done face to face with the participants and the maximum time for each single interview was an hour. Selection of the data analysis of this date is discussed in the sections below.

4.3 Data Analysis

Data analysis is an approach used to explain the significance of data collected with in relation to the area under study (Babbie & Mouton, 2001).It is a means of translating data, gathered during collection process, into meaningful information (Mlitwa,2011). The method of analysis used helps the researcher to sort, explain, evaluate and compare in detail the meaning of the data gathered during collection process (Neunam, 2006). If no meaning is given to the data collected then the research gives no reflections on the setting being researched (William, 2009).This implies that without meaning given to the data collected from employers, interns, HODs and HR managers in this research, there will be no visibility on the efficacy of SE skills development initiatives in WC. There are no agreed rules and procedures of data analysis within the interpretive qualitative research (Ritchie & Lewis, 2003). These analytical approaches in qualitative research are selected depending on objectives and the data sought. Some of the analysis methods which exist in qualitative research include discourse analysis (Riessman, 1993), discourse analysis Silverman, 2001) and content analysis (Robson, 2002).The possibility of grounded theory in this research is explained below.

4.3.1 Grounded Theory

Grounded theory was proposed by Glaser and Strauss in 1967 and it mainly facilitates the discovery of theory from data (Dunne, 2011).

Grounded theory is suitable when there is little knowledge about the phenomenon being studied or a new perspective of phenomena is required (Strauss and Corbin 1998, Corbin and Strauss 2008). In grounded theory, the researcher does not wait for all data to be collected before commencing analysis. Data analysis begins as early as possible and it runs parallel to data collection. However, in the current study the researcher interviewed all

participants, transcribed the responses and only after transcribing, was data analysis commenced. This implies that, in this study, data was collected first and then transcribed. It was only after transcription that data analysis started. It was a linear sequence. There was no concurrency of data collection and analysis, hence grounded theory was not appropriate for this study. On another note, grounded theory heavily depends on theoretical sampling and its data analysis relies on coding. Furthermore, this theory does not promote a predetermined theoretical framework; it relies on the collection and analysis of data to formulate theory and hypothesis (Engward, 2013). To this effect Grounded Theory is not suitable for the current study and since this study is deductive, this theory will not be appropriate. However in this research, Polyvocal Analysis as a prospective analysis method is discussed below.

4.3.2   Polyvocal Analysis

Polyvocal analysis is another way of data analysis in qualitative research. This method is used to analyse data collected for particular voices, which will be used in the final form (Hatch, 2002).The method focuses more on the voices that contribute to the data, and the researcher study the data related to each voice to narrate a story related to each voice (ibid).

Polyvocal analysis fits within the assumptions if the poststructuralist paradigm due to the complexity of humans. It is not meant to prescribe but to suggest what needs to be considered to complete an analysis. Interviews, observations and other kinds of data collection are organized around the objective of capturing particular voices.

However for this research, data was collected from different participants as stipulated in the sampling table and was not selected according to voices. All data collected was transcribed and analysed without targeting specific voices. This implies that this method of analysis is not suitable for this study and the use of and reasons for using content analysis are explained in detail below.

4.3.3   Content Analysis

Content Analysis is used to examine words or phrases from a number of sources such as literature, interviews and questionnaires (Palmquist, 1993). This method enables the interpretation of content, from a wide range of sources of data, into significant information (Berelson, 1952). This method focuses on those themes and phrases used most frequently, and the researcher takes note of these with specific attention on how they are presented (Robson, 2002). In content analysis, the most frequent words, phrases and those with similar meanings are grouped together and used as the basis of analysis (Weber, 1990). This method is suitable for analysing interview related data (Mlitwa, 2011). Since interviews form

the core of the primary data, content analysis proved to be the most appropriate technique, and was adopted in this study.

As a supplement technique, the study also draws on basic statistical analysis to outline numerical details of participants. For example, basic information about how many participants, and who feels a certain way requires some form of numerical differentiation, hence some limited and supplementary use of statistical tools could not be ruled out.

To analyse the data collected, the researcher transcribed the interviews from audio to text and then noted the responses. When this had been done questions were grouped into themes as specified in the sampling table. Each theme was then analysed using responses from different respondents. Examined words and phrases relating to each theme were colour coded as indicated some of the transcripts in appendix section. In response to SE skills shortage problem , words such as, "not easy", "Difficult to get", "zero experience" were noted in response content and these signify an acknowledgement that there is SE skills shortage. These words were colour coded under the status and magnitude of SE skills shortage and used under this theme. Similar responses were grouped together. These responses were used to answer the main question under each theme. The findings are detailed and presented in Chapter 4.

4.4 Ethical Considerations

Although this research is about SE skills and the industry, it also considers human elements, in the sense that data is collected from people. Several people have been interviewed to get their views on SE skills development initiatives in the Western Cape. It is because of this human interference that formal research in this field should comply with the ethical practices in social research.

This research, indeed complied with the research ethics of the Cape Peninsula University of Technology. Consent forms, with clear explanations of the purpose of the research and how data will be handled, giving the interviewee the option to accept or decline participation, were distributed prior to the interview date. Participants and the researcher signed the consent forms as an agreement on the confidentiality terms of the interview. Anonymity of participants in this research is considered. The researcher indeed satisfied the ethical requirements of the University A ethics committee and was granted permission to continue with the research. Some of the signed consent forms are annexed in the appendix section.

4.5 Summary and Conclusion

This chapter outlines the methodology by which this investigation on the efficacy of the internship component of SE skills training in the Western Cape was conducted. Research

approaches which include the positivist paradigm, critical paradigm and interpretive paradigm are discussed in detail giving justification on why the interpretive paradigm was chosen in preference to the other approaches. As the current study is a qualitative research, an interpretive approach to the study was followed.

A number of research methods exist in the field of qualitative research. In this research, because data was collected from multiple sources, which includes Interns, employers, HODs and intern organisations, a case study method was used. The units of analysis were selected using purposive sampling. The sampling table listed and gave details of issues of investigation, data sources, and units of analysis, units of observation and the total number of participants for this research.

Methods of data analysis were also discussed in this chapter and these include Grounded theory, Polyvocal Anlaysis and Content analysis. Content analysis was chosen as the most appropriate method of analysis in this study because of its focus on mostly used themes and phrases (Robson C, 2002). Most data in this dissertation was gathered through interviews and then content analysis was applied in the analytical process. Basic statistical analysis was also utilised in this research to extract useful meaning from the numerical details of participants.

All data collected was transcribed from audio to text. The responses were used to gather findings from different participants. These responses were analysed, and from this analysis findings were drawn. The findings were grouped by theme to match each issue of investigation outlined in the sampling table and then used to answer the main question in each theme. The findings are discussed in the next chapter.

CHAPTER 5: FINDINGS

5.0 Introduction

This chapter draws on the theoretical framework in chapter 3, and the research approach (including the methodology and the content analysis technique of qualitative data analysis) to present the findings of the research process. In particular, those findings that were revealed in the interview data were drawn from various participants in the population samples.

Participants ranged from the Heads of Departments of universities' computer science faculties, Software Engineering (SE) interns, HR managers from SE companies, SE managers and internship Organizations involved in the SE field.

The main question raised in the study was, "What is the efficacy of the internship component of the SE sector in the Western Cape?" For analytical purposes, this question was divided into five themes. The themes (areas of investigation) cover the range from the Status & Magnitude of SE Skills Shortage in the WC, the Goal/ objective of internship programs, Structure of internship programs (insight), Curricula issues (balance of theory & practice), to the Progress: success & failure aspects of internship programs. These themes shape the structure of this chapter as shown in Figure 10.
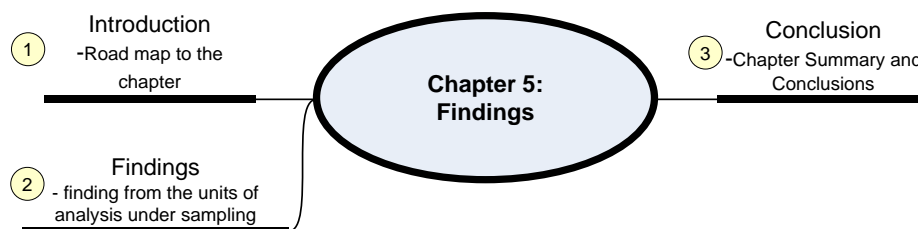
Figure 10: Chapter 5 Roadmap

In terms of the structure therefore, section 5.1 presents the findings. This section is further broken down into: the status and magnitude of SE skills shortage in 5.1.1, curriculum issues in 5.1.2, the structure of internship programs in 5.1.3, the goals and objectives in 5.1.4 and finally the successes and failures of the program in 5.1.5. Section 5.1 is then followed by a discussion of findings in section 5.2, and a conclusion to the findings is in section 5.3.

5.1 Findings

Findings are presented according to the five areas of investigation. The first issue of investigation, Status and Magnitude of SE skills shortages in the WC, is presented and discussed in section 5.1.1.

5.1.1 Status and Magnitude of SE Skills Shortage in WC

Under this theme the researcher wanted to find out how Software Engineering (SE) resources are allocated in the field of operation. The main focus was on the state, condition, and adequacy of SE skills in the Western Cape. The aim was to understand range of SE expertise acquired at tertiary institutions and at different companies during internships. The ANT concepts and related assumptions were drawn and applied to the framing, and ultimately, the analysis and interpretation of this question.

Findings for this theme were obtained from companies, Universities and internship organisations. A total of 14 participants were drawn from these sample clusters, and a breakdown of answers by respondents to questions under this theme (issue of investigation) are outlined in Table 2 and described fully in passages that follow.

Table 2: Status and Magnitude of SE Skills Shortage in WC

Participants	What is the status and magnitude of SE skills shortage in Western Cape?				
	High Shortage	Low shortage	No Shortage	Don't know/ No Response	Total
IT Managers	3	0	0	0	3
HR Managers	2	0	0	1	2
Internship organisers	1	1	0	0	2
IT HoDs in Universities	2	0	0	1	2
Interns	0	0	0	3	3
Totals:	8 (57%)	1 (7%)	0 (0%)	5 (36%)	14 (100%)

As shown in Table 2 a total sample of 14 subjects was selected to participate in the study. On the status and magnitude of SE skills question, 8 participants (57% of 14) of whom, 3 were IT managers, 2 were HR managers, 2 were heads of university IT departments (HoDs) and 1 was a representative from the internship organising structure, felt that the shortage of SE skills in the Western Cape is extremely high.

However, 1 participant (7% of 14) a representative of the internship organising structure, acknowledged a shortage of SE skills in the province, but felt that the shortage was insignificantly low. Whilst this remains a minority view, it does raise controversial considerations. These are critiqued under the discussion section, later in this chapter.

On the same question, 5 (36% of 14) participants were excluded from participating (or did not respond), for various reasons. For example, 3 of these were interns. Hence, they were not asked questions relating to the status and magnitude as they were not directly involved in hiring and recruiting skilled SE human capital. One participant was from a university that did not consent to the interview request, and finally, one HR manager was not available and was represented by a qualified substitute in the interview process.

On this issue the starting point was to ascertain the status and magnitude of SE skills shortages in the Western Cape. In this respect, the assumption from the ANT was that if the SE skills development initiative through the internship programme was ideal, that the SE internship programme would be yielding the desired returns. The skills development initiative to address SE skills through the internship program has been defined as a network which involves SE Industry (as an OPP), Universities, SE Internship Organisations, SE Interns, SE curriculum and SE Employers as actors and actants. According to the ANT theory, all these actors and actants, that is, the Universities, Interns, and SE Employers must all participate equally in the network and should all work towards increasing the number of SE skilled personnel to provide an adequate supply to the SE Industry.

