

Supply elasticity within the South African ICT labour market

by

Johan Breytenbach
Department of Informatics
University of Pretoria
breytenbachj@gmail.com

Prof Carina de Villiers
Department of Informatics
University of Pretoria
Carina.devilliers@up.ac.za

ABSTRACT

Creating a sufficient, sustained supply of tertiary level ICT skills at graduate level to stimulate growth in the developing South African economy is an important concern for all stakeholders involved in the South African ICT labour market. This article furthers the discourse on the much discussed ICT graduate shortage in South Africa by presenting a neo-classical labour market analysis of the demand and the supply of scarce skills ICT graduates in South Africa, validating the existence of a shortage through labour market theory, and then exploring the validity of variables influencing the supply side of this ICT labour market.

Reports describing South African ICT skills supply and demand are readily available¹, but the consistency and accuracy of these figures have been questioned (Lotriet & Matthee, 2010). Presenting the available data using labour market supply and demand curves provides another angle of approach to this data and an opportunity to validate the existence of a skills shortage (if it exists), as well as reasons for such a shortage. This neo-classical labour market view of the South African ICT skills deficiency is enriched with a discussion about the elasticity of supply within the South African ICT labour market. Findings from this section of the study includes the tendency of an increase in scarce labour supply to trigger further increases in demand for such skills through an increase in capital investments within the scarce skills sectors, causing a yearly supply shortage to remain until capital investments reaches profit-maximizing equilibrium.

¹ As example, see 2011 figures published by the MICT SETA at http://www.mict.org.za/downloads/Isett_Seta_Sector_Skills_Plan_2011_2016_Jan_2011_Version_v2p1.pdf

In the latter part of this article we investigate variables that influence the elasticity of supply within the ICT labour market using a large scale survey of tertiary students. Ways of (i) increasing the elasticity of ICT graduate supply and (ii) increasing the overall ICT graduate supply level through the manipulation of these variables are discussed. Findings include, amongst others, the importance of long term relationships (with well-informed parents and teachers) as primary motivator for tertiary ICT study and the importance of industry informed (demand driven) ICT related subjects at secondary school level as motivation for tertiary ICT study. The match between ICT skills being supplied and demanded also receives mention as part of this conceptual ICT labour market analysis.

Keywords: e-Skills shortage, ICT labour market in South Africa, ICT education, IS education

I. INTRODUCTION AND PROBLEM STATEMENT

This article discusses the South African ICT skills shortage and ways in which the ICT skills market can be made more effective from a human capital perspective.

A generally accepted proposition from neoclassic human capital theory states that investment in the education of labour increases the productivity, and hence the output, of a workforce. Stated differently, education increases human capital, and increased human capital results in higher productivity. Increased productivity and output, in turn, supports economic development (the existing workforce is more productive and better equipped for work, making new levels of efficiency possible). Cross-industry analysis of this human capital approach has found it to apply, not without criticism, to technology and innovation labour markets as well [Toner, 2011]. From within this generally accepted position, we assume as starting position for this study that investment in the education of ICT graduates will stimulate economic growth in South Africa. This economic growth includes greater capital investment in the ICT sector.

The South African ICT industry, employing professionals with skills including basic e-Skills, software development skills, and Information Systems (IS) skills such as business analysis and systems analysis, have been identified as an industry that is not contributing enough towards economic development in South Africa, especially through ICT education and

training². The ICT industry's response to this critique often includes mention of the country-wide ICT skills shortage as a reason for the industry's lack of performance. The role of industry in ICT education and training is an important secondary question within the ICT skills shortage debate, and receives frequent mention in this article.

According to much debated surveys (for a summary of this debate, see Lotriet and Matthee, 2010) there is a shortage of ICT professionals in South Africa. This shortage, if left unchecked, may hinder the country's economic development, and cause South Africa to fall behind in global ICT development trends [Merkofer and Murphy, 2010]. This statement is supported by the abovementioned human capital view of labour markets. The authors of this study agree that an increased supply of ICT professionals can stimulate economic growth in South Africa by stimulating capital investment in ICT ventures. The problem statement of this article revolves around ways of increasing the supply of ICT professionals in South Africa so that accelerated economic growth can be achieved – growth that is not limited to the ICT industry, but rather a diffused growth within all the ICT reliant economic functions in South Africa.

The reported ICT skills shortage in South Africa (and its effect on industry growth) is difficult to analyse [Calitz, Greyling, and Cullen, 2010; Lotriet and Matthee, 2010], with reasons for the proposed shortage varying from fast changing industry demands to a lack of standards in defining ICT careers and the parts of tertiary curricula they relate to [Calitz et al., 2010]. Data indicates a seemingly clear and agreed upon shortage in graduate level software developers and business analysts [Cremer, 2011; ITWeb, 2011], and yet the extent of and reasons given for this skills deficiency are hard to validate [Calitz et al., 2010].

This article provides another presentation of recently published data in the form of a supply and demand curve for scarce graduate level ICT skills, including software developers/engineers (and mobile application developers) and business analysts. The agenda behind presenting the data using this typically neoclassic economic approach is threefold: (i) to place the South African ICT skills shortage dialogue within the boundaries of neoclassic labour market and human capital theory in order to discuss the effects of education-

² Trialogue 2010. The CSI handbook, 12th Edition.

stimulated increases in the supply of scarce skill labour, (ii) to start a discussion regarding the elasticity of supply in the South African ICT labour market, and (iii) to validate a detailed look at variables influencing supply and elasticity of supply within the South African ICT labour market.

Following a similar approach as recent studies on this topic [Lotriet and Matthee, 2010] this article focused on tertiary level graduate supply and demand of ICT skills, and not on the full spectrum of ICT skills, often referred to as e-Skills.

