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The Range and Level of Software Development Skills Needed in the Western Cape, South Africa

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Abstract

Information Technology (IT) skills are in high demand in South Africa but currently, there appears to be a poor supply of these relevant skills as positions are not easily filled. The purpose of this study was to determine the range and level of skills required for software development work in the Western Cape and to ascertain the challenges faced by companies while trying to fill these positions. The research objectives are to (1) determine the range and level of software development skills needed in the Western Cape to meet industry demands, (2) determine the availability of relevant software development skills in the Western Cape as per industry demand, and (3) identify the challenges faced by industry while recruiting software developers in the Western Cape. Findings of the study is intended to inform the development of a University of Cape Town (UCT) approved qualification, for commencement by 2015, based on the gaps identified in the market.

Keywords: Software Development Skills, Western Cape, South Africa Skills Demand, Skills Gap.

Introduction

In May 2014, the top 100 occupations in demand in South Africa and the national scarce skills list were published by Higher Education Minister Blade Nzimande (“Scarcest IT skills in South Africa,” 2014). Systems analysts and software developers were listed as the top two Information Technology (IT) related professions in high demand in South Africa (“Scarcest IT skills in South Africa,” 2014). The growing demand for IT skills in South Africa has been noticeable for the past few years. In 2011, the Career Junction Index ranked positions in the IT sector as the fourth most difficult to fill (CareerJunctionIndex, 2011). The ITWeb-JCSE Skills Survey (2011) further amounted the demand for IT workforce to 20 000 to 30 000 job opportunities. In 2014, Career-JunctionIndex ranked the demand for IT skills as the highest and but also most difficult types of positions to fill (Career Junction Index, 2014).

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This trend is also visible in Africa. In January 2014, IBM published the findings from their study whose goal was to understand how IT leaders can deliver on the strategic potential of emerging technologies by addressing key adoption challenges. Their study identified that even though 87% of African IT leaders

recognize the importance of emerging technologies only 34% are adopting such technologies (“Setting the Pace in Africa,” 2014). Moreover, the study specifies that the lack of IT skills as well as the inability to attract and retain skilled IT professionals as one of the reasons for this poor adoption rate (“Setting the Pace in Africa,” 2014). In particular, less than half of the surveyed companies developed the adequate level of IT skills needed to bridge the technology adoption gap and both expertise and technology are required to maintain companies’ competitiveness (“Setting the Pace in Africa,” 2014).

Globally, the overall picture is no different. In 2010, Singapore’s ICT sector reported 16 100 vacancies which they attributed to lack of career advancement opportunities and unattractive salary packages (“ITWeb-JCSE Skills Survey,” 2011). In 2011, Dice.com reported around 83 000 ICT related vacancies in the US, which they attributed to a high demand for mobile applications (“ITWeb-JCSE Skills Survey,” 2011).

Currently in 2014, not only is the demand for ICT skills high in South Africa, there also appears to be a poor supply as these positions are not easily filled (Career Junction Index, 2014). In addition, the unemployment rate in the country in 2014 increased to 25.20% from the fourth quarter of 2013 (Trading Economics, 2014). However, there is evidence that people with the right skills in the right locations are finding employment (“ITWeb-JCSE Skills Survey,” 2011). For example, Microsoft successfully trained and placed in employment 6000 unemployed graduate (“ITWeb-JCSE Skills Survey,” 2011).

In 2013, an assessment was conducted of the Financial Services sector in South Africa to inform future strategy in this area. The findings, published in the Financial Services Assessment Report 2014 indicated that there is a need for skills in the software development space.

The Cape IT Initiative (CITI) and the Western Cape Department of Economic Development and Tourism (the Department) have been working in partnership for several years in order to develop the supply of quality Information and Communication Technology (ICT) skills in the Western Cape. Based on the findings of the above-mentioned report, and discussions between the Department, CITI and UCT, necessary research was conducted to understand the demand of software development skills in the Western Cape.

The purpose of this study was to determine the range and level of software development skills needed in the Western Cape, South Africa. Findings of the study was intended to inform the development of a University of Cape Town (UCT) approved qualification, for commencement by 2015, based on the gaps identified in the market.

The research objectives were formulated as follows:

- Determine the range and level of software development skills needed in the Western Cape to meet industry demands
- Determine the availability of relevant software development skills in the Western Cape as per industry demand
- Identify the challenges faced by industry while recruiting software developers in the Western Cape

Based on the above-mentioned research objectives, the following research questions were formulated:

- What is the range and level of software development skills needed in the Western Cape to meet industry demands?
- To what extent are relevant software development skills available in the Western Cape as per industry demands?

- What are the challenges faced by industry while recruiting software developers in the Western Cape?

The study focused on ICT, financial and retail companies employing software developers in the Western Cape for their respective IT projects.

Literature Review

In order to better understand this research context, the computing disciplines are first reviewed. In addition, the various job descriptions (profiles) and their corresponding requirements are detailed, setting the scene for an overview of the software development role within different environments.

Overview of the Computing Disciplines

All computing disciplines are often broadly referred to as Information Technology (IT). However, IT is an academic discipline of its own, alongside Information Systems (IS), Computer Science (CS), Computer Engineering (CE) and Software Engineering (SE), as recognized by the Association for Computing Machinery (ACM) and the Institute for Electrical and Electronic Engineers (IEEE) (ACM SIGITE, 2012). Table 1 provides a brief overview of each discipline.