In this theoretical analogy, an ideal status is when there is an adequate number of matric students enrolled into the Computer Science courses at Universities and the SE Lectures are also well qualified to teach or train in such courses. Enrolled students should perform their role in the internship network by being hardworking and able to think out of the box, as SE Industry requires such talent in the field of operation. Commitment and dedication are vital responsibilities for interns, to create a balance in the skills development initiative network. From Table 2, it has been noted from the findings that a high value of 57% for SE skills shortage implies that the supply of SE interns from Universities does not meet industry demands. Some Universities have lowered the math requirement by not doubling the math mark anymore (HOD-UC_13) to try and increase the enrolment numbers of SE Students. Although adjustments were made by the University Faculty of Science department regarding mathematics pass rate one university indicated that at a rough estimate, 1500 offers are made for SE courses, but only about 450 candidates qualify (HOD-UC_13). Thus the main reason for the SE skills shortage problem is that the number of matric students who enrol at Universities is lower than the target enrolment for the year (HOD_UC_R16). A concern was also raised by Universities that schools do not produce students who are capable of thinking for themselves, as this is a major characteristic required in Software engineering (HOD_UC_R16). In addition companies require interns who will go the extra mile in the

work they do (TF_R8) and thinking seems to be lacking in those who successfully enrol into the program (TF_R9).

Under ideal conditions in this network, the University's role would be to provide an adequate, up-to-date and relevant software related curriculum. In the skills development context, an adequate curriculum would be one that encompasses theory and practical lessons as well as work related learning exposure. In answering the question concerning the adequacy of the University's curriculum, responses derived from the findings indicate that Universities are teaching old ways of doing things and yet the SE industry has new ways of working. This situation creates a huge gap (MG_TF_R18). A point was raised that the University curriculum seems inadequate, as it focuses more on theory than on the practical aspects (TF_R9). It was also pointed out that the technical skills graduates have when they leave Universities need to be brushed up when they start careers in the SE industry (DT_R10)

On this aspect, it is the University's responsibility to collaborate with SE employers when preparing the curriculum because SE employers are the people most aware of the appropriate skill set required in the SE industry. A university also needs to be diligent in its own curricula research and development process, with full awareness of the international standards, whilst balancing these with what is required nationally. In addition to ensuring the adequacy of the course content, under ideal circumstances, universities would also need to ensure that there is a balance between theoretical and practical components in their offerings, if SE courses are to address the skills gap in the industry. In an ideal SE development network, careful emphasis will be placed on maintaining a balance between the duration of practical sessions, theoretical sessions and tutorials to ensure that they conform to a standard measure. In answers to the question to find out if there is a balance between theory and practice, findings have indicated that SE interns have inadequate practical knowledge. One University indicated that practical knowledge is not part of their curriculum (HOD_UC_R14). Other companies have also indicated that graduates lack practical knowledge (TF_R9). This suggests a misalignment between what Universities produce and what the industry expects. Thus Universities do not interact with SE industry to get input when preparing their curriculum. (HOD_UC_R5).

Further to this, Universities should perform their duties in the network by enrolling well qualified SE lectures to run SE courses. If there are instances where standard class time is not adequate for interns to acquire all the knowledge that they need, then universities should run tutorials to fill that knowledge gap. In addition to that, the government should perform its roles by collaborating with SE Industry, Universities, interns and SE Internship Organisers to come up with solutions on how to reduce the SE skills shortage in the province.

In answering the question on whether government is contributing to solving the SE skills shortage problem, it was found that it is playing its part .The government through Organisation B contributes by collecting a 1% levy from companies and pays back some of the monies as training funds to companies that contribute to the SE skill development programs (MC_R9). These payments go to companies that provide internships (HR_FM_R17). Also through the Organisation B the government is monitoring the internship programs by directly speaking to companies and interns (MC_R5). The efficacy of these interventions will be further analysed in the discussion of findings section.

The OPP, which is the SE Industry, should connect and collaborate with firstly Universities, especially for curricular drafting; secondly with interns by offering learner ships for the SE skills build up and thirdly with government for the support of the initiative to develop SE skills. From table, it is clear that SE skills shortage levels are extremely high and this means there is an imbalance in the Internship network. As elaborated in the following sections, a number of reasons (and assumptions) were offered by respondents to explain the status of SE skills shortages, during the interview process. The high level of SE skills shortage may be due to the limited number of interns employed by companies, as there is no standard number gazetted for that.

5.1.1.1 Causal Factors to SE Skills Shortages

According to the Actor Network Theory (ANT) as depicted in Figure 8 an ideal network is where various social and non-social elements are channelled in such a way that they can work together (Mlitwa, 2011). This theory (ANT) suggests that there is a balance between actors and actants in the network and that OPP needs to be connected with everyone in the network. However Table 2 indicates that there is a high Software Engineering skills shortage in the Western Cape and this results in the SE industry malfunctioning when there is high skills shortage.

It is clear in the findings that software engineering (SE) skills shortage is more severe in the Western Cape, than in other provinces, like Johannesburg (DT_R6), with Java skills ranking high amongst the most scarce skills in the SE job market (HR_FM_R2 & DT_R6). When asked to explain the high demand for Java developers, one manager cited an emergent industry trend that manifests in "...a major drive towards developing in Java" (DT_R4) as a leading reason. The same manager cited nine (9) dot.Net and 16 Java vacancies in his Company, to illustrate this point (DT_R6). Again the ANT network faces a possible collapse if it is not balanced. From the findings analysed it is clear that there are insufficient SE developers and this is a cause for concern in the SE Industry. In addition, if there is a

shortage of skilled SE professionals in the industry, then the supply of mentors flowing into the internship programme to train SE interns is also threatened. The severity of the challenge has seen companies resorting to outsourcing, using Java and .Net developers from India (FM_R7 & DT_R5). One manager added that although his Company had 13 Java developers, only three of them were actually in their Cape Town office, the other 10 team members were sitting in India, were they were sourced. It has proved to be a challenge to get skilled Java developers in Cape Town, as stated by (FM_R12).

The shortage of SE skills is described as a major impediment to innovation, expansion and growth, with managers failing to take up larger development projects due to limited availability of skilled personnel. Obviously, this has severe implications for competitiveness and the growth of the sector. To emphasize this concern, one manager even complained about the many projects they lost, but could have won if they had had adequate skills (DT_R7). This implies a loss of potential revenue and profits for the Company, due to a shortage of Java and .Net skills in the region.

When asked to reflect on possible solutions, one HR manager complained that current alternatives do not seem competitively viable. Whilst outsourcing seem to be an alternative trend, this HR manager complained of its exorbitant cost, saying that they often find that a senior SE specialist (especially Java developers) will charge a fortune when they are hired (HR_FM_R3). She suggests that this is because of an intense competition for Java developers in the industry. Employers often have to beat other offers to get the personnel, meaning that the demand for SE skills far exceeds the supply in the IT industry .The adequacy of efforts made by the industry and the academic sector, to react to this challenge, are discussed in more detail in the discussion section, later in this chapter.

However, there is scepticism about the supply side of SE skills on the part of employers. On this point, one Company official argued that it is not about getting any Java developer with qualifications, but finding a skilled resource with experience and capable of working in a fast paced environment, is what is really needed (HR_FM_R3). A strange example was shared: a Company employed a graduate who wanted to train as a developer, but they are using him as a deployment engineer (FM_R15). The shortage of appropriate software developers has seen companies having to overwork their few developers for the unreasonably long hours – this situation sometimes affects morale and productivity. On this point, a question was asked whether there are sufficient Java developers. One response was a big "NO! it's never adequate for our team at all" (FM_R8). The same respondent added that sometimes they feel extremely overwhelmed with work. The team is always strained by working overtime and weekends to complete urgent work projects (FM_R10). Another participant pointed out that

they are limited in what they can propose in terms of Java developments due to there being few skilled Java developers in the market (DT_R7).

When asked to explain the current survival strategies under the current skills shortages, one respondent said that they have reverted to either recruitment agencies or referrals from people who used to work for them, to find skilled SE resources (TF_R3 & TF_R5). The problem however, is that this alternative is limited in terms of the pool of sources, and is very costly, particularly, because the small pool of skilled developers are either employed and do not want to move from their companies, or can only take on a limited workload at any given time (HR_DT_R6). In terms of cost, whilst skills themselves do not come cheap, companies also have to pay a lot of money to people who refer skilled SE personnel, which reduce the income and profitability of the business. This looks like a scramble for SE skilled personnel. If there were enough skilled SE personnel then there would be no need to even look at the people who already have jobs.

Once again, the question of the current academic structure and curricula comes to the fore in this context. Causes, implications and possible alternatives are critiqued further in the discussion section later in this chapter.

5.1.2 Curricular Issues

The main point under this theme was to ascertain the extent to which the theory content was being supplemented and balanced with the practical aspects in SE related tertiary offerings. The researcher explored the balance of practical and theory through interviews with IT Managers, HR Managers, HoD for SE courses at Universities, SE Internship Organisers and SE Interns. The findings are summarized in Table 3 and described fully in passages that follow.

Table 3: Responses of Curricula Issues of internship programs

Participants	Is there a balance between theory and practice in internship programs?				
	Theory	Theory and Practical	Not a Requirement	Don't know/ No Response	Total
IT Managers	0	3	0	0	3
HR Managers	0	2	0	1	3
Internship organisers	0	2	0	0	2
Interns	0	3	0	0	3
IT HoDs in Universities	0	1	1	1	3
Totals:	0 (0%)	11 (79%)	1 (7%)	2 (14%)	14 (100%)

As outlined in Table 3, a total of 14 participants were in the sample of the study. The findings, according to 11 (79%) of the participants in Table 3 shows a theoretical and practical balance of SE courses in the curriculum. However no-one has indicated the main focus as theory only and only 1 (7%) indicated that the balance is not part of their requirement. There was no response from 2 (14%) who were not available during the time of interview. These 2 subjects pulled out at the last moment, leaving only 12 participants to eventually respond to the questions.

The findings on this issue give mixed responses, with a mix ranging from a complete absence of the practical component, to a moderate balance between the academic and the practical contents in their SE related curricula. The ANT theory assumes collaboration and mobilization of actors and actants in a network for the SE skills development initiative to be a success. In an ideal SE skills development programme according to this ANT logic, the SE Industry, Universities, Interns and Internship Organisers all need to be well connected and perform their duties equally in the network.

SE employers need to engage with Universities by often giving feedback on intern performance and on their expectations. Regular interactions create a strong link and the employer feedback is beneficial in the creation of SE curricula by Universities. Universities should encourage their students to attend community forums where they can meet and have discussions about different technologies. This would help universities to adjust their curricula to fit in with employer expectations and it would help Universities and students to be on a par with the ever-changing software engineering demands in the industry. Currently this is not the case, as University students are never seen attending or participating in such forums, despite being invited (TF_R17). According to the findings there is limited interaction between Universities and SE Employers (Kruss, 2014), as Universities feel they do not want to be dictated to by the industry (HOD_UC_R5). (TF_R10) considers that there is no interaction between Universities and SE industry.

Internship Organisers like Organisation A and SE professional bodies like the Computer Society of South Africa should regularly interact with Universities and SE interns to facilitate strong relationships and to make contributions to the curriculum preparation. In an ideal situation there should be a balance between all these roles and responsibilities of each actor in the development of the relevant curricula. This is supported by the ANT as it advocates for a balance between Actors and actants, and maintains that all actors are equally important. Data in the table gathered from the findings under this issue of investigation, suggest that theory and practice are not balanced when making curriculum. This may be because some Universities rely on Computer societies of other countries, like the British Computer Society, and this might not be specific to South African needs (HOD_UC_R7). Several other reasons

are discussed in detail in the findings section. It should also be noted that local government does not get involved; neither does it influence the curriculum of the internship programs (MC_R5). On the other hand internship organisers collaborate with Universities and Industry when preparing their curriculum (C_R11), however the extent to which their internship programs are succeeding compared to other internships, will be further scrutinised in the findings chapter.

One university official for example, stated that Internship is not a requirement in their curricula. He indicated that "No, we have no internships" (HOD_UC_R14), and therefore do not offer nor require their students to undergo internship before they graduate. The official indicated that internship is something they have never done and they feel their students can learn on the job (HOD_UC_R15). This approach does not seem to support efforts towards SE practical skills development at the time when employers are dealing with under-prepared graduate employees on an increasingly frustrating scale. The Actor Network Theory (ANT) depicted in Figure 8 suggest that there is a symmetrical assumption between human and non-human actors in a network and it assumes some level of balance between roles and relations of actors within a network. In this study it has been discovered that there is no balance between theory and practice and this has proven to be a major challenge in producing graduates who adequately meet the SE industry skills expectations. A general frustration for employers is that though "graduates learn more of classroom material they don't really know anything about the practical side of a software application" (TF_R8). The feeling is that whilst they seem to understand key concepts from their curricula content, graduates cannot do "….the practical aspect we require in the industry" (HR_FM_R15). One of the most common explanations is that universities offer generic courses, with no focus on the exact needs of the industry (DT_R11).