This paper is structured as follows. First, a short literary overview of the South African ICT skills shortage debate is provided. Second, we present the supply and demand curves for the mentioned scarce ICT skills in neo-classical labour market fashion. Third, we discuss the elasticity of ICT graduate supply. Fourth, variables are identified that influence the supply side of the ICT market, and a model for identifying potential ICT graduates are constructed. Fifth, we test and validate this supply-side model with a large scale survey (4475 students). Finally, we discuss the findings from the survey in the light of supply elasticity and suggest ways of increasing the level of supply (and elasticity of supply) of ICT graduates in South Africa.

II. LITERARY BACKGROUND

The ICT skills shortage in South Africa

This study joins the ICT skills shortage debate during 2011-2012. During this time the South African government institution responsible for ICT skills development, the Media, Information and Communication Technologies Sector Education and Training Authority (MICT SETA), published ICT skills shortage statistics based on information gathered from industry partners (companies registered as members of the MICT SETA), for the period 2009 to 2011 [MICT SETA, 2011]. An extract from this publication is presented in Table 1.

Table 1: MICT SETA ICT skills shortage figures published in 2011

Career/Job description	Shortage (Registered vacancies within

	ICT industry and other industries)
Business Analyst	299
Systems Analyst	362
Web Developer	51
Analyst Programmer	52
Software Developer / Programmer / Engineer	572
Security Specialist	63
Systems Administrator	175

Positive characteristics of the MICT SETA data include (i) it being informed by a large scale industry survey [ITWeb, 2011] and industry partners, (ii) the data being verified using trend analysis over a longer period of time – three years, and (iii) this (demand side) data being measured against validated national graduation figures (supply side data), if only at a very basic level. Criticisms of this data and its validity include (a) yearly data being based on faulty, or inflated, historical data, (b) the data not matching with other large scale studies and media reports, and (c) the data being flawed due to a lack of industry standards for the classification of ICT careers. Overlooked points of concern that can be added to the list of criticisms are the MICT SETA report’s mention of both an oversupply of diploma level students and the high percentage of ICT graduates that are not South African citizens and will possibly put their skills to use outside the South African ICT labour market (causing the shortage to be incorrectly presented) [MICT SETA, 2011, p.47]. For a critique of the MICT SETA data, as well as other data sources, see the contribution by Lotriet and Matthee [Lotriet and Matthee, 2010]. For a detailed mention of other data sources often used to justify statements within the ICT skills shortage discourse, see the Calitz thesis [Calitz, 2011].

The shortage of two skills seem to be agreed upon in literature: (1) Business Analysts, and (2) Software developers – particularly scarce programming skills include graduate level Java and C#, and C#.Net skills. Graduates that are capable of combining these scarce programming skills with basic SQL skills are even harder to find. A recent large scale skills survey [ITWeb, 2011] hints at a third core skill soon to be added to this list, (3) Mobile Application Development.

To summarize, there seems to be agreement on the existence of an ICT skills shortage within literature and industry, and even the nature of the shortage (which skills are needed most and how they can be produced), but literature includes conflicting reports [views] on the magnitude of the shortage and the (seemingly minimal) effect that skills-increasing projects have had on the ICT skills deficiency over the last five years. It is to this end that we approach the data from a labour market perspective.

The ICT labour market in South Africa

Recently [Merkofer and Murphy, 2010], the South African ICT skills shortage was conceptually placed within an economic “supply and demand” context, as writers confirmed the South African ICT industry’s poor economic development performance based on international ICT industry benchmarks. According to education-focused development benchmarks, “South Africa lags heavily behind Finland, India, Ireland, Vietnam and Mexico” [Merkofer and Murphy, 2010]. Joining in on the economic approach to the discourse [Calitz et al., 2010], the South African ICT graduate supply was seen by writers as a “supply chain” and critiqued as such. No labour market theory was used to analyse the interaction between the supply and demand of graduates or the elasticities within this market – *how, and how fast* the market would react to increases in either the volume or the price of labour supply.

Toner [Toner, 2011] summarizes the application of human capital theory to the field of “innovation skills development” as follows:

*“Firstly, ‘human capital’ is regarded as analogous to physical capital, in that increased ‘investment’ in labour, especially through education and training, improves the productivity of labour. In other words, human capital is one of the prime determinants of labour productivity. Secondly, improving the quality of labour through education and training **increases the complementarity between labour and capital**. Higher-quality labour raises the productivity of capital, **stimulates further capital investment**, and hence raises the demand for skilled labour”* [Toner, 2011, emphasis added].

From this human capital perspective of the ICT labour market, we learn from Toner that an increase in investment into labour supply (via education and training initiatives) will increase the supply and the quality of the supply. This will, in turn, increase the demand for the same skills because of greater capital investment in the affected (scarce skills) industries. This plausible chain of events, where not without critique, differs from classic labour market

theory. In a classic labour market analysis there is no skills shortage as all skills are readily available at all levels of income and increased supply (or increased quality of supply) results in no change (or even negative changes) to the level of demand. We will further discuss this important concept of “increased demand as a result of increased supply” in the section called “The supply and demand for ICT skills in South Africa”.

The human capital perspective mentioned above can be seen as a theory that opposes the economic labour market theory of *signalling*. A comparison between signalling and human capital theory is beyond the scope of this article. The authors of this article acknowledges this as a limitation of this study and agrees that signalling as a theory can provide valuable answers towards the problem statement of this article.

Variables influencing ICT graduate supply / elasticity

Our literary review now moves on to the foundation for the latter part of this text, where our focus shifts from a presentation and validation of the magnitude of the South African ICT skills deficiency to an analysis of the variables influencing the supply of ICT graduates in South Africa. A western example of a similar discussion (Walstrom, Schambach, Jones, & Crampton, 2008) that looked at motivations for students to choose ICT as study focus and, eventually, a career – mentions the following variables as important when measuring the popularity of ICT as study or career choice:

- The role of parents and teachers in students’ study/career choices
- Understanding of various industries (as potential working places)
- Understanding, having knowledge of, specific career descriptions
- The public/media image of careers/industries
- Marketing approaches of different industries

These variables, amongst others, and their influence on the supply of graduate level ICT students are investigated and discussed later in this article in section V. We present a statistically tested model that shows the importance of each variable on a student’s choice of study/career path.