Table 1: The Computing Discipline

Computing Discipline	Explanation
Information Technology	IT mostly focuses on the application, deployment and configuration aspect of computing. IT focuses on meeting the needs of end users within organisations and society through the selection, creation, application, integration and administration of computing technologies (Lunt et al., 2008).
Computer Science	Computer scientists are usually involved in (1) designing and building software (2) developing effective ways of solving computing problems, and (3) devising innovative ways of addressing challenges in robotics, computer vision or digital forensics through the use of computers (ACM, 2008).
Information Systems	The IS discipline is concerned with the information that can be obtained from computer systems to enable businesses, non-profit or governmental organisations in identifying and meeting their goals. IS is also concerned with the identification of business processes that companies can implement and improve on through information technologies (ACM, 2008).
Computer Engineering	Computer engineering focuses on the design and construction of computer-based systems and computers in general. It relates to the study of hardware, software and the interaction and communication between them (Shackelford et al., 2005).
Software Engineering	SE focuses on the reliable, efficient and affordable development and maintenance of software systems. SE also focuses on organisational issues as a means of developing information systems that are appropriate to the client organisations (Shackelford et al., 2005).

Individuals choosing a career in computing usually have a choice between four paths as shown in Table 2. Career paths 2 and 3 are specifically in the domain of computer science. Career 4 has

spawned new majors in software engineering and information technology. Computer scientists also fill positions in Career path 1, as do graduates of software engineering, information technology, and information systems (Shackelford et al., 2005).

Table 2: Career Paths in Computing

Career Path	Career Path Description
Career Path 1: Designing and Building Software	This career path incorporates work relating to web development, interface design, security issues, mobile computing etc. This can be completed in large or small companies of all kinds.
Career Path 2: Developing effective ways of solving computing problems (e.g. storing information in databases, new approaches to security problems etc.)	This career path involves works related to application or development of computer science theory to identify the best solution to intense computational problems.
Career Path 3: Devising new ways to use computers	This career path involves research work in innovative use of application technology. Individuals following this path usually have a research position at a university or industrial research and development laboratory.
Career Path 4: Work around organisational technology infrastructure	This career path involves work in Planning and Managing organisational and technology infrastructure

One particular job description in the computing discipline is that of programmer which often is referred to as computer programmer, developer, coder or software engineer. A programmer writes, tests, debugs and maintains computer programs, the requirements of which are obtained from systems analysts. Programmers are required to design, implement and test logical structures for solving problems (or business problems) by computers. Programmers work in varied work settings (e.g. big or large firms) and also in consulting companies deployed at client sites (contractors). This study focuses on the range and skill requirements of computer programmers in the Western Cape. Computer programmers fall into Career path 1 which is serviced by all 4 computing disciplines.

Methodology

This section presents the methodology employed to undertake this study, given the research questions and objectives presented in the introduction. An overview of the research approach is first presented, followed by a description of the study. A brief description of how the data analysis was conducted is also provided.

Research Approach

The study followed a two phase approach as follows:

1. Pilot Study to identify range and level of skills demand for software development within ICT industry
2. Round 2 to confirm and identify range and level of skills demand for software development within ICT industry

Research Phase 1

Phase 1 of the research focused on a pilot study to obtain a preliminary understanding of the range and level of skills required pertaining to software development roles and validate the interview questions (Creswell, 2013). This pilot study was conducted between October and November 2013. At the beginning of that phase, it was important to first analyse and summarise the IT related findings gathered from the Financial Services Sector Assessment Report (Draft 1). The research instruments were then devised based on the findings drawn from this first draft of the report. The pilot study was both quantitative and qualitative in nature using surveys and interviews.

Survey data was obtained from a questionnaire distributed via SurveyMonkey. The questionnaire consisted of 30 questions grouped into six parts/sections. Some questions were measured on a Nominal scale, while others were measured on a Likert scale:

- PART 1 - Demographics
- PART 2 – Graduate Information
- PART 3 – IT Usage (Programming Languages, Development/Reporting Platforms,)
- PART 4 – Skills Level Evaluation
- PART 5 – Skills Requirements
- PART 6 – Appetite for Qualification

Qualitative data was obtained from interviews conducted with IT specialists from various companies in the Western Cape. The interviews lasted approximately 1 hour. The interviews were semi-structured and the interview protocol consisted of 34 questions, grouped into six parts, similar to the survey questionnaire. The quantitative data from the pilot study was analysed descriptively and the qualitative data was analysed using thematic analysis as proposed by Braun and Clarke (2006).

Research Phase 2

The second phase of the research study was aimed at confirming the preliminary results. The survey questionnaire and the interview protocol were carefully updated in light of the research findings obtained from the first phase of the study. For the second phase of the study data was collected between February and March 2014.

The survey questionnaire was updated to include 50 questions regrouped into 5 sections. Some questions were measured on a Nominal scale, while others were measured on a Likert scale. The survey was also distributed using an online survey tool, SurveyMonkey. The survey analysis was mainly conducted using descriptive statistics on the items measured on the Likert scale. Some of these items were grouped together for analysis based on the sections (e.g., the section that measured the skills required for software development roles in the Western Cape); while others were grouped for analysis based on the variables measured (e.g., level of programming skills, level of business analysis skills). The descriptive tests carried out calculated the means and the means were used as basis for analysis and used to draw inferences from the data.