The software engineering (SE) field is constantly evolving and changing, yet in some cases university curricula are older than four to five years, with most universities only concerned with theory rather than with the evolving practices in the industry (TF_R9). Added to this, there is also a lack of a real relationship between companies and Universities (TF_R10 & HOD_UC_R5). Instead of cooperative collaborations, there has been a disturbing trend of arrogance from universities who argue that companies do not have to dictate to them on the subject of what to put in their lectures (HOD_UC_R5). There is a mismatch here, because companies feel that their practical operational needs are neglected in university curricula, and that there is a clear need for urgent transformative measures (DT_R10 & TF_R9).

Nevertheless, certain academic institutions seem to be doing better than others in producing trainable graduates. According to interview data for example, out of the four universities and two major colleges in the Western Cape, the Cape Peninsula University of Technology

(University A) and its Organisation A1000 students are preferred by potential employers in industry, over graduates from other institutions, as their curriculum involves some technical skills (DT_R11; HR_FM_R7; HR_DT_R7).

Whilst this issue is critiqued in detail under the discussion (of findings) section later in this chapter, one begins to wonder whether the source of the problem can be located in academic curricula structure, and how much of it is industry generated. In effect, some internship organisers are desperate for solutions, with most going as far as teaching the practical aspects of software development to their interns (C_R4). Internship organisations for example, do actually "… spend a lot of time training and coaching them when they come from tertiary institutions ..." (DT_R10). In these programs they facilitate Oracle Advanced Java Programming Certification, PGDIP Software Development Programme, SAP Certified Application Associate Training Certification, Microsoft.net & other Certifications (C_R5). This is done to close the gap between what universities teach and what the Company needs. For this reason, companies prefer interns trained by internship organisers as they have been exposed to the practical skills needed in the field of operation (D_R9). This is supported by another participant who said, "… Trainees do perform well because most companies ask for our interns ..." (C_R5).

One of the Universities interviewed admitted that their syllabus is influenced by the British Computer Society (HOD_UC_R5). When the question as to why the British Computer Society and not the South African Computer Society was raised there seemed to be no clear answer (HOD_UC_R7). Therefore it is likely that what this university offers will be biased towards the expectations of the British society rather than the South African society, where the shortage exists.

Due to the critical SE skills shortages some organisations are fast-tracking non-IT graduates and unemployed IT graduates into IT careers (C_R2). From the data gathered it was found that these organizations interact with different companies and structure their program according to what companies need (C_R11). These organizations recruit graduates from different Universities and train them in different areas depending on what the Company needs (MC_R5 & C_R11). Before interns are accepted for practical classes they must have attended at least 80% of the in-class training (C_R10). These theory classes run for approximately 9 months at the one of the Universities (C_R13).

In explaining that interns from Universities know a lot of theory but close to nothing of practical, one of the interviewed managers said, "When I graduated, I knew what it means to say an algorithm, I knew how to develop a compiler but that didn't mean I know how to apply it to the practical business problem"(TF_R9). To add to the subject of imbalance between

practical and theory at universities, the same responded said, "I have seen people who go to CTI have more experience and knowledge on the practical side which is what we require. They apply what they learn while people who go to Universities are more theoretical in what they learn" (TF_R9). The same participant has indicated that there is little focus on teaching Microsoft products at universities (TF_R17).

Although the findings, according to table… reflect a balance between theoretical and practical in the curriculum of SE courses of (79%), the situation is very different when one looks at the responses of the interns concerning the amount of actual practical knowledge they have when they join the SE industry. Reasons for these differences are further analysed in the discussion of findings section.

5.1.3   Structure of Internship Programs

Under this theme, the researcher wanted to find out how SE internship programs are structured across different SE companies, Universities and Internship Organisations like CAPAciti. The researcher explored duration, course outline of the program and how different companies and tertiary institutions structure their internship programs. Data to answer the questions was collected from IT Managers, HR Managers, HoD for SE courses at Universities, SE Internship Organisers and SE Interns. The findings are summarized in Table 5 and described fully in passages that follow.

Table 4: Structure of Internship Programs

Participants (Arora, 2009)	How is the Internship Program structured?				
	Six Months	**One Year**	**Two Years**	**No Internship/ No Response**	**Total**
IT Managers	0	2	1	0	3
HR Managers	1	0	1	1	3
Internship organisers	0	1	0	1	2
Interns	0	2	1	0	3
IT HoDs in Universities	1	0	0	2	3
Totals:	2 (14%)	5 (36%)	3 (21%)	4 (29%)	14 (100%)

The main point under this question was to ascertain exactly how the internship programme was structured in each organisation. According to Table 4, 5 (36%) of the participants reported internship as a one year program, 2 (14%) as a six months program and 3 (21%) as a two year program. This shows that companies structure their internship to suit their business needs.

Table 4 reflects a 4 in the No Internship/No response category. This is partly because 2 of the 4 participants decided not to participate in the research process. Of the remaining 2, one

University academic and a representative of the internship organizing entity (internship organiser), neither could recall any SE internship programmes in their own organisations.

To answer the question regarding how internship programs are structured, the findings reveal that, internship structures differ between companies. Where in some companies the program runs for one year (FM_R21 & TF_R15) and in others it runs for 2 years (BM_DT_R9 & HR_DT_R12). In addition to these differences in the duration, internship programs also differ in the way they are structured. Some companies require their interns to be certified in a field of specialisation in the SE area (BM_DT_R12 & MG_TF_R15) whereas other companies do not have that requirement at all (FM_R22). This raises   questions on the rationale and adequacy of these time-frames and on whether the internship time-structure is adequate to facilitate the required amount of practical training, understanding the motivations for the selection of these internship time-frames, therefore, would be enlightening. Thus, the ANT framework was used to explore this aspect. It was found that key aspects, such as the process of problematisation and inclusive communication would have facilitated a clear articulation of the ideal structure of the programme – with foresight on the desired end-goals.

5.1.3.1 Adequacy of Programme Structure

In an ideal ANT, a successful network is where problematisation is done properly and all actors and actants work together to understand and solve the problem. An inclusive communication process between all actors (the universities, government, SE Employers and interns) is also important in establishing a common ground towards the alleviation of the SE Skills shortage problem. Thus, actors and actants in the skills development initiative network need to collaborate in order to build a good internship structure suitable for SE skills development plans. From the results in the table above, it seems that problematisation was not adequately addressed. One apparent explanation is inadequate interaction between Universities and SE employers to solve the problem faced by the SE Industry in the Western Cape.

Assumptions from the ANT framework are that universities need to perform their role in the network by making sure that they have a clear SE course structure for their students. They should establish links between themselves and both employers and SE candidates for input, in order to structure their programs in a way that best suits the SE industry. On this point, findings point to a disjoint between academic theory and practice. A major concern for most employers was that graduates tend to know a lot of SE theory, but lack the practical knowledge needed in the SE industry (HR_FM_R15). This has been blamed on Universities that rely mostly on the generic courses rather than focusing on the requirements of the

evolving SE industry (TF_R9). Hence, there is need for Universities to collaborate quite often with the Industry to structure their SE courses according to the SE industry expectations. On this basis, the tenure of programs does not seem to be the cause of the problem, but a lack of a collaborative initiative on curricula related matters by universities. Extending the tenure therefore, may not address the disjoint between theory and practice, but a collaborative alignment may be a relevant attempt. Nevertheless, understanding the role of other actors under the current circumstances (in this SE skills development network) is equally important.

Professional Bodies, like the Computer Society of South Africa (CSSA), actively engage with the industry and Government in order to influence policy formulation on behalf of both its own members and industry. It would be good if Universities regularly communicated with such bodies. The skills gap is a problem which need to be resolved by all parties (Tony, 2014) in the Software Engineering network. This would assist them to structure their internship programs to suit what is best for the industry. CSSA also encourages the growth of skills development throughout South Africa and Universities could make use of such bodies for support regarding SE skills development efforts. On this point, it has been discovered from the findings, in the table above, that there is no collaboration between Universities and the South African accreditation body, which is the Computer Society of South Africa (HOD_UC_R5). This could be the reason why structures differ so much across Universities and SE industry. In addition, students do not participate in these CSSA initiatives (TF_R17) which can provide a helpful means of getting new information on technological advancements.

On the other hand the government should be aware of its responsibilities in the network by communicating with all participants in the network. It needs to support the activities of the network for the smooth operation and achievement of the SE skills development initiatives. In addition, the government can budget funds for the skills development initiative. These will be given to SE companies who abide by the recommended internship structure, so that they can pay Interns for the basic expenses that they incur during their internship. Universities and Internship Organizers who also abide by the recommended structure can also get the funds to educate SE students and for basic educational needs for the duration of their courses. From the findings, it has been realised that the government already has some funds allocated to the internship program (MC_R4 & HR_FM_R17) but the extent to which this is influencing the program is further discussed in the findings section. The government also funds other internship programs which are run by the Internship Organisations (C_R12). Several reasons that have led to the failures of some internship programs are discussed in detail in the discussion of the findings.

One HR manager and one University official were clearly aware of an internship program in their organisation, describing it as a 6 months program of practical and theoretical learning (HR_FM_R16). 36 % (highest percentages in the categories) indicated that their internship program is a full year of combined theory and practice. Another respondent, a University SE HoD confirmed that Internship is not a requirement in their curriculum and therefore they neither offer internships nor require theory students to undergo internships before they graduate (HOD_UC_R14). Some companies, 21% of the participants, run their internship programs for, 2 years, (HR_DT_R12 & BM_DT_R9). Further discussions and analysis on the duration of the internship program are in the section that follows.

Some Internship programs are for one year (FM_R21 & TF_R15) and during that year the organisers do not require the interns to do any certifications until they finish their studies (FM_R22). During the internship, interns are given a stipulated wage for the real work they do (MG_TF_R11 & MG_TF_R11).

Another participant indicated that their internships run for two years and during the two year programs interns are assigned to different companies depending on their roles (BM_DT_R9 & HR_DT_R12). During the first six months of internship, interns are promoted to junior level role (ibid) if they successfully complete and obtain a certification in their areas of expertise (BM_DT_R12 & MG_TF_R15). "You get ISEB certificate first during your six month internship, and Java certified if you want to become a Java developer" (BM_DT_R12). For the two year program; interns get reviews quarterly depending on their performance at different companies (HR_DT_R15&16). Internship Organisers said they facilitate Oracle Advanced Java Programming Certification, PGDIP Software Development Programme, SAP Certified Application Associate Training Certification, Microsoft .net & other Certifications (C_R4).

Other than the tenure of the programme, the description and content of the internship programme was considered as equally important. For example, it is only when the quality of the internship programme and the relevance of the training provided that the tenure would be beneficial to a realisation of the training objective. On this aspect, interns work with senior resources that mentor them on what is required in the Software Engineering field they are entering (BM_DT_R17 & TF_R11). MG_TF said," I work with a senior developer who shows me what to do and guides me in development". He basically works as my mentor (MG_TF_R4). However, some interns feel there should be an improvement in the structure of the internship program in companies. For example they feel more training is needed giving a more technical overview (CJ_FM_R19 and BM_DT_R16). It seems the reason for inadequacy of technical training is because interns and employers have different priorities. For example an intern was training on deployment work although he wanted to be trained as

a Java developer (FM_R16). The employer felt the need in their department at that moment was a deployment task and they would rather train their intern to carry out the deployment tasks and outsource the development work (FM_R16). Further, mixed reactions and sentiments among organisations suggest that the adequacy of the programme is limited. Internship providers feel that instead of offering a comprehensive package of training, employers structure their internships according to their selective needs (MC_R5).

In essence, it is clear in the findings that the structure of the internship program differs across different organisations, with variations tailored according to respective business needs. To this effect, the adequacy and ultimately, the efficacy of these structures are limited. A critique of the causes and related implications is in the discussion section later in this chapter. Findings on the goals and objectives are discussed in the following section Goals and Objectives.