Our discussion regarding these supply side variables within the ICT labour market, and the model we construct to measure these variables, might cause the reader to become confused

about the primary argument of this article. Therefore we mention again at this point the assumption of the labour market theory underpinning this study:

An increase in the ICT graduate supply (and/or quality of supply), through education and training, will have a positive influence on the growth of the ICT industry through stimulating capital investment. Conceptually this will then contribute to South African economic development. Our aim is towards *education-driven economic development*, and not towards the production of another theoretical model for predicting the career choices of students. We want to stimulate economic growth by increasing the efficiency of the ICT labour market through education.

Before we continue with the contribution of this article, we add one final disclaimer. Influencing ICT labour supply side variables will inevitably take the form of “ICT-education focused projects”, for example projects that influence the long term career motivation of students towards a career in ICT, or projects that increase the number of students that take Computer Application Technology as a secondary school subject. We have to deconstruct ICT supply to this basic level where we have variables that we know how to influence through education or institutions for this study to have a practical impact. For a more complete analysis of the character of education focused ICT for Development (ICT4D) projects that aim towards increasing the supply of ICT skills in South Africa, and how such projects can be accelerated towards sustainability, see Breytenbach et al. (2012). It is also for this reason – change in the supply side of the ICT labour market being *education project driven* – that this article concludes with a short, practical discussion about how such skills-supply-increasing projects should be structured [approached] by stakeholders from both the supply side and the demand side of the market.

III. THE SUPPLY AND DEMAND FOR ICT SKILLS IN SOUTH AFRICA

In this section the authors attempted to construct a supply and demand curve from the (limited) MICT SETA data mentioned earlier, informing the available data with two investigations of their own³. The result is presented in Figure 1⁴.

³ Reviewed CareerWeb statistics for software development, business analysts and mobile developer vacancies 2008-2012, and the ICT vacancies survey done by Cremer (2011).

⁴ At the time of writing, R1000 (ZAR – South African currency) equalled \$122, or €96.

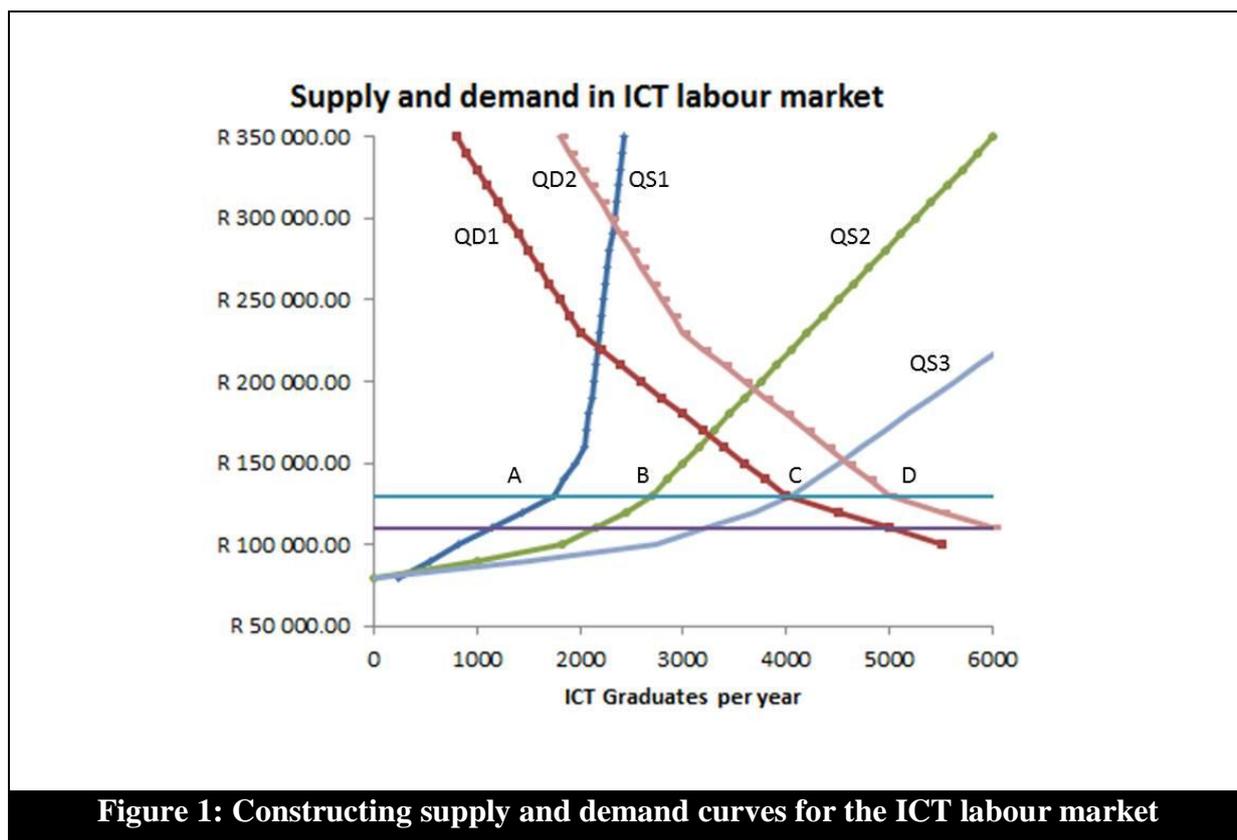


Figure 1: Constructing supply and demand curves for the ICT labour market

Currently the South African ICT industry is functioning on supply curve QS1 and the demand curve QD1. Major characteristics of the current ICT labour market situation are (i) supply drying up almost completely at around 2000 graduates per year, regardless of the salary offered (price-inelastic), (ii) industry taking in about 1750 graduates each year at an average salary of R130 000 per year – where QS1 intersects the average salary line [point A], and (iii) the industry reporting a shortage of about 2200 graduates a year at the current average graduate salary level, indicated by the intersection of QD1 with the average salary line at about 4000 graduates [point C]. This position can be supported from MICT SETA and ITWeb data. Labour supply curves often take on inelastic shapes similar to QS1, indicating a production possibility frontier – the current maximum labour supply in the market. If this production possibility frontier [2000 graduates per year] is less than the current demand at expected salary [4000 graduates per year], there is a labour shortage in the market.