The interviews were semi-structured, each interview lasted approximately one hour and the interview protocol consisted of 53 questions, grouped into 3 parts as follows:

- PART 1 – Demographics
- PART 2 – Required Skills for Software Development Roles in the Western Cape
- PART 3 – Appetite for Qualification

Qualitative analysis was conducted using thematic analysis, based on the research questions specified in the introduction (Braun & Clarke, 2006). The various themes identified are described in detail in the Findings Section, including sample quotes from the respondents.

During the qualitative analysis of both Phase 1 and Phase 2, the search for key themes and patterns took place throughout the data analysis process and was iterative (Creswell, 2013).

Sample & Respondents

A summary of the number of respondents is provided in Table 3.

Table 3: Responses Summary

	Round 1	Round 2	Total
Survey Responses	21	18	39
ICT sector Interviewees	4	3	7
Financial services sector Interviewees	2	1	3
Retail sector Interviewees	0	2	2
Total Interviewees	6	6	12
TOTAL Respondents (survey & interview)	27	24	51

In Table 4, it can be seen that the majority of the responses were from the ICT industry sector, followed by the Financial and Insurance sector. In addition, the responses were from a wide range of IT-related job titles as shown in Table 5. For the interviews and survey, the sample consisted of (1) the UCT IS department’s industry contact list and (2) the contacts available on the UCT IS Department LinkedIn profile.

Table 4: Responses by Industry Sector

Survey Responses		Interviews	
Industry Sector	Total	Industry Sector	Total
Financial and insurance	7	ICT	7
Health	1	Financial Services	3
ICT	26	Retail	2
Manufacturing	1		
Mining	2		
Services	2		
Grand Total	39	Grand Total	12

Table 5: Count of Responses by Job Title

Survey Responses		Interviews	
Job title	Total	Job Title	Total
Business Development Manager	2	Development Manager	2
Business Systems Manager	1	Software Engineer	2
Consultant	1	Senior Software Developer	2
CTO	1	Chief architect	1
Developer	1	Project Manager	2
Director	7	CEO	1
Electronic Engineer	1	CIO	1
General manager	1	Head of Professional Services	1
Manager: Implementation Engineering	1		
MD	2		
Personal Assistant	1		

Survey Responses		Interviews	
Job title	Total	Job Title	Total
Product Development Manager	1		
Programme Manager	1		
Project Manager	1		
Prototype Team Lead	1		
Recruiter	1		
Senior IT strategic Manager	1		
Senior Manager	1		
Senior Manager, Mobile Development	1		
Senior software developer	1		
Software Development Manager	1		
Software Engineer	1		
Solution Architect	1		
Specialist Business Analyst	1		
Specialist: Business Improvement Management	1		
Specialist: Knowledge Management	2		
Systems Specialist	1		
Operational and Support Manager	1		
SAP Consultant	1		
Chief Information Security Officer	1		
Grand Total	39		

Findings

This section describes the results of round 1 and round 2 of the study. The results relate to the needs and challenges faced in the Western Cape. The topics discussed include, (1) Challenges faced during the recruitment process (2) Skills required for software development positions, and (3) Perceived competency software developers.

Challenges Faced During the Recruitment Process

Timeframe to fill up software development positions

The respondents reported that the recruitment process for software developers usually lasts on average 3-5 months (with some lasting as long as 12 months). For every software developer being employed, about 20 have been interviewed and were deemed inadequate. Respondents struggle to recruit software developers with the right skillset and experience. 75% of the CVs are rejected during the initial screening process and companies often fail or battle to recruit software developers even after extensive recruitment exercises lasting several months.

Between February last year and today I've only hired five software developers and I've had at least that many positions to fill. It's taken me a year to fill five software development positions. In that time I've probably interviewed between twenty five and thirty software developers from Western Cape and around the country.

Various reasons have been put forward for the recruitment duration period including: candidates have poor software development skills, the number of good software developers (with the right skillset) is limited in spite of having a large pool of available developers, a shortage of the correct skillset pertaining to software developers, software developers have high salary expectations but limited skills.

Skill levels (generally) are very poor; therefore each candidate is tasked with a simple logic test, which they mostly do poorly in.

The long recruitment periods are not only attributed to a lack of adequate skills and expertise in the relevant technologies, but also to a lack of IT-related and business-related experience required from the companies. DotNet skills were perceived to be more easily available than Java but it is nevertheless harder to find people with the right level of experience in these languages. One respondent specified that, because the courses that some software developers attend are rudimentary, they are unable to perform while working in complex projects. It thus makes it harder to find people with the right skill and level of experience. Those with the relevant skillsets are scarce and available at a very expensive price as can be seen from these statements:

So, basically what you are left with is a very small group, who are exceptionally expensive, that's the bottom line. And you then have to be able to justify it with your business plan, to afford those people.

There is a fair amount of developers out there, but very few good one. For every 20 candidates that is interviewed who have at least 3+ years' experience there is 1 really good developer and 5 average developers

Both the quantitative and qualitative findings demonstrate that some companies have “alliances” with tertiary institutions, which facilitate their recruitment process. In particular, these companies seem to recruit software developers from “trusted sources” in order to mitigate risks of hiring poorly skilled people. These can relate to software developers graduating from education institution with whom the companies have a strong tie because of the quality of the graduates being produced, or those that have been personally recommended to them.