5.1.4   Goals and Objectives

Under this theme the researcher wanted to find out the main goals and objectives of the internship program. The researcher asked employers what their main purpose were of employing new graduates and how the graduates have managed to achieve those goals. From the Universities, the researcher wanted to understand what the main goals and objectives were of sending students on internship programs. More data was collected from interns themselves to help understand what their perceived goals were in enrolling in the internship program. Thus employers, internship organisers, University HoDs and interns were interviewed, and the findings are summarized in   Table 5 and described fully in passages that follow.

Table 5: Goals and Objectives of Internships

Participants	What are the goals and objectives of internships?				
	SE Technical training	SE Skills Development	No Response	Don't know	Total
IT Managers	0	3	0	0	3
HR Managers	1	1	1	0	3
Internship organisers	1	1	0	0	2
Interns	3	0	0	0	3
IT HoDs in Universities	1	0	1	1	3
Totals:	6 (43%)	5 (36%)	2 (14%)	1 (7%)	14 (100%)

As shown in Table 5, the main question under this theme was raised in interviews using 14 participants, with a 12 out of 14 (86% response rate) respondents actually taking part in the interviews. In other words, 2 (14%) respondents did not participate in the interviews. One of the respondents who did not participate in the interviews was an HR manager who was not

in Cape Town and thus not available at the time of the interview. The other responded was one IT HoD who could not be reached either at the time of interview.

The findings according to 6 (43%) of the participant in   Table 5 show the goals and objectives of internship programmes as mainly (and mostly) to strengthen the Software Engineering (SE) technical (or practical) abilities of the interns through industry practice. Another reason according to 5 (36%) of the participants, is also to develop and improve general SE skills among the interns.

The respondents reflect that the technical (or practical) skills among graduates (and new entrants into the labour market) are limited, and are a concern. These skills therefore need practical strengthening through the internship programme. In response to the question on the main objective (and goal) of the programmer , one Internship Organiser said one of the reasons for the internship programs is to train non IT graduates and unemployed IT graduates for careers in industry where there is critically short supply of suitable candidates. (C_R1). Given the urgency in terms of the dire shortage of skills in the sector, the main goal is "…to fast-track non-IT graduates and unemployed IT graduates and diplomats, into IT careers in critical short supply ..." (C_R2). To realise this goal, some internship Organisations were created specifically for this purpose.   (C_R2). The main reason according to one HR manager is concerning "…scarcity in IT skills and it makes sense for companies to implement the graduate program so that they can train people "(HR_FM_R4). Within this internship program according to one of the IT managers interviewed, interns are guided and mentored to give them exposure to technical and analytical skills so that they can specialise in Software Engineering (SE) skills (DT_R12). The question in this respect however, is whether these efforts are adequate – and whether they are yielding the desired results towards the intended goals to fast-track the development of the scarce SE skills in the sector. The ANT framework (in Figure 8) offers a useful analytical basis in this respect.

In an ideal network according to the ANT actors and actants should work at their respective roles towards a common goal. This implies that each actor in the network is as important as any other for the completeness of the network. Looking at the interns, their main goal is to be enrolled for SE courses at Universities after passing examinations at matric level. As a pre-requisite however, they need to have a passion for mathematics and science subjects to be able to qualify for SE courses after matric. After enrolment, they need to pass SE courses for them to qualify for internship programs. This puts them in a viable position to find employment and in turn, be successful in their SE careers, in order to earn a decent living. Therefore, it is their responsibility to be hardworking and to think out of the box. From the questionnaires, it was found that University students do not attend the SE community forums (TF_R17). It is at these forums that new technologies used in the industry are discussed. In

addition to this non-attendance, it seems that some SE graduates lack commitment. For example, one Company indicated that they had 50 graduate applicants and more than half of them did not complete the assessment (TF_R17). This implies that there is no dedication amongst students themselves. More details on the causes and implications will be found in the discussion of findings section.

As an actor in the SE development network according to the ANT framework in Figure 8, universities should attract and adequately train SE aspirants. To do this, they need to advertise SE courses to all matric students, so as to get those with good quality appropriate matric results, making applications for enrolment into their SE program. The number of enrolled students determines the output that will be supplied to the industry. In addition to enrolling students, Universities need to make sure that a proper curriculum is in place and well qualified lectures are readily available to run the modules. Best teaching practices should already be formulated by the University and the main goal is to supply well prepared interns to the industry for experiential learning. According to the findings, Universities have an industrial advisory board that meets once a year to discuss the curriculum that will be used to teach SE courses (HOD_UC_R5). University departments also work with Internship Organisers on some of the best teaching practices for the courses they run (C_R13). To increase enrolment levels, Universities have lowered the mathematics requirement to be able to get more students to qualify (HOD_UC_R13). This effort is an indication of the need for higher enrolment numbers of SE students in Universities. The efficacy of these teaching practices is discussed in detail in the findings section.

Employers are the most critical actors in this internship and skills development network. To participate fully in the SE skills development network, employers should employ a fair number of interns to give them the experiential training required. In an ideal network, according to the ANT framework, this should be facilitated by dedicating skilled mentors who can work with the interns and share the necessary knowledge giving them real SE responsibilities and not just any work that suits the Organization. The mentors should be always available for interns in case of any questions or work related to the experiential learning. By training and giving interns an opportunity in the industry employers are contributing to the SE skills shortage. According to the findings, employers are enrolling interns to try and solve the shortage of SE skilled personnel like Java developers (DT_R8). Employers are looking into employing interns on a yearly basis (TF_R12) to train them in the practical aspects of SE that Universities do not do. During the course of internship, employers give interns the practical learning (CJ_FM_R4) and (MG_TF_R6). Employers allocate mentors who are always available to interns (CJ_FM_R10, MG_TF_R5 and

BM_DT_R11) although there is a feeling that not all technical training is provided by mentors (CJ_FM_R11.

Further discussions on the level of success of the contribution that employers make to the SE skills development network is critiqued in the findings section.

Internship organizers are also the most significant actors in the SE skills development and internship initiative. For a potent SE skills development internship program according to the ANT framework (Fig.8), these organisers should bridge the gap between Universities and SE industry and train interns on industry expectations. According to the findings, Internship Organisations address the systemic challenges of high quality skilled SE personnel by fast-tracking non-IT graduates and unemployed IT graduates and diplomats, into IT careers, where qualified personnel are in critically short supply (C_R2). Graduates from the Internship Organisations like Organisation A are in demand (C_R6 and DT_R8) which implies that they have the skills that Universities do not offer (C_R10). Although such Internship Organisations exist and produce skilled interns on demand, there is still a shortage of SE skills in the Western Cape and details will be discussed in the findings section.

The government as an actor in the SE skills development network is responsible for supporting the education system. This can be done by introducing favourable legislation to ensure the smooth uniform operation of SE internship programs. In addition to that, the Government can contribute to the SE skills development network by coordinating relationships between SE educators and the SE industry. According to the findings, the Government's intervention is by ensuring that 1% of all the companies' payroll goes to the Organisation B (HR_FM_R17). If the companies give a satisfactory report of the training programs they do, they then get a percentage of the money back as an incentive (HR_FM_R17& MC_R9). The government's main goal in doing this is to promote skills development in the Software Engineering Sector. More details on the successful interventions of the Government to the SE skills development network are discussed in the discussion of findings section to follow.

All these roles and responsibilities for different actors and actants are aimed at training interns and giving them theoretical and practical experience.

From the table it can be seen that participants had a variety of different goals and further discussions as to the reasons for this are discussed in the discussion of findings.

5.1.5 Success and Failures

Under this theme, the researcher's aim is to find out the levels of success and failure of the implemented SE internship programs. The questions asked under this theme were related to

the success rate and the main accomplishments of the internship program for both the interns and the companies. These questions were asked of SE companies, Internship Organisations, Universities and interns through scheduled interviews. To get the relevant information IT managers, IT HR managers, University heads of department, internship organisers and interns were interviewed and the findings are summarised in table and described fully in passages that follow.

Table 6: Successes and Failures of Internships

Participants	What are the successes and failures of internship programs?				
	Highly Successful	Moderate Success	Failed	Don't know/ No Response	Total
IT Managers	3	0	0	0	3
HR Managers	2	0	0	1	3
Internship organisers	2	0	0	0	2
Interns	1	2	0	0	3
IT HoDs in Universities	1	1	0	1	3
Totals:	9 (64%)	3 (22%)	0 (%)	2 (14%)	14 (100%)

As shown in Table 6 the main question under this theme was to assess the Progress which is the successes & failures of internship programs. Out of expected 14 participants 9 (64%) indicated that the internship program is highly successful with 3 (22%) raising a flag for a moderate success. One of the respondents who did not participate in the interviews was an HR manager who was not in Cape Town and not reachable at the time on interview. The other responded was one IT HoD who could not be reached as well at the time of interview

The findings in Table 6 show that the internship programs were considered to be successful and that no-one thought they had failed. None of the internship programs implemented by Universities, companies and internship organisers had failed by the time the interviews were held. The main reasons why 64 % of the respondents consider the programs to be successful are discussed in the following paragraphs. Also more analysis will be done in the findings section as to why there is skills shortage and yet no internship programs have been recorded as failed.

According to ANT a successful network is where problematisation is done properly and all actors and actants work together to understand and solve the problem. From the results in the table above, it is possible that problematisation was not clearly done and it could be that there is no adequate interaction between Universities and SE employers to solve the problem faced by SE Industry in the Western Cape. In an ideal ANT situation, if problematisation was done properly and a good communication process was defined

between the Universities, government, SE Employers and interns, then there could have been a properly structured internship program that all Companies will follow to try and alleviate SE Skills shortage. Chasing independent goals is unacceptable in the ANT and leads to the downfall of the main objectives of the network.

Looking at the internship programs from the perspective of the interns, a question was asked on whether internship programs were a success. One of the participants responded, "Yes, definitely. We give them real world exposure. Our internship was successful for example we had DE shortage in my team and we trained our intern to do some DE task and now he has done several successful deployments" (FM_R23). When the same question was asked to a different participant they said, "Yes, I had an intern who was working at old mutual free of charge and in two months the interns outperformed a senior member and six months later he got technical exposure and he finally become a team lead" (DT_R19). Another intern has indicated that he has worked on software that is being used now (TF_R19).

Another question was asked whether they would recommend the program to a friend. CJ_FM responded, "Yes, because there is more to gain in doing this program and interns will always benefit. They get experience and they get salary (CJ_FM_R23). When another intern was asked she indicated that she has gained from the program. She said, "I am now a certified tester and definitely marketable" (BM_DT_R19). MG_TF working for a Microsoft certified Company said, "Yes, definitely I would recommend. It's a good program "(MG_TF_R19). Another intern said, "Yes, definitely. I have recommended a friend of mine …" (BM_DT_R20).

After completing internship program, most interns get employed, some by the same Company and others by other companies. DT_Manager indicated that some interns left for other companies after completing internship program (DT_R14). TF_Manager indicated that he had two interns in 2013 and these were promoted to junior level positions (TF_R11). Internship organisers said, "Trainees do perform well and most companies ask for our interns "(C_R5). The internship organiser mentioned that most of their interns get employed in SE technical roles like Systems Analysis and software development using development languages like java and php, etc (C_R15). As viewed from the Organisation A website, some companies which profited from the SE internship program are Old Mutual, Sanlam and Metropolitan Health.

From the successes and failures findings reflected in Table 6, it seems internships are highly successful with a 64% success and no failures. However, further analysis on whether we can conclude to say skills development initiatives are successful in alleviating the SE skills shortage, is assessed in the discussion of findings section to follow.

5.2 Discussion of Findings

Findings were presented in a descriptive format in section 5.1. The reason for this was to break down the research question into "bite-size" sub-categories (issues of investigation), with a focus on understanding the extent to which the findings respond to all components of the question, address the problem, and fulfil the objective of the investigation.

The objective of the study was to explore the adequacy of the SE internship programs in alleviating the SE skills shortage in the Western Cape, and the findings show significant shortcomings in the SE internship programs.