In order to answer the problem statement of this article, we now analyse the effects of a hypothetical education-driven increase in the supply of graduates. If an increase in supply can be engineered [this is the focus of the latter part of this article] so that supply moves to QS2, where supply is higher and more readily available at all salary levels, the immediate shortage

of new graduates will become smaller as the distance between the intersection of the supply and demand curves with the average salary curve becomes smaller [point C – point B]; we now see a yearly shortage of less than 1500 graduates.

At this point we can easily oversimplify the analysis by suggesting a targeted yearly increase of about 2000 ICT graduates (through education and training initiatives), and feel justified in our assumption knowing that 2000 graduates per year is an attainable target when the responsibilities, and costs, of this increase in supply are divided between several tertiary institutions. We would however be in error if this was our conclusion, and very surprised when the MICT SETA again publishes data that reports a shortage of more than 2000 graduates per year! The reason for our error would be an oversight of the labour market theory that states an increase in scarce skills supply will cause an increase in the demand for those scarce skills by stimulating capital investment in the scarce skills industries [Toner, 2011].

According to this theory, the demand curve QD1 would also move outwards, say to QD2, as supply continues to increase through QS2 towards QS3. We now see a very realistic position where the supply of an additional 2000 graduates per year has caused an increase in demand of a further 1000 graduates per year. The move from QD1 to QD2 happens as more skilled labour in a growing industry causes the industry to expand through capital investment as companies try to maximize the profits they are generating by producing more income per additional employee than the average salary of each additional employee – Toner refers to this as “the complementarity between labour quality and capital investment” [Toner, 2011]. A monetary concern that makes this position appealing to graduates is the likelihood of them earning well above the average expected salary, leveraging the skills shortage that still exists (and will remain as the industry expands), and taking advantage of the higher expected salary levels associated with a higher demand curve. This stability in salary expectation makes ICT a more secure career choice in that the market is still some years away from supply saturation. Non-monetary factors supporting this market position include increased mobility of ICT labour supply as more graduates become available (this will increase the elasticity of supply and prevent the “drying up” of supply as demand increases) and a lower level of risk being associated with the ICT labour market, both from an employer and employee perspective.

If we then, to summarize this section, follow this cycle of events through a complete year, we end where QS3 now intersects QD2, still well above the average salary line, meaning there is still a profit to be made for industry, and reason for supply and demand to grow further. A shortage still exists (the distance between point C and D on the average salary line), and this small [consistent] shortage is to be expected in the light of our discussion above. According to this view of the available data, there is an ICT skills shortage in South Africa, and the shortage will remain for years to come.

IV. THE ELASTICITY OF SUPPLY IN THE ICT LABOUR MARKET

We now turn our attention to the concept of supply *elasticity* in the ICT labour market. In this section we describe the concept of *elasticity* and motivate why increasing the elasticity of ICT graduate supply is an important concept when discussing how to approach the ICT skills shortage in South Africa.

In Figure 1 we see not only the level of supply increasing from QS1 to QS3, but also the shape of the supply curve changing – becoming more horizontal with a more moderate gradient. This change in shape indicates a change in what economists term the “price elasticity of supply” – how sensitive the supply [of ICT graduates] is to a change in price, or in this labour market scenario, a change in expected salary. A moderately elastic supply, such as supply curve QS3, indicates a measure of fairness [competitiveness] in a labour market – a position where companies cannot attain labour too far below the average salary and labourers cannot expect wages too far above the average salary rate. Moderate supply [price] elasticity in a labour market moves the intersection of the supply curve and the average salary line much closer to the intersection of the supply and demand curve – the point of optimal profit and efficiency within the market. From a development economics or welfare economics viewpoint, this is our goal: to increase supply and the elasticity of supply until we have eliminated inefficiencies from the labour market and have the supply and demand curve intersect each other on the current [realistic/internationally competitive] average expected salary line.

Increasing the elasticity of the supply is, according to the authors, at least as important as increasing the level of supply, **as this increases the profitability for companies in the market, the attractiveness of the market for graduates (from a salary and industry risk**

point of view) and, by definition, moves the labour market to a more efficient, competitive state.

If we work with the supply curves constructed in Figure 1, the measurement of the price elasticity of supply (PEoS) for the South African ICT labour market can be calculated as follows:

Table 2: Price elasticity of supply – projected figures for supply curves in Figure 1		
PEoS = (% Change in Quantity Supplied)/(% Change in Price)		
Curve	PEoS	Description
QS1	0.16	Very inelastic
QS2	0.28	Very inelastic
QS3	0.74	Higher elasticity, nearly unit elastic [good level of price elasticity for a labour supply curve]

If we accept the basic premise, from our discussion of labour market theory, that the higher elasticity of QS3 results in a more optimal economic position in the ICT labour market (and a position that stimulates economic growth more than the current position of the ICT labour market), we can now elaborate on some education-based variables that can be used to engineer this desired increase in elasticity.