Non-standardised level of experience

Respondents reported a lack of standardization across companies pertaining to software development experience level. For instance, people who claim to be intermediate or senior software developers in their CV often do not have the appropriate level of experience and expertise and do not meet the entrance requirements of companies for that level of work.

Because of the simple fact that of the twenty five people that have applied through job ads and things like that, technically I would never employ them. We've had people who call themselves intermediate software developers who I Computing Degrees & Careers: Computer Science wouldn't touch with a ten foot pole. That's just from sitting them down and doing a technical three part test which is nothing advanced and nothing out of the ordinary and they failed on that every single time

Lack of problem-solving skills and understanding of business domain

Software developers should be able to solve complex problems. Businesses come with business problems and software developers should be able to contribute to conversations around business problems and possible best solutions to these problems. However, software developers with good problem solving skills are hard to find in the Western Cape. Senior developers are more likely to have these skills but not younger ones. It was mentioned that they typically do not employ software developers solely on their technical skills as they might not be able to adequately reason through a problem.

Also the ability for problem solving, it's a case of it's something that's missing in a whole bunch of the candidates that I interviewed. When I do it is pretty much the pseudo code thing. I am not asking them to be syntactically correct, I'm just asking them to reason through a specific problem and talk through the reasoning and frame how they arrive at a specific solution. Problem solving is something that is just not there. From our perspective we are growing our own, in other words the realisation that employing for technical skill is just not a good strategy. We employ for technical aptitude.

Most developers are solely focused on the technology. This challenge is also particularly relevant to firms in the financial services and retail sector or consultancy firms delivering services to these institutions. Being able to practically apply IT knowledge to solve business problems specifically related to financial environments is a crucial ability which is lacking in the Western Cape.

Lack of expertise and experience in programming languages

The study found that most of the software developers who claim proficiency in certain programming languages actually lack real expertise and experience. Software developers who are highly skilled and experienced in DotNet, PHP and Ruby on Rails were found to be scarce. However, Java skills were found to be even rarer. This sometimes influences companies' choice of technology during software projects and also their outsourcing decisions.

For financial and retail institutions, given that the core of their business is not IT, they tend to hire the required expertise from software houses/vendors. Some of them also take on trainees and skill them up or allow the consulting firms to skill them up. These consulting firms can be both within and outside of South Africa.

It takes us very long to fill positions because we get rubbish CVs. Because we get people who claim they can do things but that don't have the experience that we need in terms of the programming languages.

So we talk to them and we've got a list of .NET, Java and PLC code questions. We got about 25 questions and if they don't know about 15 of them, then they don't know the language.

Lack of design skills focusing on user-experience

Skills in user experience design were recognized as important but respondents mentioned that there are few software developers available in the Western Cape who are able to embark on this type of work. One respondent mentioned two companies specialising in user experience (UX) design namely Origin Interactive in Pretoria and Platinum 45 in Cape Town. UX design was described as more complex than simple Web Design and in need of more specialised skills which are not easily available in the Western Cape.

One respondent from the retail sector who agreed that software developers skilled in UX design are scarce in the Western Cape mitigated the situation by ensuring that software developers spend enough time with marketing experts. In doing so, software developers would get to understand the user needs and model their GUI accordingly.

Lack of UX skills is also relevant for respondents involved in mobile development work. It was reported that software developers lack experience in designing GUIs for mobile phones and even less for entry level phones.

There's no one in the market at the moment that is... Two companies that I know, Origin Interactive in Pretoria and Platinum 45 down in Cape Town who sell themselves as UX designers. There are web designers, hundreds of them in South Africa but for me it doesn't matter. Web design is it's not good enough for me anymore. You use an experienced person first that you put into the shoes of the user and designs appropriately for them

Limited capabilities in large-scale and complex real world infrastructures

The inability of software developers to leverage off existing large and complex infrastructures has been reported as a challenge. This is the case for both junior and experienced software developers (only 20% of people interviewed according to one respondent). While some of them might be proficient in some programming languages, they are unaware of how to code within a complex infrastructure to support a large pool of end users (more than 3000 users) without running the risk of system crashes and security threats. It was also reported that most software developers have limited experience with big data. Respondents deplored the fact that existing courses offered by tertiary institutions do not include such material in their syllabus.

Those with good theoretical understanding of software development principles have limited understanding of the building blocks required to build a reliable and stable application in a complex real world infrastructure (e.g. with complex network infrastructures) and which could be deployed across several continents. They are unable to look at a problem from various perspectives and develop an application solution, taking into consideration all the myriads of other systems which their application could impact or be impacted by. Software development experience in the Western Cape (and possibly South Africa) is mostly limited to simple projects and infrastructures.

What we find with candidates both inside and outside varsity is that the depth of knowledge is very shallow. Even the guys with 3-5 years of experience, they'll be extremely strong in one specific area in development for example. They could be a coder and they would have very strong skills when it comes to coding, they have no understanding of how it ties to real world systems. And we look for that in the interviews

Lack of understanding of good software development principles and practices

The findings revealed that in the Western Cape, most software developers have a poor understanding of the principles and best-practices of software development work. This can relate to a poor understanding of software development methodologies, a poor understanding of object-oriented concepts and an inability to efficiently apply these concepts, an inability to design well-structured codes, an inability to implement good design, poor understanding of software architecture and poor understanding of good testing practices. The following quote clearly illustrates this gap:

I would be giving you a rough estimate, but I would say that 70% of the people don't have that understanding. It's only the top 30% of the people in the industry who understand. Maybe I just have bad luck in dealing with people. And if you think of the pool from the university, then that's already much fewer. Some graduates only acquire these skills after having worked in the industry for a few months.