Firstly, on the status and magnitude of the SE skills shortage, despite the internship initiative, findings still confirm a continued severe SE skills shortage in the Western Cape. Explanations range from the inadequate competencies of students enrolled in SE courses at Universities, a lack of qualified SE personnel to train new entrants, to the inadequacy of the practical component in SE curricula at Universities, and the limited interaction and collaboration between Universities and the industry. Secondly, responses to do with University SE curricula emphasize that there is an imbalance between the theoretical and the practical components. This is cited as a major impediment to the SE skills development initiative in the WC. Thirdly, on the structure of the internship program, findings indicate that different companies have different structures to suit their business needs, which inhibits coherence in the content and output of the program. Difference in terms of time lines in particular was apparent in the findings. For example, instead of uniformity the internship tenure can vary between 6 months and 2 years of practical training, depending on operational circumstances and policies of the internship host. The objective of the program in the eyes of all stakeholders, thus, becomes contextual. In confirming a common understanding that all actors should hold on to the goals and objectives of the program, it was found that most organisations cite the exposure and the up-skilling of SE interns in the practical aspects of SE as being the main objectives. This sentiment is interrogated against the identified challenges in the SE skills industry later in this section. In the eyes of the interns however, the internship program is appraised as a success, albeit without adequate substantiation. The only motivations given by interns is that they get the opportunity to gain real world exposure in the technical aspects of the SE field, and some get technical certifications which are relevant to their career.

Nevertheless, the aim of the discussion section is to unpack the causal aspects and implications of these findings, so that informed conclusions can be drawn up and, ultimately, recommendations can be made.

Following the same approach (dividing the inquiry into 5 sub-categories or issues of investigation) therefore, this section draws on the ANT framework and its embedded assumptions to critically discuss the findings presented in the previous section (section 5.1).

Progressively, the aim of the discussion section is to unpack the causal aspects and implications of these findings, so that informed conclusions on the problem and, ultimately, recommendations – can be drawn.

Following the same approach (dividing the inquiry into 5 sub-categories or issues of investigation) therefore, this section draws on the ANT framework and its embedded assumptions to critically discuss the findings presented in the previous section (5.1).

5.2.1   Status and Magnitude of SE Skills Shortage in the WC

From the investigations done on this issue, the findings reflect a high status and magnitude of SE skills shortage, particularly in the Western Cape, greater than that in other regions like Johannesburg (DT_R6). Most of the skills in short supply are programming skills for Java, dot Net and Microsoft (DT_R6 and). Other skills in short supply are database knowledge and Microsoft skills. These are some of the practical skills that are required in the Industry but have been highlighted as lacking in University graduates (TF_R9). The lack of SE skills has been largely attributed to the inadequacy of SE students enrolled at Universities and this is largely because of low enrolment numbers. Universities should not take the full blame as they raised a concern that schools do not produce adequate candidates for SE courses for Universities (HOD_UC_R16). The inadequacy was related to the low pass rates for high school mathematics which result in the low enrolment levels in SE courses at Universities. Mathematics is a pre-requisite for entry into SE courses and Universities complain that few matric students pass this subject (HOD_UC_R16) and the few who pass seem to have made it because they simply studied for it and they are not thinking students, which is a requirement for SE (HOD_UC_R16). In a rough estimate given for University enrolment statistics, 1500 offers are made and about 450 responses qualify (HOD_UC_R13). From the few responses SE departments receive, most of the candidates indicate an interest in SE only as an added advantage and not a course they would want to major in or a career path they would want to follow (HOD_UC_R12). This is even after Universities have lowered the qualifying pass mark for mathematics (HOD_UC_R13).

According to the ANT, an ideal skills development network is when all actors operate at the same level and there is no superiority amongst actors operating in same environment. If there is no such balance a network is doomed to collapse. From the findings, it has been noted that although the main goal of tertiary institutions' is to produce SE graduates and

supply these to the SE industry, not all these institutions operate in the same way. For example, one University does not offer SE internship program at all (HOD_UC_R14) while other Universities do. In addition Internship Organizers offer SE internships (HR_DT_R7). One of the Universities operates as a technical University and offers hands on experience (HR_DT_R7 and DT_R21) whereas the other mainly focuses on the theoretical aspects of SE engineering (HR_DT_R7 and TF_R9). In this scenario Universities which offer internships have a competitive advantage and their students are in great demand in the industry, due to the industry exposure they get during internship. (DT_R21) are unique and operate differently to produce SE skilled students. This skills development network has already deviated from what ANT advocates to be ideal and this is why the SE skills shortage in the industry is high.

If the skills development network collapses due to the imbalances mentioned above, the SE industry is at risk, it can suffer business losses which in turn hinders economic growth (Roman, 2010). Some companies indicated that they have lost some business due to a shortage of Java developers (DT_R7). Since SE is a major driver to economic growth (Cagiltay, 2007) the implication is that if there is a lack of skilled SE professionals then there is a threat to economic growth. The consequence of having low SE enrolment in Universities means that there is low supply of potential SE skilled personnel to enter the industry. This has seen some internship and intern support programs like Organisation A trying to bridge the SE skills gap by training the unemployed SE graduates with more practical expertise (C_R2). As it stands the SE skills shortage problem can only worsen if the problems discussed above are not solved.

Following the status and magnitude of SE skills shortage discussion above, an analysis of curricular issues is discussed in the next section (section 5.2.2).

5.2.2 Curricular Issues

Under the Curricula theme, the main focus was to ascertain the balance of theoretical and practical components in the SE modules of the tertiary institutions. From the findings, employers blame Universities. They say that Universities use generic modules and do not have enough practical components in their SE curricula (DT_R11). Employers cite a lack of Microsoft specialty skills that are required in the industry (TF_R3) and that as far as databases are concerned, more theory is taught than practical aspects (TF_R9). It has also been observed that Universities do not work hand in hand with the industry when preparing their curricula (TF_R10). It would be beneficial if such a relationship existed. It would avoid the shortcomings in the curricula by facilitating knowledge transfer on the expected practical

knowledge that graduates need when they join the SE industry. Employers have based this argument on the fact that they have seen interns from colleges out performing University interns in the practical elements of SE (TF_R9).

According to the ANT, an ideal skills development network is when there is some form of balance between actors and actants. If this balance is compromised then the network faces dangers of collapsing.)It has been revealed from the findings, some Universities have internship as part of their curricula (DT_R21) and some do not require it although they seem to consider it (HOD_UC_R14). The differences in the curriculum are due to different people involved in curriculum preparation and also based on what each University can teach (HOD_UC_R5 and C_R13). At present there is no standard curriculum that is uniform across all tertiary institutions that run SE courses. Nor does anyone validate the adequacy of the curriculum by looking specifically at the balance between theory and practical and at the duration of the modules. These differences already pose a problem, since some Universities are producing SE graduates with a lack of practical knowledge (TF_R9). This problem is especially noticeable at those Universities that do not offer internship as part of their curricula (DT_R21). Having more graduates with theoretical knowledge than graduates with practical knowledge in the industry already creates an imbalance in the skills network and threatens the survival of the network. Thus, there is a high SE skills shortage in the Western Cape.

Following the curricular issues discussion above, the structure of internship programs is discussed in the next section (section 5.2.3).

5.2.3 Structure of Internship Programs

Under this theme, the structure of internship programs is questioned across different actors in the skills development network. The findings unveiled that different companies have different internship structures to suit their business needs (MC_R8). As shown in the findings, internships time period range from 1 year (FM_R21 & TF_R15) to 2 years (BM_DT_R9 & HR_DT_R12). During the internship, interns are taught practical skills as well as theory (DT_R19) and this is facilitated by a mentor assigned to take care of the interns (MG_TF_R4).In regards to the practical training, interns are given an opportunity to work in real projects (TF_R11 and MG_TF_R20) in their areas of specialisation (BM_DT_R9) although some are trained in areas where there is a need (FM_R16). However

According to ANT, an ideal skills development network internships should all have same internship content and run over same time period, to be rated fairly. As reflected in the findings, interns are already operating in different business scenarios which mean the

78

environments in which they operate, are already different. Furthermore, some actors do not fully execute their roles for a successful network. For example there is no government legislation on how internships should be run. If there had been at least a standard set of rules that all SE companies who employ interns should follow, then a proper structure would have helped to alleviate the SE skills shortage. The result of not having a proper structure in place shows that problematisation was not properly done by all the actors and actants to solve the SE skills shortage problem in the Western Cape. This is mainly as a result of a lack of balance between the roles and relations of actors within the SE skills development network. However, although there are mixed feelings on the effect that the different duration of internship programs has on the Industry, this on its own cannot be a major problem. Thus the lack of structure in internship programs combined with other issues like imbalances in the curricula seem to be the problems that contribute to the high skills shortage in the industry

Following the structure of internship programs discussion above, an analysis of goals and objectives of internship programs is discussed in the next section (section 5.2.4)

5.2.4 Goals and Objectives

On this issue of investigation, the main goals and objectives of internship programs was explored. The findings from the interviewed participants all reflect the need to strengthen the SE technical skills of interns through industrial experience (DT_R7, T_R8 HR_FM_R7). For example, a Company increased its six month internship to a year as they felt that the six month program was not adequate for technical skills training for its graduates (HR_FM_R16). It is clear from the findings that technical skills are in short supply in the industry, especially skills like Java development (DT_R5) and some Microsoft skills (TF_R14). This lack of technical skills often results in SE skills shortages. These are the skills that are in high demand in the Western Cape (HR_FM_R2).

According to the ANT, all actors in the SE skills development network should be working towards the same goal for a successful network. In relation to the goals and objectives component in this issue of investigation, if all actors are working together to achieve the same goal for technical skills training, then this should hold the network together and avoid its collapse.

One aspect investigated in this dissertation is to find out whether government, SE industry and tertiary institutions are realising the benefits of SE internship programs and alleviating the skills shortage in the Western Cape region. It is clear from the findings that main goal of all actors of providing SE technical skills training to interns are positively contributing to the

alleviation of SE skills shortage. However, offering technical training during industrial experience on its own is not adequate to solve the problem. More practical training at tertiary institutions could be a better way to up-skill the large number of software engineers needed in the industry as the industry can only (employ) a few which is not enough to sustain the demand.

Following the goals and objectives of internship programs discussion above, an analysis of successes and failures of internship programs is discussed in next section (section 5.2.5).

5.2.5 Success and Failures on Internship programs

On this issue of investigation, the focus was on investigating the level of success of internship programs in the Western Cape. As reflected in the findings, a number of interns gained SE technical expertise through industry experience (DT_R19 & C_R9). Most interns who complete their internship programs are in high demand to take up skilled positions in the SE industry (C_R5). This clearly shows the success of the program. Some interns from internship organisations end up getting employed by their host companies (C_R9) as a result of the technical expertise they have acquired during internship. Some companies keep employing interns each year (TF_R12) and this is because of the benefits the interns bring to the Company after they have been technically trained. If internships failed companies would not waste time and money employing interns every year. Furthermore if the quality of graduates from Universities is not that good (DT_R17), and interns who complete internship programs are in demand it simply confirms the success of the internship program.

As discovered from the findings Universities are working to produce software engineers (HR_FM_R15), and internship organisations as well as the SE industry are producing SE technically skilled interns (DT_R13& TF_R11).   At the same time the government implemented legislation gives a 1% levy back to companies that train interns (HR_FM_R17& MC_R9). All these efforts suggest that the actors in the SE skills development network are working together. This situation supports the ANT and achieves a successful network. It is clear from the findings that the internship programs are a success. However as it stand only a few graduates get internship positions and this is not enough to sustain the SE industry with the required SE skilled personnel. This implies that there must be many unemployed SE graduates who lack the technical skills that the industry requires. Although internships are a success (DT_R15), on their own they cannot solve the SE skills shortage problem in the Western Cape (DT_R16). Other solutions will need to be taken into considerations. These solutions will be found in the recommendations section in Chapter 6.

Following an analysis of the successes and failures of internship programs above, the final section of this chapter, the conclusion follows (Section 5.3).