Before we turn our attention to supply side variables that can influence supply and supply elasticity, we acknowledge, from literature, one critique of increasing the elasticity of supply within labour markets through education focused projects. Toner [Toner, 2011] notes that “employers are unwilling to invest in [education and training initiatives] because workers who receive this training can leave to work for another firm before the employer has recouped the cost of training in terms of higher productivity and output” (emphasis added). Education is good for the industry, but not always profitable for the companies investing in this increase in labour supply elasticity due to the difficulty of retaining newly educated skilled labour, especially in a scarce skills environment. If, because of the risks associated with investing in education, companies then decide not to invest in increasing the elasticity of labour supply through education, the resulting capital investment and further industry growth we discussed earlier will also not occur. This, in turn, will reinforce any current skills

shortages within the industry, leaving companies with few options besides outsourcing their ICT demands. Labour markets have traditionally responded to the abovementioned critique in two ways: (i) increasing the elasticity of supply becomes the responsibility of academic institutions who do not share in industry's profit motives, and (ii) companies approach training initiatives through apprenticeship programs. An analysis of industry's approach to increasing the skill levels of new and existing staff members is beyond the scope of this article, but we note from a recent large scale survey in South Africa (ITWeb, 2011) that (a) companies prefer professional training above all other methods of staff retention, but (b) internship training programs are the least used form of training within these companies. Graduate and post-graduate employees [the supply of which is seen as the responsibility of academic institutions] are still the most popular choices when recruiting more labour, with employment agencies and internet advertisements being the two preferred tools for matching demanded skills with existing supply. From this discussion we note that academic institutions and private sector companies carry a joint responsibility in moving the ICT labour market to a more efficient state. This relates back to our introductory remark about the ICT private sector not contributing enough towards the education of the personnel they require to function and stimulate further economic growth.

We continue now, in the next section, with a discussion of some variables influencing the career choices of prospective students (and hence the elasticity of supply). The reasoning behind this is as follows: If more students choose to study ICT, this will change the elasticity in the market, make the ICT industry a more attractive career option, and iteratively encourage more students to choose to study ICT.

V. VARIABLES INFLUENCING ICT GRADUATE SUPPLY – TOWARDS A MODEL

In this section we introduce variables that can influence supply level and elasticity in the ICT labour market. Some of these variables have been mentioned in the literature review section of this article, and some of them resonate with previous research of the authors (Breytenbach et al., 2012). This section also includes a description of the large scale survey that was undertaken to measure the importance of these variables, and the model the authors constructed to measure the validity of these variables.

Students' perception and knowledge of the ICT industry as potential workplace, and the role of the media and social recognition

Students' career choices are partially dependent on their understanding of their prospective work environments. Their understanding can be influenced by perceptions that are created by the media as well as the social recognition given to certain work environments. We measured this variable with questions that test the following indicators:

- Student indicates ICT as a possible career preference
- Student shows a basic understanding [correct perception] of ICT as a career
- Student has considered a career in ICT while at school

While measuring this variable we have to acknowledge that secondary school students will have no in depth knowledge about industry shortages or labour market elasticity. This is where the media and social perceptions come into play. A secondary school student may, as an example, interpret the increased elasticity and supply stability within the ICT industry, through pure media influence and popular social views of ICT, as the industry offering a good basic salary with good growth potential, and [if asked] may present a gut feeling that the industry is still expanding/growing. In the sections to follow we investigate prospective students' understanding of ICT at the start of their tertiary studies and ask students to tell us what their dream jobs are – our findings gives an interesting indication as to the current popularity of ICT as portrayed by youth-focussed media.

The role of primary motivators in tertiary study choice

For students to choose ICT as study direction [or career] and become part of the South African ICT labour supply, they need the correct information about the industry, portrayed to them by someone that they trust – someone that can influence their career choice. If primary motivators – teachers, parents, and role models – are given the correct information (marketed correctly) about the ICT industry as a workplace, they can make a substantial difference in the career choices of students, and hence in ICT supply elasticity. We asked students who/what their primary motivator/motivation was when choosing what to study, and after basic analysis, confirmed the following indicators for this variable:

- Student had the primary motivation of parents or teachers
- Student indicates personal interest as primary motivation
- Student indicates life experience as primary motivator

The interaction between this variable and the previous one (Student's perception and knowledge of the industry) is also measured statistically in the sections to follow.

Socio-economic disadvantages and access to ICT resources

From previous work (Breytenbach et al., 2012), and in the light of the 2012 ICT charter⁵, the socio-economic conditions of secondary schools and the level of ICT access students enjoy before having to choose ICT as a career was considered as a potentially important variable in the South African ICT labour market supply. The following indicators were investigated towards this end:

- Student had access to computers and internet at home prior to career choice
- Student had frequent access to computers and internet during secondary school
- Student studied at an economically disadvantaged secondary school

ICT as a secondary school subject

From literature [Walstrom et al., 2008] we note that interest in subjects at secondary school level often inspire career choices. In order to measure the effect of this variable on ICT labour market supply, we asked students that participated in our survey to indicate the following:

- Student had Computer Application Technology (CAT) and/or Information Technology (IT) as subject at secondary school

The interaction between this variable and having parents and teachers as primary motivation for career choice is also measured in sections to follow.

Salary expectation

From our earlier discussion of how labour markets function in a skills-shortage scenario, it is clear that the salary expectation of new labourers is an important variable. We did not test the salary expectation of survey participants – not even the ones now studying ICT related degrees. The rationale behind this was that survey participants, being first year students at university, would not know what a reasonable salary expectation would be. We discuss this situation again in our conclusion, as this “not knowing” is indicative of a crucial miscommunication of information in the process of increasing ICT labour supply.

⁵ South African Government Gazette, June 2012, No.35423.

Prospective students must know about ICT careers and how much ICT professionals earn before they make a career choice.

Career preferences (“dream jobs”) were measured as part of the survey, and it is clear that traditionally high-earning jobs remain solidly at the top of the rankings, with very stable careers and industries following them.

Setting up the survey

All first year students at a representative South African university were asked to complete an online survey shortly after starting with their tertiary studies. The survey was made available (online) to about 7000 students of which 4475 completed the survey. The survey consisted out of 12 questions covering minimal demographic information and the variables discussed above.