Respondents described graduates' programming skills as "prototyping and hacking" as opposed to being carefully crafted and designed to fit enterprise level development projects. Copying, pasting and editing code until the program works has been reported as a common practice by some software developers whom they perceived as "lazy" as opposed to being "more intellectual". On the other hand, "intellectual" software developers were sometimes prone to over-complicate things. One respondent resorted to regular code reviews to address the problem.

They do develop but in a way that we call prototyping and hacking. So when you start to develop for enterprise level development projects you are often find that there are good engineering practices that go along with it

The lack of good software development practices is also translated in the design. Hence, they have to resort to strict screening of candidates to identify the correct ones. One respondent mentioned that only 40% of the candidates interviewed demonstrate some ability to apply design patterns. In particular, respondents reported that some software developers are unable to think logically and should be introduced to systems thinking in the long run. Some candidates to software development positions have poor understanding of layered architecture and the need for business logic and data access layer. It was perceived that some software developers are used to being given specifications and just code off that specification without questioning the relevance of the design and the value being added by their design. However, one respondent perceived that candidates with university degrees are more likely to have good design skills as they would usually have been exposed to design patterns during their degree. Overall, irrespective of whether the design is done by a software architect or a software developer, it is important that they are able to see the big picture and apply the relevant design patterns, and the number of people who can do so (knowledge & experience) is scarce.

Another respondent also noted that graduates often have poor understanding of good testing practices, including unit testing and other forms of testing. Knowledge and experience in automated testing and test-driven development was highly valued and found missing in the Western Cape. In addition, good testers are hard to find and expensive in South Africa. Good testers should be able to understand and test for the real business value of a use case.

Good programming practice, error handling is something that people can't spell. They just don't...everyone assumes that everything works. They don't assume it will break, so my engineering background, because I did engineering first and then I did IS, is that you assume everything breaks first and then you make sure it breaks elegantly. I think that is another key thing is that people haven't been taught to, critically analyse the likely things that can go wrong with a project. To find people who can do that is actually really hard, even experienced developers.

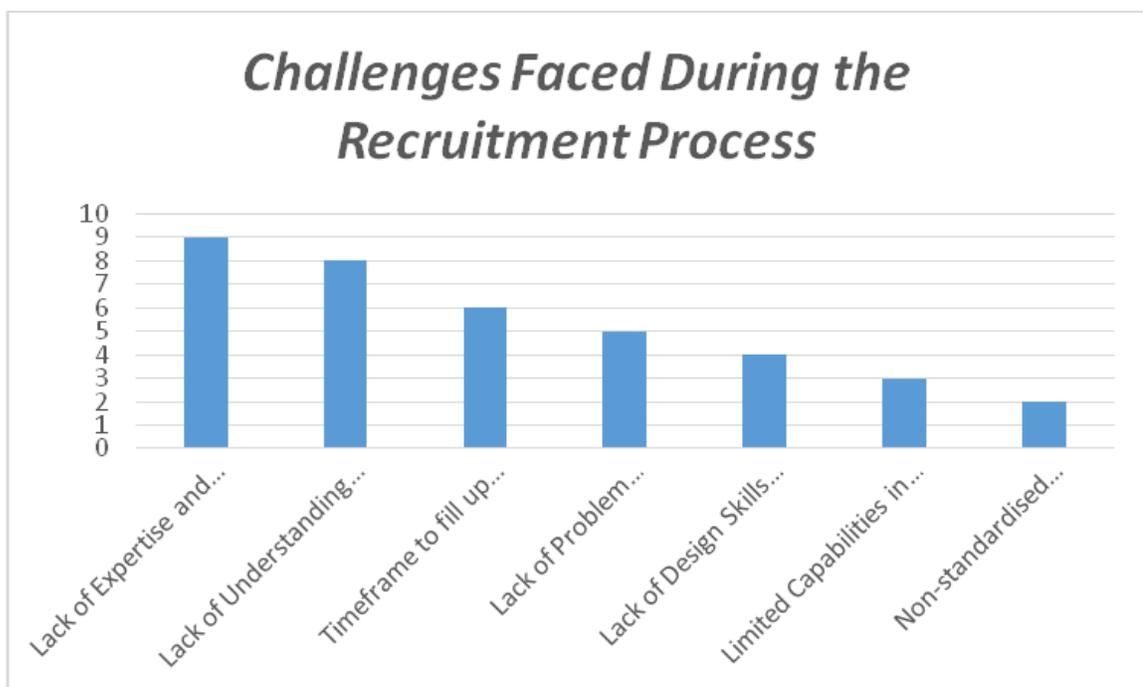


Figure 1: Challenges faced during the recruitment process

To mitigate the problem, some companies send their software developers on training courses. These courses serve as a platform to teach them the principles of software development (e.g. why do we test, importance of specific tests, release planning etc.). They also have yearly refresher courses on systems design (e.g. database design) as it was perceived that *people keep forgetting*. According to one respondent from the retail sector, junior and inexperienced software developers are usually the ones to be sent on these courses.