5.3 Conclusion

The aim of this research was to investigate the efficacy of SE skills development initiatives in the Western Cape Province. Investigations were mainly focused on the emphasis placed on internship programs as part of the initiatives shared by government, industry and tertiary institutions in the Western Cape. This was to understand if graduates are groomed well enough for SE entry level vacancies, according to the SE industry expectations.

Due to the qualitative nature of this study under the interpretivist paradigm, interviews and observations were done with SE interns, Universities, SE employers, human resources personnel from SE industry, SE managers and Internship Organisers. Findings were drawn from the 5 issues of investigation which dwelt on the status and magnitude of SE skills shortage, SE curricular in Universities, structure, goals and objectives and the successes and failures of the SE internship program in the Western Cape. These results are presented as percentages to simplify the view of the findings.

Data was analysed using the methods of content analysis and the findings were tabulated under each theme in the findings section. From the first issue of investigation which answered questions on the status and magnitude of SE skills shortage, it was discovered that there is an extremely high SE skills shortage in the Western Cape Province. The second issue which mainly focused on SE curricular issues revealed an imbalance between practice and theory in University programs, which is mainly a result of no SE industry contribution to the preparation of SE modules in Universities. The third issue touched on the structure of the internship program and it was discovered that each Company has its own structure. There is no uniform structure of internship across SE companies, which allows industries to do what suits them best. The fourth issue was goals and objectives, and as presented in the table most organizations have similar goals with only slight variations. The final issue considered the successes of completed internship programs. Most programs are considered to have succeeded well with a few being considered to have achieved moderate success levels.

This chapter related the findings to the ANT theory and in most cases the findings reflected an imbalance in the SE skills development network. The imbalances in the SE skills development network point to the collapse of the network which implies that the problem being investigated will get worse unless positive preventative measures are taken.

Chapter 6, which is the final chapter, gives a summary and makes recommendations for further investigations based on the findings of this dissertation.

CHAPTER 6: CONCLUSION

6.0 Introduction

This chapter presents a summary of all the chapters. It looks again at the research problem and questions raised during the investigation, summarises the whole thesis, outlines key aspects of the findings and highlights recommendations for further study. Due to the qualitative nature of this study under the interpretive paradigm, the findings came from the data collected using interviews from a selected sample of fourteen (14) participants. These included heads of departments (HoD) of University computer science faculties, SE interns, HR managers from SE companies, SE managers and internship organizations. The data gathered was analysed using content analysis which revealed the themes on which the research focused. The chapter concludes by pointing to possible further areas of research that could be carried out.

The structure of the chapter is outlined in Figure 11 the chapter roadmap.
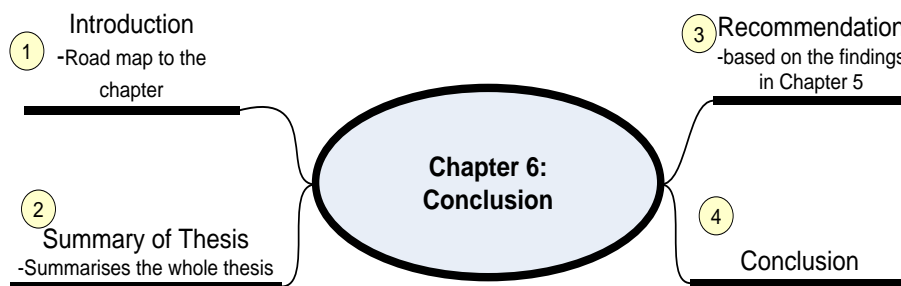
Figure 11: Chapter 6 Roadmap

6.1 Summary of Thesis

This study investigated the efficacy of the internship programs in the Western Cape Region of South Africa. The objective was to examine the contribution made by SE internship programs in reducing the SE skills gap in the WC region. Additional aims were to gain insight into the benefits of such initiatives, to find out if there are any gaps, and ultimately, to suggest improvements that may benefit the Software Engineering (SE) field of operation. To fully investigate the efficacy of internship programs, a background study was done using the existing literature from published Journals, and other accredited sources. It is from the background study that the importance of SE skills in the Western Cape Province of South Africa was highlighted. The research questions and sub-questions guided the research.

In order to answer the research question, an analytical framework and several theories were introduced. The ANT was the relevant framework used to give proper meaning and clarity on how important the different actors in the skills development network are. This framework was used to break down the different components of the SE skills development initiatives in South Africa and it helped to give an understanding of the roles played by each actor and actant in the SE skills development network under discussion . This theory was used within the interpretivist epistemology together with a qualitative research approach.

Data gathering was done through interviews with14 participants selected by using purposive sampling technique. The interviewed participants included SE interns, University heads of departments, SE employers, human resources personnel from SE industry, SE managers and Internship Organisers. As a way of getting relevant data the research question was broken down into sub-questions which formed the five (5) issues of investigation. These issues included status and magnitude of SE skills shortage, SE curricular in Universities, structure, goals and objectives and the successes and failures of the SE internship program in the Western Cape. The findings were based on the same five (5) issues of investigation and the ANT provided a basis upon which recommendations concerning the SE internship program were made.

Despite the promising efforts made to support/expand the SE internship program, findings reflect a bleak picture in terms of progress. Findings reflect that the shortage of software engineering (SE) skills remains a major concern in the Western Cape region. SE companies have reported that they are constantly looking for skilled Software Engineers and that there is huge competition in the market for personnel with technical SE skills. Due to this competition some skilled professionals are able to charge a premium. The lack of technical SE professionals has been blamed on the small numbers of new Software Engineers that Universities supply to the industry each year. However, the Universities say that the real concern is the fact that so few applicants have a sufficiently good mathematics pass rate matric, which is a pre-requisite for enrollment into the University SE courses. The Industry maintains that, the few SE graduates that Universities produce do not have the SE technical knowledge that the SE industry requires. This lack of technical skills among University graduates is associated with the imbalance between theory and practice in the SE curricula that the Universities offer, and with the lack of collaboration between Universities and the SE industry, especially in terms of involvement in curricula drafting.

Respondents were worried that Universities offer generic and theoretical aspects of SE rather than the technical aspects that the SE industry is looking for. It was also discovered that students are not proactive to gain more knowledge on what is transpiring in the SE industry in addition to what they are being taught in the tertiary institutions. Despite having a

number of knowledge sharing sessions outside the Universities' schedules, SE students did not attend these. These sessions are designed for the benefit of students. If students do not attend they do not get to know some of the practical requirements in the field of operation, and hence they lack much of technical knowledge expected by SE employers when they graduate. This causes an imbalance in the SE skills development network, and reduces the likelihood of a successful ANT network. This shows that, if not managed properly, SE skills shortage will increase despite the existence of the SE internship programs that are currently running.

The researcher's recommendations are highlighted in the section that follows.

6.2 Recommendations

From the problems and their causes reflected in the findings, the researcher suggests active participation of SE employers in the preparation of the University SE curricula. This can be done when Universities involve the SE industry and get their input in regards to what is actually used and required in the SE industry. Although the universities feel they do not want the industry to dictate to them, it seems technology is dictating to the industry at the other end. As a result of this situation it would be beneficial if companies were consulted by universities when the curriculum is prepared. This sort of cooperation could help to close the skills gap that currently exists when interns join the field of operation. Such consultation could also help tertiary institution to review and change their syllabus at the right time and to focus on what is required in the field of operation. This is in line with what ANT advocates to be a successful network where all actors and actants in the SE skills development network work together to achieve the same goal. In addition the Provincial government needs to work with the Universities and industry, to draw up a plan showing how SE curricular should be drafted   and who should be involved.

The researcher further recommends students to attend informative seminars on the benefits of SE communities and professional bodies. These can be encompassed in the SE curricula so that it is mandatory for students to attend. The best way to promote these during class time is if they are made part of the modules. Furthermore, exchange programs should be considered amongst SE training institutions so that there is knowledge sharing between students from different institutions.

Students registering for SE courses should be advised to join at least one professional body like the Computer Society of South Africa. This should be a requirement for acceptance the SE degree program. The Computer Society of South Africa often host knowledge sharing sessions with other professionals in the SE industry. Attendance at these sessions would help students to network with other SE students and employers, to learn about technologies

that are currently in use in the SE industries and to participate in other SE related knowledge sharing, thereby enhancing SE technical knowledge. For example those from Universities of technology who benefit more on the technical aspect can share knowledge with interns from non-technology Universities.

Lastly, it is recommended that more time be allocated to secondary school mathematics so as to increase the pass rate. This would have the potential to improve the marks obtained in mathematics. As some Universities have lowered the required grade in mathematics, in order to increase enrolment numbers in SE courses, the researcher recommends that those universities provide more tutoring sessions for such students. Employers should be able to employ   as many interns as they want, in order to give them the experiential training required, but this is impossible if the supply from Universities is limited. The government should ensure that there are adequate qualified mathematics teachers in secondary education. If the supply is inadequate, the government should design a program to attract skilled teachers from other nations. All these suggestions could help to restore balance in the SE skills development network. This would prevent the collapse of the SE skills development network.

6.3 Conclusion

The useful contribution given by this research was the insight it provided into the efficacy of SE skills development initiatives in the Western Cape Province of South Africa. It revealed the importance of the Software Engineering (SE) discipline as both a field of study and a field of operation, particularly in the Western Cape Province. Furthermore the research pointed out that Software Engineering (SE) as the main economic driver in the region has been hindered by the lack of skilled SE professionals. According to the findings two of the causes for the SE skills shortage are the low number of student enrolments on SE courses in Universities and the lack of technical knowledge among SE graduates. Suggestions on how to resolve these problems have been highlighted under recommendations in each theme of investigation in section 6.1. Limitations to the study are discussed in the section below.

6.3.1 Limitations of the study

The study is about the efficacy of SE skills development initiatives in the Western Cape Province. The sampling plan focused on interviewing and observing human resource managers, IT managers, Interns from IT companies and Heads of SE Department from Universities. Since software engineering is the main driver for economic growth of many industries, it would have been advantageous to include all industries in the sample However, due to time constraints, other industries were not included in the sample, so they were not

interviewed. Some interviews were carried telephonically as the participants could not be reached directly. This was due to busy schedules and offices located in a situation different from the operating company. This limited the access the researcher had to all the facial expressions and other body language that arises during interviews, which can add a different meaning to what the participant is conveying verbally.

Only Universities were considered in this research. Those tertiary institutions, like private training institutions, that offer IT qualifications on behalf of other external universities, were not considered. These tertiary institutions also supply a number of students to the SE industry. These were considered outside the scope of this thesis due to time constraints.

6.3.2 Considerations for Further Research
This research has demonstrated the need for future investigation into the ways in which a more solid relationship can be built between SE tertiary institutions and the SE field of operation. This could enhance the quality of the syllabus taught and hence the graduates would be better aligned with what the SE industry needs. Internship programs positively contribute to the alleviation of SE skills shortage in Cape Town and more focus on enhancing such programs will benefits the SE field particularly in the Western Cape Province, where such a shortage is very pronounced.

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8.0 Appendices

Due to the qualitative nature of this study, interviews were used as a data gathering technique. This chapter reflects on how data for this research was collected from the fourteen (14) participants. It presents the questionnaires used to collect data, consent form used to assure participants on the safety of confidentiality of the information they provide. It further presents a sample of the interview questions and answers (transcripts) and the request letter.

8.1 Consent Form

Cape Peninsula
University of Technology

INFORMED CONSENT FORM
M:Tech Thesis

Dear Sir/Madam

I am Tendai Marambire, a student at Cape Peninsula University of Technology. I am researching on the efficacy of Internship Component of the Software Engineering Sector in the Western Cape.

Purpose: This research examines the contribution of current Software Engineering (SE) internships towards SE skills gap reduction in the Western Cape region. The focus is in the relationship between SE internships and the SE skills shortage problem.

I am trying to understand whether SE related skills development initiatives is helpful in solving SE skills shortage in WC. In this respect, emphasis is placed on internship programs as part of the government, industry and tertiary institutions in the Western Cape. The idea is to explore the structure of the internship programs, for a full insight on the benefits for such initiatives so as to identify if there are any gaps, and ultimately, to inform improvements. The end goal therefore, is to understand whether graduates in tertiary institutions are groomed to the industry's expectations for entry level careers in the software engineering field, so as to contribute towards the reduction of the skills gap in the industry.