The model

In order to measure the influence of each of the mentioned variables on the desired result – a student choosing to study ICT at tertiary level and eventually joining the ICT labour force – a statistical model was needed. We constructed a basic multivariate model as shown below, and performed regression analysis on the data of the 4475 surveyed students using this model.

Table 3: Variables used in supply prediction model

Table 3: Variables used in supply prediction model	
Y	student choose to study ICT (and potentially become part of ICT labour supply)
X1	student had the primary motivation of parents or teachers when choosing career
X2	student had CAT or IT as subject at secondary school
X3	student indicated ICT as a possible career preference/”dream job”
X4	student showed a basic understanding of ICT as a career
X5	has considered a career in ICT while at school
X6	had access to computers and internet at home
X7	had access to computers and internet at secondary school
X8	previously disadvantaged school
X9	personal interest as primary motivator
X10	life experience as primary motivator

In the sections to follow we show the results of the regression analysis of the survey data using the model, and discuss our resultant findings. We also discuss how the survey results can be translated back to potential increases in ICT labour supply.

VI. SURVEY RESULTS – VALIDATION OF THE MODEL

This section presents the results from a large scale survey (4475 students) used to validate the labour supply variables discussed in the previous section.

Table 4 shows what survey students chose to study. We thus had a control group of 371 students (8.3% of sample population) that chose to study ICT related degrees (IS, Informatics, IT, or Computer Science).

BCom (excluding IS related courses)	1094
BSc (excluding Computer Science)	833
BA (Languages, Art, Culture, Politics)	661
BEd (Education)	487
LLB (Law)	343
MBCbB / BChD / Therapy	325
IS, Informatics, IT	316
BTh (Theology)	59
Computer Science	55
Radiology / Pharmacology	33
Other fields (less than 50 survey entries)	269
TOTAL	4475

CA (Accountant)	653
Doctor / Surgeon	605
Teacher	472
Lawyer / Attorney / Advocate	464
IT / IS / Programming	301
Therapy (Speech, Physio, Occupational)	207

Financial management	174
Actuary	108
Musician	105
Economist	88
Business Analyst	11
Other choices (less than 50 survey entries)	1287

When we compare the results in Table 4 with those from Table 5 – the career preferences of students, an interesting picture starts to emerge. One would think that the 301 students that indicated ICT as a dream job would all be part of the 371 students currently studying ICT. This is not true, however. Only 147 students indicated both studying ICT and it being their dream job, with the majority of students that indicated ICT as a dream career were studying something else(151 students). This poses a question as to how strong motivations were when choosing a study field. The primary motivators for study choices are presented in Table 6.

Table 6: Primary motivators for study choice.	
Personal interest	1845
Parent(s)	1083
Life experience	598
Family members	288
Teacher	257
Role model	164
Friend	98
Aptitude	93
Unanswered	49
TOTAL	4475
Personal interest + Parent or Teacher	367

Other results include the following:

- 90% of the students indicated having access to a computer at home, and 80.5% indicated having internet access at home

- 80.6% of the students indicated having regular access to a computer at secondary school, and 69.8% indicated having regular access to internet while at secondary school
- 19.4% of the students indicated having CAT as a secondary school subject, and 12% indicated having IT at school.
- 83% of the students indicated that they understand that “computer knowledge” will be essential in their careers (after completing tertiary study)
- 5% of the students indicated having strongly considered ICT as a career option, with 31% considering it weakly (only “once or twice”)
- 13% of the students indicated studying at a secondary school that is classified as disadvantaged
- 20% of students indicated at least a basic understanding of what a career in ICT would entail

After a basic analysis of the survey data, regression modelling was performed on the data to see how significant the identified variables were in the students’ choice to study (or not study) ICT. These findings are discussed in the next section.

VII. FINDINGS AND DISCUSSION – A RETURN TO LABOUR MARKETS

In this section we discuss our findings related to each of the variables measured in the previous sections. We link each variable directly to our human capital approach to the ICT labour market by clearly indicating how each of these variables can increase the supply and/or the elasticity of supply of graduates in the ICT labour market.

Students’ perception and knowledge of the ICT industry as potential workplace

First, no significant relationship could be found between students that indicated ICT as a career preference and students that chose to study towards a career in ICT. Less than half the students that chose to study towards a career in ICT listed an ICT related career as their “dream job”. More than half of the students that indicated ICT as a dream career chose not to study ICT. This was a surprising find, and one that suggests that either (i) current popular perceptions of ICT as a career is not negative but is also not strong enough to motivate a decisive career choice towards ICT, or (ii) even though ICT is perceived as a viable career choice, the social recognition linked to these careers are lower than that of other equally obtainable career options.

Second, a highly significant relation ($p < 0.001$) was found to exist between students that showed a solid understanding of ICT as a career and students that chose to study towards a career in ICT. Stated differently, almost all students that chose to study ICT had at least a basic understanding of what a career in ICT would entail. This finding highlights the importance of creating a thorough, realistic understanding of ICT as career option under secondary school students. According to our survey more students understanding ICT as a career will translate directly into more students studying ICT, and hence higher levels of ICT labour supply.

Third, a moderately significant relation ($p < 0.05$) was found between students that considered ICT as one of various career options while still in secondary school and students that chose to study ICT. This finding suggests, again, that perceptions surrounding ICT as a career choice compares well with perceptions about other career options and that, if given the correct information about ICT as a career, a student may choose to study ICT as readily as any other field of study. In future research it would be valuable to measure salary expectation as part of this variable.

From this section we gather that supplying prospective ICT students with correct, realistic information about ICT as a career remains a known key factor in increasing ICT labour supply. The role of the media in supplying this information to students in an unbiased way requires further research. The role of current popular perceptions about ICT as a career also requires further research.