A summary of the challenges faced is provided in Figure 1.

Range and Level of Skills for Software Developers

This section describes the range and levels of skills required for software development positions in the Western Cape. Table 6 shows the software development platforms, programming languages, mobile development platforms and reporting tools employed by the respondents and provides an indication of the type of software development skillset required in the Western Cape.

From the responses, the majority of the respondents assert that their IT project teams work on windows based development, database development and mobile development platforms but do not use Mac development platforms. Other platforms mentioned include: ERP Packages (SAP), AS/400 RPG, Java (J2SE), IBM, Linux based PHP and Oracle ODI.

The most popular programming languages include Java, C# and Javascript in contrast to Visual Basic.NET, PHP and COBOL. Other programming languages mentioned include Advanced HTML/CSS for responsive design, Python, ABAP, RPG and NoSQL.

For Mobile Development the platform development environments that the IT project teams currently focus on include Android and iOS SDK. One of the respondents suggested that they would *“rather target HTML5 capable to make the solution more platform agnostic”*.

Crystal Reports and SQL server were the more popular reporting tools being used by the IT project team(s). Other tools mentioned are: ERP BI, SAP Business Objects, Micro Strategy, and DevExpress Reports

Finally, the majority of the respondents claimed that software developers are proficient in Object-Oriented Programming Languages and Scripting Languages rather than Functional Programming Languages.

Table 6: Usage of Platforms, Languages and Tools

	% usage	Responses
Software Development Platform		
Windows Based development (.NET)	40%	35
Mac development	3%	35
Database Development (MS SQL Server, My SQL, Oracle etc.)	51%	35
Mobile Development	31%	35
Programming Languages		
Java	34%	35
C#	34%	35
PHP	20%	35
Visual Basic.NET	17%	35
Javascript	46%	35
COBOL	9%	35
Platform for Mobile Development		
Android	31%	35
Blackberry	14%	35

	% usage	Responses
iOS SDK	34%	35
.NET Compact Framework	20%	35
Windows Mobile	20%	35
Reporting Software Tool		
Active Reports	0%	35
Cognos BI	20%	35
Crystal Reports	29%	35
Oracle Reports	17%	35
SQL Server Reporting Services	34%	35
Software Developers Proficiency in		
Object Oriented Programming Language	100%	18
Functional Programming Language	41%	17
Scripting Languages	78%	18

Proficiency in relevant programming languages

Table 7 shows the results of the quantitative tests analysing respondents' perceptions of the level of expertise of software developers in specific programming languages and their availability in the Western Cape. Generally the level of expertise in scripting, object oriented and functional languages is below average and needs improvement. Object oriented languages appear to require the most improvement. The respondents perceived that the level of expertise of software developers in the specified programming languages is between average and good. The lowest expertise appears to be in C#. The availability of skills is below requirement in all language types and languages with the exception of VB.NET. In terms of availability object oriented languages are the least available and especially C#.

Table 7: Level of Expertise of Software Developers in Specific Programming Languages and their Availability in the Western Cape

	Level of Expertise (3=average; 5=excellent)	Availability of Proficiency (3=meets requirement; 5=far above requirements)
Object Oriented Languages	2.5	2.2
Functional Programming Languages	2.8	2.3
Scripting Languages	2.7	2.4
Java	3.4	2.4
C#	3.1	2.3
PHP	3.5	2.6
VB.NET	3.6	3.3
Javascript	3.4	2.5
Cobol	3.3	2.3
Other software development languages	3.8	2.3

Based on the qualitative findings, an ideal candidate for a software development position should have some expertise in both functional and OO programming. The respondents mentioned that they look for evidence of proficiency in the programming languages employed within their company. The candidate's level of qualification is not as relevant as the expertise, proficiency and experience in the language and technology. They thus dedicate a proportion of their recruitment

process to the assessment of candidates' degree of expertise and flair for relevant programming languages and technologies.

For software development positions, they favour candidates with more exposure to software development by the time they get out of university, which they feel is more the case of computer science students. Information systems students follow a business analysis career path in some organisations. However, some organisations believe that programming languages are easily taught, provided that the software developer has a good theoretical understanding of the concepts and a strong technical aptitude.

Senior software developers are expected to have a deep understanding of relevant programming languages and technologies, given their experience. They are also expected to have good understanding of best-practices and standards pertaining to software development work, irrespective of whether these standards are embedded in the programming language being used or not. However, given that the range of technologies available on the market is currently quite vast, respondents found it difficult to find software developers with 3-5 years of experience in specific technologies. They perceived that software developers engage and migrate from one technology to the next.

Financial institutions reported that, in addition to experience and expertise in the programming languages and technologies, experience on trading systems and financial accounting systems would be a plus.

For programmers themselves the most important thing is that we can see evidence that they are proficient in one of the languages that we use

In terms of more senior people, we look for obviously years of experience in specific technologies. Now again those specific technologies today are so vast and wide that to find somebody with three to five years in a specific technology is hard because people are doing all kinds of different things.