Benefits: This research is expected to give insight to the internship planners, Universities and employers on what need to be maintained and improved in the internship programmes. This will shape the structure and curriculum of the program according to industry expectations.

Confidentiality: This study has been approved by an Ethics Review Committee of Cape Peninsula University of Technology, Faculty of Informatics and Design.

Your answers to the interview questions and the results will be kept confidential and will only be used for academic purposes. Some answers will only be used for improving internship programs and sources will be kept confidential. Combined results (from other participants) of these interviews will give insight to what needs to be done to improve (if need be) SE internship programs. Your name or details will not be used in any reports without your consent.

If you have any concerns you may ask. You may also contact the project promoter (supervisor) at Mlitwan@cput.ac.za if you need additional clarity.

Certificate of consent:

I have been invited to take part in a research study on Software Engineering Internship Programs in the Western Cape province. I have read the foregoing information, or it has been read to me. I have had an opportunity to ask questions, and any questions that I have asked have been answered to my satisfaction. I consent voluntarily to participate as a subject in this study and understand that I have the right to withdraw from the study at any time.

Name:_____Signature: _____

Date: 4 March 2013

Name of Researcher Tendai Marambire

Signature: *tmarambire*

 Date:4 March 2013

8.2 Interview Questions

Table 7: Interview Questions

Main Question: What is the Efficacy of the Internship Component of the Software Engineering Sector in the Western Cape?					
Issue/ Point of Investigation	**IT Managers**	**HR Managers**	**Internship Organisers**	**University HoDs**	**Interns**
Status of SE Skills Shortage in WC	1. What is the current state of SE skills shortage in the Western Cape? 1.1 What is the core business of your org? 1.2 What programming languages are in demand in your industry? 1.3 Which of these do you need the most in your organization (task vs. programme)? 1.4 Why are these (is this) more important for your organisations 1.5 What kind of technical skills (i.e. developers, testers, etc) does your core business need? 1.6 How many people with these skills are employed in your organisation? 1.7 Is this number adequate (…and why)? 1.8 If inadequate – why not employ more skilled persons? 1.9 What is the impact of having inadequate skilled experts? 1.10 What are you doing to solve the problem? 1.11 Do you find new graduates to be adequately skilled & well prepared to meet your skills demand when they enter employment? 1.12 What are the gaps? 1.13 What are the causes of this?	6. What are the main skills on demand in SE in Western Cape? 6.1 What sort of skills do you recruit for? 6.2 Is it easy to get those skills in the market? 6.3 If not, what do you think is the reason? 6.4 What is the total number of skilled people you currently need? 6.5 Do you ever consider recruiting interns? 6.6 Where do you get these interns from? 6.7 Any reasons why recruiting from there? 6.8 What is the selection criterion when recruiting interns? 6.9 Do you find it easier to get the interns? 6.10 Do the interns you recruit meet your entry level expectations? 6.11 How many interns do you employ per year? 6.12 How many interns do you currently have? 6.13 What are they training on?	10. What are the main skills on demand in SE in Western Cape? 10.1 How does your organisation operate? 10.2 Why was it formed? 10.3 Which skills is in short supply? 10.4 Why? 10.5 How critical is the IT skills shortage? 10.6 Do you train for all those skills in demand? 10.7 How is the performance of the trainees? 10.8 How many skilled people does the industry need? 10.9 How many do you supply? 10.10 Why that number? 10.11 Do all your trainees secure employment after training?	15. What is the Impact of SE skills shortage? 15.1 What IT courses do you offer? 15.2 What programming languages do you specialise in? 15.3 Any reason why those languages in particular? 15.4 What is your yearly target enrolment into these courses? 15.5 What is the average enrolment you normally have? 15.6 If less than target number, why? 15.7 Do all enrolled students in that program graduate? 15.8 If no, why? 15.9 Do you think it the reason why we have skills shortage? 15.10 What are the other factors that cause SE skills shortage in the industry?	20. Are the interns SE interns getting relevant exposure in the field of operation? 20.1 What are you currently training on? 20.2 Is it the career path you wanted? 20.3 If not they why following that path? 20.4 Do you see yourself in the same path for the next 5 years? 20.5 Is your mentor always available to you? 20.6 Do you get all the training you need?
Goal/ objective of internship programmes	2. What is the purpose of employing these new graduates? 2.1 How many interns do you have currently? 2.2 What is your target number of interns in each financial year? (If number of currently employed is less than target, why?) 2.3 What goals do you want to achieve by employing interns? 2.4 Are the goals achievable with the current number of interns you have? 2.5 If not why? And if yes which goals have been achieved so far? 2.6 How do you measure these goals? 2.7 Is there any structure to adhere to, to measure these goals?	7. What are the goals of these initiatives? 7.1 What is the main reason for training these interns? 7.2 Are these the skills that you are looking for? 7.3 Is the government involved in anyway? 7.4 How? 7.5 How does the internship program benefit your organisation?	11. What is the purpose of the SE internship programs in Western Cape 11.1 What are the main objectives of forming this program? 11.2 Which industry do you mainly target when supplying interns? 11.3 Why that industry/s? 11.4 What do you achieve as an organisation?	16 What are the goals and objectives of sending students out for internships? 16.1 What do you aim to achieve by sending students out for internships 16.2 What do you gain as a University by doing that? 16.3 Are there any benefits to the IT field of operation from interns?	21. What is the main objective of interns in enrolling in the program? 21.1 Why are you enrolled in the internship program? 21.2 What do you expect to achieve during the internship? 21.3 Is it of any benefit to you? 21.4 How?

Structure of internship programmes (insight)	3. How does your internship program work? 3.1 What is the duration of your internship program? 3.2 During the internship period, what are the roles and responsibilities of the interns? 3.3 How do you train your interns? 3.4 What are the main skills you train them? 3.5 Do all your interns successfully complete the program? 3.6 How do you determine successful completion of the program? 3.7 Are there any drop outs from the program? 3.8 What are the reasons of not completing the programs? 3.9 Do you think the current structure is perfect for the program? 3.10 What sort of motivation do you give your interns during the training period? 3.11 What are the chances of your interns securing full time employment? 3.12 How do you give performance feedback to interns?	8. What is the role of the government in the internship programs? 8.1 How is the structure of the internship in your organisation? 8.2 How long is the program? 8.3 Do you give any incentives to your interns? 8.4 What are the incentives for your interns? 8.5 How do you measure the incentives? 8.6 Do you do regular performance checks on intern performance? 8.7 How regular? 8.8 Are there any target goals for interns?	12. What are the selection criteria for students who enter into the internship programs? 12.1 What are the prerequisites for interns before they go to the industry? 12.2 Do have any specific organisation you supply interns to? 12.3 Which are they? 12.4 Why those? 12.5 Is there any communication with companies on what interns are supposed to cover during the program? 12.6 How long is the program? 12.7 Do you think the structure is well structured? 12.8 Who is involved in structuring the program? 12.9 Any government involvement? 12.10 If yes, how is it involved? 12.11 Is it of any benefit?	17. How is internship at universities structured? 17.1 What are the criteria used to consider if students are ready to be sent to industry? 17.2 What are the selection criteria for students who enter into the Software engineering programs? 17.3 What is the structure of internship programs? 17.4 How do employers give feedback on the programs?	22. What sort of training is done by interns? 22.1 How do you spend your day at work? 22.2 How do you report on the tasks you have done? 22.3 Is there anyone who verifies your work? 22.4 Do you find your work challenging? 22.5 Do you get any incentives? 22.6 Do you think the way your internship is structured is the best? 22.7 Why / Why not? 22.8 Is there any area you feel should be improved?
Curricula issues (balance of theory & practice)	4. What sort of skills do they have when securing full time employment? 4.1 Are there any certifications your interns get during the program? 4.2 Which courses do they do? 4.3 Which educational bodies do you use? 4.4 How are the courses paid for? 4.5 Do they get any practical experience during the course of the program?	Same as above	13. How is your internship program operated? 13.1 What is the role of government in this internship program? 13.2 Does the internship program include theory and practical work? 13.3 Do you conduct any classroom training – instructor led? 13.4 Where are these classes conducted? 13.5 How is the syllabus prepared? 13.6 Who is involved in preparing the syllabus? 13.7 Is there any practical work tasks given to interns? 13.8 What sort of practical do they do? 13.9 What determines the practical tasks they do?	18. How is University internships structured? 18.1 How do you prepare internship curricula? 18.2 Is the government involved? 18.3 If yes, How? 18.4 When do you send students for internships? 18.5 How do you determine student readiness for internship? 18.6 How do you allocate companies to students? 18.7 How long is the internship? 18.8 Do you think it's long enough for students to grasp all the expertise required in industry? 18.9 How do you mark successfully completion of internship? 18.10 Do you have any idea on what the industry expert form interns?	23 Do interns find the curricula of the program helpful in gaining necessary skills? 23.1 Are you required to write any certifications? 23.2 Are they theory or practical? 23.3 What certification are they? 23.4 Do you find the tasks the theory useful in solving real scenarios you face at work?
Progress: success & failure aspects of internship programs	4.6 Are software related internships important for your organisation – and why? 4.7 How are these important for the software industry as whole? 4.8 What are the particular benefits to your organisation? 4.9 Do you consider the current internship programme as successful (& why)? 4.10 Do you think internships are a useful way of solving the skill shortage problem? 4.11 What could be done to improve? 4.12 What possible additions do you think are needed to solve the problem?	9. How successful is the internship program? 9.1 Was the internship program a success in your organisation? 9.2 What are the benefits did you gain from the program? 9.3 Do you have plans to recruit more interns in the next year? 9.4 Are you going to increase the number compared to the previous year? 9.5 How much more? 9.6 For which roles specifically?	14. How successful are the internship programs? 14.1 Do the interns produce any practical work during the program? 14.2 Is any of the work they produce used anywhere? 14.3 Where and what for? 14.4 Are all your interns to date employed? 14.5 In what roles are they employed? 14.6 If not employed, what could be the reason? 14.7 How many companies recruit from your interns? 14.8 How many request do you get from the companies?	19. How is the demand of interns form organisations? 19.1 Do you all your students find it easy to get internships? 19.2 How many did you send this year? 19.3 How many failed to secure internships? 19.4 What are the possible reasons for failing to secure internships? 19.5 Out of those who secured internships, are they all in IT? 19.6 What sort of roles are they occupying? 19.7 Does everyone who goes out for internship graduate? 19.8 If not, why?	24 Do trained interns continue working in same field after the program? 24.1 Do you think you are gaining necessary skills to remain in the job market? 24.2 Do you see yourself using the same skills you are getting in the next three years? 24.3 Would you recommend internship program to a friend? 24.4 Why?

8.3 Questionnaires

Interviewed by: Tendai Marambire

Month: March 2013

Introduction:

My name is Tendai Marambire and thank you for allowing me to have this interview with you. I am researching on efficiency of the Internship Component of the Software Engineering Sector in the Western Cape. The purpose of this study is to explore the structure of the internship programs, for a full insight on the benefits for such initiatives so as to identify if there are any gaps, and ultimately, to inform improvements in SE field

Q:Good afternoon ▮▮▮▮, how are you?
TF_R0: Cool, thanks

Q:Daniel, what is the core business for your Organisation 3Fifteen?
TF_R1: We basically develop custom solutions for clients, we specialise in Microsoft products in a couple of areas, we develop share point solutions, CRM solutions, integration work and we do business intelligence work, web applications but they all focus on Microsoft Technologies. We are a Microsoft partner in all those technologies. Everybody here has Ms Skills as well. We recently started mobile work which includes other operating systems such as OIS, Android but we are in Cape Town and we do not do those. These are in our Johannesburg office

Q: In your Cape Town office, which of the development skills do you require?
TF_R2: We specialise in all five of those skills I have mentioned and if we look at all people in the office now, they have strong business analysis skills and they know about SQL, report writing skills, design skill for BI people and share point need skills to design share point. They have to know how to configure share point so we develop custom work. Its not just configuration of share point but development of share point as well, we need Web Channel Server skills. For integration work, we have C- sharp, for CRM – CRM skills and for custom development currently we need Java script, jaison , c-sharp, asp.net, xml and debugging skills.