The role of primary motivators in tertiary study choice

First, a moderately significant ($p < 0.05$) relationship was found between students who indicated that a parent(s) or a teacher(s) had the biggest influence on their career choice and students who now study towards a career in ICT. This was an expected find, with parents and teachers being two groups that can have a sustained, long term influence on the perceptions of prospective ICT students. This finding underlines the importance of supplying both parent and teacher groups with correct, realistic information about ICT as a career choice. From this finding it can be assumed that if more parents and teachers promote ICT as a competitive career option, more students will choose to study ICT. This will increase the supply of ICT labour and the availability of correct, realistic information about ICT careers and the expected

salaries linked to these careers will stimulate an increase in the elasticity of ICT labour supply.

Second, “personal interest in ICT” did not turn out to be a significant indicator of ICT as a career choice, but “life experience” did ($p < 0.05$). This interesting finding may indicate that (i) the perceived importance of ICT/technology in the life experiences of prospective students convinces them that ICT will be a secure, risk averse career choice, or that (ii) personal interest in ICT/technology and its importance in the modern working environment is not a strong enough motivation towards a career in ICT.

From this section we gain that it is important to inform parents and teachers – the groups that have long term influences on the career choices of students - about ICT as a career option, and that the importance of technology in the life experiences of students may also guide them towards considering a technology related career.

Socio-economic disadvantages and access to ICT resources

We asked students whether they had access to computers and/or the internet at home and/or secondary school, and classified the schools they attended as being economically disadvantaged or not, based on the income profile of the suburbs surrounding the schools.

No significant relationship could be found between students that had access to computers at school/home and students now studying ICT. Furthermore, no significant relationship could be found between students that had access to the internet at home/school and students now studying ICT.

Another interesting finding was a highly significant relationship ($p < 0.001$) between students now studying ICT and students coming from economically disadvantaged schools. Marketing ICT as a viable [rewarding] career choice at economically disadvantaged schools would seem to promise a greater increase in ICT graduate supply than investments into infrastructure such as computers and internet at schools.

ICT as a secondary school subject

South African secondary school students have the option to choose either Computer Application Technology (CAT) or Information Technology (IT) as secondary school subject. This choice must be made during the second of five years of secondary schooling.

A highly significant relationship ($p < 0.01$) was found between students that had CAT or IT as a secondary school subject and students now studying ICT. This was an expected result, as students with CAT or IT backgrounds will have access to more up-to-date, realistic ICT career information and would have had access to at least one teacher (motivator) with basic knowledge about ICT as a career choice.

Any plan for increasing the supply, and the elasticity of supply, of ICT graduates will have to include guidelines for how to increase the number of secondary school learners taking CAT or IT as school subjects.

VIII. CONCLUSION AND FURTHER RESEARCH

In this section we summarize our findings in three sections: (1) observations from the labour market discussion in the first part of this article, (2) observations from the supply side analysis that constituted the second part of this article, and (3) a short section discussing the match between ICT labour supply and demand and our thoughts towards a sustainable solution.

It is the authors' opinion that a positive change to the South African ICT labour supply, and an eventual solution to the so called "ICT skills shortage", will be accomplished through *education-driven projects* at (i) secondary school level, (ii) diploma reskilling level, and (iii) at graduate level (skills-matching, reskilling, transition programs, and apprenticeships). Each of these levels thus receives frequent mention in the sections below.

From labour market analysis (approaching the skills shortage)

The graduate level ICT skills shortage being experienced in South Africa is real, and from available data [and our labour market approach to this data] we estimate a graduate level shortage in supply of about two thousand graduates per year in the fields of software development, business analysis, and mobile application development. This shortage, having been present in industry for some years, has left a total skills deficit of more than five

thousand graduates (when we look at available data conservatively)⁶. Industry demand (the number and type of vacancies available in the market) is dynamic, however, and from experience we suggest that most vacancies not filled for more than two years become obsolete; this suggests a “backlog” of about four thousand vacancies at most. Increasing ICT graduate supply with two thousand graduates per year seems to be an attainable goal, given the recent growth in final year students reported by selected large universities in South Africa⁷. National e-Skills Plan of Action (NeSPA) initiatives are also starting to have a sustainable impact on the number of ICT graduates, and the impact of other e-Skills Institute (eSI) initiatives must still be measured. Cooperation between tertiary institutions are also growing through joint e-Skills initiatives.

From a labour market viewpoint it is important to create a positive, realistic, well-informed view of the ICT industry at both secondary school level and diploma level. Prospective graduates must become more aware of salary expectations, industry growth, and exciting trends in this labour market if they are to choose ICT as a study major and, eventually, a career. Information Systems departments should consider this when marketing towards secondary schools and colleges.

It is clear from the MICT SETA data that many potential ICT graduates do not study further than diploma level. This complex situation requires urgent further research as it suggests a divide between higher education colleges and universities in South Africa. From a human capital perspective we suggest reskilling diploma level students (leaving college) through short graduate level courses (at local universities) that are coupled with industry apprenticeships/internships, making sure these students are not left without work when one or two more years of study could potentially match their skills to industry’s scarce skills needs. The creation of such short courses, and a communication channel between colleges and universities should be one of the main focus points of governmental e-Skills initiatives.

The shortage in ICT labour is only one of the concerns discussed in this paper, and as we explicitly state earlier in the paper it is only half the problem. A second [equally important] concern is increasing the price elasticity of the existing supply. As discussed, an increase in the elasticity of supply will result in the investment and productivity increase needed to get

⁶ Similar views are expressed in the ITWeb survey summary (ITWeb, 2011).

⁷ University of Pretoria and University of the Western Cape data are available on request.

the labour market moving towards [accelerating towards] (1) a continually growing demand for ICT graduates as the industry expands, and (2) a competitive state where supply and demand meets each other closer to current salary expectations.