Qualifications for software development roles

While most companies recruit at Bachelor's or Honours level, the level of qualification required from the applicants varies depending on the nature of the work being performed within the company. For less complex and smaller scale projects, qualifications from universities of technology are deemed sufficient. For larger scale projects, undergraduate and honours university degrees are favoured. Candidates with university degrees are usually found to be more versatile with a wider range of skills (e.g., project management, software design, software analysis, problem solving skills) in addition to development work.

Generally here at XXX we do look for people with a university degree. As an institution, we feel that it is easier to take a person with a university degree and be able to move them around within the business because they have a better understanding of the principles behind these things. Again it depends. Some guys don't even have degrees. They are auto dialect and they teach themselves, we're happy to take them as long as they show that they're bright. We've got our own metrics that we look at before we hire someone, we've got our own psychometric test that we perform and there is a general face to face interview. But the majority of people that do work here have got degrees.

Respondents further noted that they seek intelligent software developers with a desire to learn and identify gaps in their knowledge, who are patient and with a strong will to acquire new technical skills to solve software problems. Respondents usually associate the dedication and perseverance required to solve programming problems with university graduates, who in their opinion would

have spent many “all-nighters” trying to learn and devise new algorithms to solve particular business problems (special reference made to the IS project at Honours level).

A lot of self-aptitude and desire to learn. So I need to have them demonstrating that I learnt this cool thing and I pursued it and I learnt how to do it. These are indicators that they have that. The other aptitude is patience where someone needs to know that they won't know it initially. They will slowly start attacking what they don't know.

Skills pertaining to mobile development

The respondents were ambivalent pertaining to the need for mobile development skills in their teams. Some of them mentioned that the mobile space is too much in a state of flux to invest in; others specified that they would rather go for the “responsive design” option, as opposed to native development. Responsive design was favoured as it was perceived to yield a higher return on investment. Native development work is typically outsourced (locally) to expert vendors. Respondents did not seem particularly interested in hiring software developers with mobile development expertise, but rather sought to train their existing staff in that space.

I've done a bit of research and it seems that the easiest way to solve those problems is to outsource it. There seems to be a huge number of companies that are able to do it and until things stabilise in terms of the trend and the software development environment, in terms of the tools

Everything we are developing is mobile responsive design. So that's the extent to which we are doing mobile at the moment. I'm not saying that we are not going to be making a play into the mobile native space moving forward but right now our requirements are mobile responsive design. It's working out for us on a return of investment perspective, it's our best return

Respondents did not seem particularly interested in hiring software developers with mobile development expertise, but rather sought to train their existing staff in that space. They rationalise their decision from the notion that there is not enough demand, in the corporate world, for pure mobile development work. A mix of skills, as opposed to pure mobile development expertise, was found more important. Mobile development was perceived as relatively easy in comparison to building server-type applications which, in their opinion, require more complex skills.

In the financial service sector, the two respondents interviewed were of the opinion that mobile application development will be gaining more momentum. However, they acknowledged the fact that it is currently difficult to choose what to teach to students, given the myriads of mobile development platforms available on the market (e.g. Microsoft Mobile development, Apple, Android, Blackberry platforms etc.). They suggest that it might be more relevant to reflect on the toolset that a mobile developer should have and incorporate that in the curriculum, rather than focusing on the technology. They reported that they currently have no capacity to support mobile development work within their organisation

Analysis skills

The majority of respondents recognized that software developers should have some understanding of business analysis (BA) and systems analysis (SA). Most respondents specified that even though there is no need for software developers to have in-depth skills in business and systems analysis, they should at least be able to look at a system and identify areas in need of improvement and propose solutions.

Software developers should understand the domain and be able to contribute to analysis given the fact that software programs are meant to solve real world problems. They believed that a

programmer would only be able to understand real world problems with good business and systems analysis, as well as logical skills. A software developer is expected to engage with customers and help business analysts design better solutions. This is particularly important in an agile work environment. The programming language was perceived as a tool through which the problem can be solved. They also perceived that any talented programmer would not be able to deliver real business value without an understanding of the domain. They reported that they would not hire a programmer (no matter how good) who does not have some business analysis skill and who is not able to understand the domain.

The need for software developers with good business knowledge as well as technology knowledge was also highly relevant to respondents from financial and retail institutions, as the software developers are required to support existing applications in complex environments with multiple platforms and technologies. For instance, one respondent from the retail sector specified that candidates with business knowledge and experience in the retail field are hard to find. For financial institutions, given that the industry is governed by regulatory controls in terms of reporting and taxes, they often receive change requests pertaining to new legislations. They thus require software developers with the ability to interpret the changes, look at the domain and understand the impact of the changes for the application, the processes and the business

My opinion is that a developer should understand the domain and should be able to contribute to analysis. My reasoning is that again it goes down to the principles because a program is meant to solve a real world problem. And so, often it is your action or your own logical meta-model that creates the program not the programming language.

Design skills

Most of the respondents reported that it is crucial for software developers to perform good design. In companies where new projects are regularly initiated, good design expertise is a prerequisite and candidates are probed on their design skills during the interviews. For example, they should be able to consider the impact of their design solutions on the overall ecosystem. They should be aware of certain risks and the impact of systems crashes on the entire environment and this requires a high degree of expertise in systems design. They should be aware of issues around efficiency, performance and usability while designing the middle tier in addition to being appealing at the front-tier. However it was reported that only 20-30% of job candidates in the top pool (30% of applicants with relevant CVs) are proficient in software design.