Q: From the wide variety of skills you need, how easy is it to get resources with those skills?

TF_R3: It's not easy; our recruitment process has two parts. We have Web sources from the Agents and we have people referring from those who used to work for us and those working for us. Whoever want to work for us we do an assessment test and depending on your

specialisation you either do BI work or development point and for share point we have specifics that we look for. For integration we do not have much work in Cape Town, we only have a few senior specialised people for that. When we do have work for that we use people in office to do that. CRM skills are difficult to get as well.

Q: This problem, is it only for your Cape Town office only or for Johannesburg office as well?

TF_R4: lm not sure about Johannesburg recruitments but they are much bigger than we are. There are people with skills but not necessarily work experience .We have graduates, Junior and seniors. Usually when people come straight from college with zero experience they start off as graduates and if they show a lot of potential. We know how to rate different levels for assessments for example, I do not expect a junior to know the whole architecture. If someone tells me that they are senior, after assessment they must prove to me. We find out that a lot of people that come from the agencies, because of disparity view of themselves; they think that they are the senior when they come from small companies. We compare everyone in terms of skills here for example a senior developer here should be a senior developer in Johannesburg and not just being a senior here and a junior in Johannesburg. When it comes to senior levels we expect more than technical skills. We expect that you can talk to clients, manage your time very well and manage your time very well.

Q: What impact does this skills shortage has in your organisation?

TF_R5: I know people out there and they have skills but are with other companies and usually people do not want to move. If they do they expect much higher salaries. In terms of how they affect us we try and manage time and when we land a big project we look for people out there and work on referrals. We always want people and we are well connected so when push comes to shove we always get people. We also write incentives for people in house for referrals or we contact our agencies. We always find people.

Q: You mentioned about graduates, where do you recruit your graduates from?

TF_R6: We advertise on Media and we talk to University

Q: Which Universities?

TF_R7: UWC and UCT. But this is managed in Johannesburg and lm not sure how they do it. We also get referrals for the graduate program.

Q: Do you find the graduates skilled enough for entry level positions?

TF_R8: No, there is definitely more to be done. We look for obviously look for skills but we also look at potential. People who take initiative and study more after work not just finish a

task and go because for us our product is for people. We send them for classes where they learn C-sharp, share point etc and try to put them on project where they learn. Graduates don't really know anything about application as they learn more of class material.

Q: Do you think Universities are doing enough to equip their student to get ready for the field of practice?

TF_R9: I think Universities mainly focus on Computer science, which is the science of computers. When I graduated, I knew what it means to say an algorithm, I knew how to develop a compiler but that didn't mean I know how to apply it to the practical business problem. That's where the lack is. I also see that, there is no knowledge of databases especially what the normal form is. They don't really realise what they are doing in relation to business scenarios. Universities should focus more on practical side. I also think it depends on where you go; for example I have seen people who go to CTI have more experience and knowledge on the practical side which is what we require. They apply for what they learn while people who go to Universities are more theoretical in what they learn

Q: Looking at this gap between what you expect in the industry and what you get from the Universities, do you give feedback to the university?

TF_R10: No, there is no relationship between me and the university and I don't know about their r/ship with the University.

Q: Currently, how many interns do you have?
TF_R11: This year we do not have any, we had 2 last year and we promoted them to juniors and they stayed on and they part of developers and they team up with senior to up skill them. One guy is learning on testing another guys helping on the shared point project.

Q: Is there any reason why you didn't employ interns this year?
A: We want to nature last year interns and give them the best time to grow. We didn't really have projects of that nature last year where they can learn. And we do not have capacity for new interns this year

Q: Do you have plans to have more graduates in the future?
TF_R12: Definitely, last year we had 2, before that we had 1 and a year before that we had 1. Neither of those we offered employment for. We are different from Foschini for example, where you have a large team and you grow with the team doing the same thing. We much more dynamic and volatile and we want to give the graduates and intern a good opportunity to learn. Last year we didn't have projects and I had to create projects for them. Most of our developers were at client sites and we do not want to put interns at clients as they are not

experienced enough. If we see at the end of the year we have projects then we will do that. There are 5 classes they need to go through. We rather have less people that we can mentor rather than have a lot and do not have the capacity to teach them.

Q: For the graduates you have employed so far, do they perform really well during and after the training.
TF_R13: I asked them for specific things to do. I do not want them to do things on their own as they are still in learning projects but yes they are performing very well.

Q: Do you think your graduates program will solve the skills shortage you have?
TF_R14: It certainly addresses the Microsoft skills problem because these are not offered at universities as they focus more on c-sharp and other programming languages. That's why we take them for training.

Q: How long is your graduate program?
TF_R15: It's a year program.

Q: Do all graduates complete the program?
TF_R16: No not all of them. The problem is some do not want to take an initiative and they just want to do the working hours and finish a task and go. We giving you a salary, we giving an opportunity so you need to show that you want it and willing to step up.

Q: What do you think are other possible solutions for skills problem in WC?
TF_R17: Education. It starts from graduates themselves. My view of thing is different from this generation where they expect a lot of things to be done for them. Technology also changed and I understands that. Like we had 50 graduate applicant and more than half of them didn't complete the assessment, but the people that showed they try to answer they did well. We look for more commitment. I hasn't seen that in most young people. In my time we had a community where we meet and discuss about technologies and we never see people from universities in those. We actually reached out to university to try and get them involved. We had a program called .Net juniors were we had tutorials. There is not really a lot of participation in those initiatives from university people. So its education and the community getting involved. And also there is little focus on Microsoft products from universities. I do not know if universities have company presentations because these are also helpful.

Thank you very much

Introduction:

My name is Tendai Marambire and thank you for allowing me to have this interview with you. I am researching on efficiency of the Internship Component of the Software Engineering Sector in the Western Cape. The purpose of this study is to explore the structure of the internship programs, for a full insight on the benefits for such initiatives so as to identify if there are any gaps, and ultimately, to inform improvements in SE field. We can start our interview.

Q: **Good afternoon ▮▮▮▮, how are you?**

MG_TF_R1: Good, thanks

Q: ▮▮▮▮, which company do you work for and what do you do?

MG_TF_R2: I work for ▮▮▮▮ and I am a junior java developer

Q: What is the core business of ▮▮▮▮?

MG_TF_R2: It's an IT service provider company and mainly focuses on development of Ms Products

Q: How did you know about ▮▮▮▮?

MG_TF_R3: I started as an intern.

Q: What were you doing during your internship?

MG_TF_R4: I work with the senior developer basically showing me what to do guiding me in development. He basically works as my mentor.

Q: As a mentor, is he always there to give you all the support you need?

MG_TF_R5: Yes, he is always giving assistance and I work with him in all projects I do

Q: Which language do you use in your development work?

MG_TF_R6: C Sharp.

Q: Did you get C sharp knowledge from school or you first started using it when you were employed as an intern?

MG_TF_R7: I did it at college so it was a bit easier. But the application of it in real scenarios is challenging.

Q: How is your internship structured?

MG_TF_R8: You have to complete Ms certified certificates. So I did that and then started working on projects

Q: Does the company pay for the certifications you do?

MG_TF_R9: Yes, everything was paid for by ▮▮▮▮ (Name of the company)

Q: Do you think this certification will help you in the industry?

MG_TF_R10: Of course yes

Q: For this internship program is there any incentives you get from the company?

MG_TF_R11: Apart from my salary, it's the certifications

Q: How many interns were enrolled at the same time with you?

MG_TF_R12: We were 2 in Cape Town and 14 in Johannesburg

Q: for all the two, did you all get permanent job offers?

MG_TF_R13: Yes, we all did. As junior developers

Q: Do you thing the internship program was good?

MG_TF_R14: Yes

Q: Why do you say so?

MG_TF_R15: Everything was structured properly and we benefited a lot form it. The internship is a 12 month period. The first six months you do the certifications and after that you work on projects

Q: What sort of projects are you working on?

MG_TF_R16: Share point sites, custom software.

Q: Was there balance between the theory you did at school and the practical you are doing now?

MG_TF_R17: No, it's totally different. What I did at school was like the old way of doing things and now lm learning the new way of doing things

Q: What is it that is lacking at school?

MG_TF_R18: At school they should look at what is required in work environment and teach something similar. What's done at school is behind.

Q: Would you recommend this internship to a friend?

MG_TF_R19: Yes, definitely I would recommend. It's a good program.

Q: So what achievement have you done in the company?

MG_TF_R20: I worked on software for Anglo American and its being used now

Thank you very much.

Interviewer: Tendai Marambire

Month: March

Introduction:

My name is Tendai Marambire and thank you for allowing me to have this interview with you. I am researching on efficiency of the Internship Component of the Software Engineering Sector in the Western Cape. The purpose of this study is to explore the structure of the internship programs, for a full insight on the benefits for such initiatives so as to identify if there are any gaps, and ultimately, to inform improvements in SE field

Q: Good Afternoon ▮▮▮▮, if I may ask what roles and responsibilities do you do at ▮▮▮▮▮▮▮?

HR_FM_R1: I am a HR business partner for, and I look after our professional services business units and the graduate program.

Q: What sort of skills do you require in your company?

HR_FM_R2: We are a mobile corporation development company and financial services and we are an IT shop that develops in Java and we look for Developers

Q: Is it easy for you to find such skills in the job market?

HR_FM_R2: There is a lot of competition and often quite difficult and the reason we a graduate program is to put more skills into the pipeline. We look for skill and basically attitude that we looking for specifically.

Q: You said you often look for developers. How difficult is it to get developers you need?

HR_FM_R3: It is very difficult to get skilled or senior developers. When you get them they charge a premium for these skills.

Q: Does this affect your organisation?

HR_FM_R4: It does definitively at a more senior level. It's not a rumour there is scarcity in IT skills and it makes sense for companies to implement the graduate program so that they can train people more people and feed up more people into the industry.

Q: Do you mind explaining what you mean by charging premium?

HR_FM_R5: They want high salary because they are scarce. It's all about demand and supply.

Q: In terms of numbers, how many skilled people do you need?

HR_FM_R6: Some roles are more in demand than others for example Java Developers, business Analyst.

Q: You mentioned about recruiting interns, what sort of qualification do you look for when recruiting interns?

HR_FM_R7: We have two separate programs Internships which we run in conjunction with CPUT and CapaCITI1000. It's a 6months and its on the job training program. The Graduate program is a bit different; it is a whole year program. It's a structured program for a full year.

Q: You mentioned that you recruit from CPUT and capaCITI 1000, Is there any reason why those two?

HR_FM_R8: We work closely with technikon (CPUT) because they have internships as part of their program.Technicons has a more practical program. At the moment we look for people with Degree.

Q: Is it easy for you to get interns who meet your requirements?

HR_FM_R9: We don't do interns only with CPUT and CapaCITI as part of their program. We have a graduate program and we take people who have a qualification. We look for high marks.

Q; How do you measure graduates performance during the program

HR_FM_R10: They have a coach who gives us feedback and we interact with the manager who regularly assesses their progress.

Q: Is there any government intervention in the skills development programs you have?

HR_FM_R11: They give us skills development levy back.

Q: Are there any successes of internship programs in you have seen?

HR_FM_R12: We had 25 graduates and there has been a lot of success and we see how they develop throughout the year. We have seen people grow and they have left us and have gone to other companies and that's the whole point of the graduate program. As long as we are contributing to the job market.

Q: Do you have any plan in recruiting more interns in the future?

HR_FM_R13: Yes, definitely

Q: Do you think the internship program will help reduce SE skills shortage

HR_FM_R14: I think only if every company does it, it gives graduates exposure on what's happening in the global work. If we do not give them a chance then how will they get the experience and exposure? So, yes definitely.

Q: Do you think they have good knowledge when they come straight from University?

HR_FM_R15: Yes, they do but not the practical aspect we require in the industry

Q: Do you think internships are structured in a good way?

HR_FM_R16: Interns don't really learn much in 6 months. A lot of our interns go on to the graduate program.

Q: Is there any government intervention on the internship programs you do?

HR_FM_R17: Yes, 1% of payroll goes to SETA. If you report then you get the %of the money back. We as a company we do our reporting on the training that we do and then we get a percentage of that. This is for all the trainings we do.

Thank you.