The ability of software developers to perform good design is also relevant when software development work is being outsourced by financial institutions. These organisations have mentioned the need to conduct architectural and software design themselves, in order to retain the design and architectural knowledge in-house.

Design pertaining to internal code structuring was also noted as important. For instance, it was mentioned that during the interview process, they do look at the code written by the candidates to see whether the program has been modularised or not. It was recognised that software developers are expected to design a complete solution and think it through from beginning to end without relying on tools to generate codes.

When a developer comes in, he won't be working on the customer system but on the other system that runs it or supports it. So if you're busy with a system that runs NetFlick's website for example, you'll need that understanding and experience that tells you that the work you're doing here is going to tie in to the database server that other teams work on. They need to think, why would I do things like this and not like that? If I built my application with the database on the one side and the application server and everything on the one server, the risk is that if something goes wrong, the entire environment falls over. So that's normally experience you

gain from working in the industry. But it is also something that can be taught if you give somebody access to these environments.

A summary of the range and level of software development skills is provided in Figure 2.

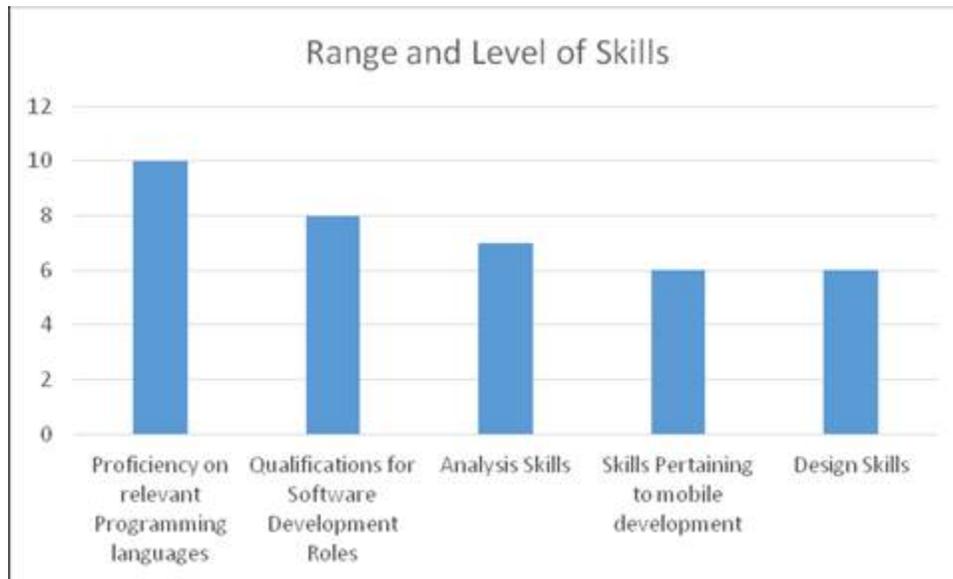


Figure 2: Range and Level of Software Development Skills

Summary of Challenges Faced During Recruitment of Software Developers

The challenges faced during the recruitment of software developers in the Western Cape relate to:

- Long and expensive recruitment process because of unavailability of relevant skillsets in the market
- Lack of standardization across companies pertaining to software development experience level
- Lack of problem-solving and business analysis skills from software developers
- Most of the software developers who claim proficiency in certain programming languages actually lack real expertise and experience
- Software developers with enough expertise and experience in User Experience (UX) design were found to be important but rare in the Western Cape
- Software developers are unable to leverage off large and complex infrastructures, in spite of being sometimes proficient in programming languages
- Most software developers have a poor understanding of the principles and best-practices of software development work

Summary of Range and Level of Software Development Skills

A summary of the range and level of software development skills needed in the Western Cape, South Africa is provided below.

- High proficiency in a wide range of functional and programming languages including Java, PHP, DotNet, C#, ASP.net, PLC Code (Oracle Programming), SAP ABAP, Pascal, Javascript and Ruby on Rails.

- While most companies recruit at Bachelor's or Honours level, the level of qualification required from the applicants varies depending on the nature of the work being performed within the company.
- Software developers are required to have good problem solving and business analysis skills in addition to technical expertise
- Software developers (especially senior software developers) are required to have an understanding of software development principles. These include an understanding and expertise in software design patterns, architectural design and software development best practices.
- Respondents reported that it is crucial for software developers to perform good design, particularly in instances where new projects are regularly initiated. Software developers are expected to design, taking into consideration the overall ecosystem, risks, efficiency, performance and usability issues amongst other
- Respondents did not seem particularly interested in hiring software developers with mobile development expertise, but rather sought to train their existing staff in that space. The respondents were ambivalent pertaining to the need for mobile development skills in their teams. Some of them mentioned that the mobile space is too much in a state of flux to invest in.

Conclusion

The findings of this study confirm that software development skills are sorely needed in the Western Cape, South Africa. Software developers with certain skill sets are required and in most cases these skills need development and are not available in terms of recruitment.

Overall, it appears that candidates with a good ability to adapt to new technologies, understand business domain and with a good attitude towards work are prized by recruiters and in great demand in the Western Cape.

Given the gaps identified in the market, it is proposed that tertiary institutions should seek to address the lack of relevant software development skills in the Western Cape. A curriculum would have to be carefully crafted to meet the exact needs of industry.

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