Supply elasticity is increased through education driven initiatives. Stated differently, education driven initiatives are used to increase variables that will, in turn, increase supply elasticity. This is worth reiterating: the aim of supply-increasing education projects should not be to decrease the measurable skills shortage (difference between supply and demand at the current average salary level) to zero, as a small yearly shortage indicates a healthy year-on-year growth in demand – an indicator of industry growth. The aim of supply-increasing projects should rather be to increase the elasticity of supply in order to stimulate the maximum amount of growth through capital investment while *almost* meeting the industry demand for graduates at a reasonably competitive base salary level. Secondary focus areas of such education driven projects should include making local supply cheaper than foreign supply, increasing the supply chain's capacity to move with [fast moving] demand trends, maximizing the economic welfare generated for both supply and demand stakeholders by eliminating harsh inefficiencies within the ICT labour market, and not allowing the undersupply of graduates to block the growth of the ICT industry.

In this paper we constructed a model to test the importance of several supply elasticity variables, and conclude our findings from this exercise in the next subsection.

From a supply-side analysis using our career-choice model

The measurements gained from the large scale career-choice survey, as discussed in this paper, identifies four important variables for increasing ICT graduate supply elasticity:

- The number of school learners taking CAT or IT as secondary school subject
- The number of school learners showing a good basic understanding of ICT as a career
- School learners from economically disadvantaged schools are choosing ICT as a career
- Parents and teachers still perform a critical function during the career choice process, and should be given access to up-to-date information regarding ICT career choices

Increasing these variables will, over time, result in a larger pool of ICT graduates, but it will immediately start pushing the ICT labour market towards a more competitive state. It is this

“push” that is much needed in the supply chain of ICT labour in South Africa, as it stands in 2012.

At secondary school level the emphasis should be on getting more students into CAT and IT classes (influence subject choices through active marketing), and supplying students with ICT career information. At diploma and graduate level the focus should be on giving students information about how they can reskill themselves (courses are available) in order to match industry needs. Industry has an important part to play at diploma and graduate level, facilitating more internship programs and informing tertiary academic programs with their needs.

The variables mentioned above all indicate a need for a focussed marketing approach by Information Systems departments countrywide to engage students at secondary school level in the right way, with the correct content. Departments should also be aware of how exciting and engaging they portray themselves towards media representatives and schools when busy with marketing activities.

Supply and demand match

Education and training for newer technologies, such as software development for mobile devices, should be introduced at all three levels in the ICT supply chain – secondary schools, colleges, and universities – in order to prevent future skills shortages and skills mismatches.

The institutions producing the most graduates are placed near the geographic areas requiring the most skills, so students having to relocate [the geographic flexibility of labour supply] were not seen as a major barrier between supply and demand.

Many universities and colleges are aware of the published lists of needed/scarce skills as they are in communication with the MICT SETA, and some institutions are shifting their focus towards hardware skills, software development, and business analysis. It is important that colleges, the primary suppliers of diploma level tertiary education, will motivate their students to continue studying towards graduate level to meet the industry need for graduates. This suggestion guides our thoughts towards the following realization.

Towards a solution – transition programs

Two types of transition programs – education and training projects focused on reskilling/realigning learners - are needed in the supply chain: (1) programs that motivate secondary school learners towards a career in ICT, and (2) programs that match the skills of

both diploma level and graduate level students with industry needs. Currently (in 2012), there are South African universities working hard towards creating these short, dynamic, industry focused reskilling courses. The authors of this paper are actively involved in the creation, marketing, and delivery of these transition courses and suggest this as an area for further research. Current results are still unverified, but indicate that ICT transition programs at secondary school level and graduate level are succeeding as tools for increasing the supply of ICT graduates. Diploma level programs still require much more attention.

We are moving away from a view of the ICT skills shortage where the solution involves mostly capital investment in ICT infrastructure [a shift away from dumping hardware and cables in Africa], towards a more complex view of the ICT skills shortage where education and training (in the form of transition courses) take primary focus.

Our response to the problem statement of this article - creating a sufficient, sustained supply of tertiary level ICT skills [graduates] to stimulate growth in the developing South African economy – is as follows: human capital is increased through education and training [education-driven initiatives], which in turn stimulates capital investment, a growing demand for more graduate level ICT skills, a more price elastic supply of ICT skills, and accelerated economic growth within the ICT sector. The current ICT skills shortage in South Africa is a symptom of this process in action, and guides us towards the development of transition and reskilling programs.

IX. REFERENCES

- Breytenbach, J., De Villiers, C., & Jordaan, M. (2012) **Communities** in Control of Their Own Integrated Technology Development Processes. *Information Technology for Development*. 18(4), doi:10.1080/02681102.2012.714348.
- Calitz, A. (2011). A Model for the Alignment of ICT Education with Business ICT Skills Requirements. *DBA Thesis*, Nelson Mandela Metropolitan University, 2011.
- Calitz, A., Greyling, J., and Cullen, M. (2010). The Problems Experienced within the e-Skills Value Chain in South Africa. *Proceedings e-Skills Summit, Cape Town, South Africa 2010* (pp. 1-10).
- Cremer, P. (2011). The South African ICT skills deficiency. MIT mini-dissertation, University of Pretoria.
- ITWeb. (2011). *Summary of Main Findings 2011 JCSE-ITWeb Skills Survey*.

- Lotriet, H., and Matthee, M. (2010). Challenges in ascertaining ICT skills requirements in South Africa. *South African Computer Journal*, (46), 38-48. Retrieved from <http://sacj.cs.uct.ac.za/index.php/sacj/article/viewArticle/64>
- Merkofer, P., and Murphy, A. (2010). The e-skills landscape in South Africa. *Zeitschrift für Politikberatung*, 2(4), 685-695. doi:10.1007/s12392-010-0219-y
- MICT SETA. (2011). ISETT SETA Sector Skills Plan 2011 – 2016, Version v2p1.
- Toner, P. (2011). Workforce skills and innovation. An Overview of Major Themes in the Literature. OECD Working Paper Series. http://www.abhato.net.ma/index.php/fre/content/download/19970/362215/file/Workforce_Skills_and_Innovation.pdf
- Walstrom, K. A., Schambach, T. P., Jones, K. T., and Crampton, W. J. (2008). Why Are Students Not Majoring in Information Systems ? *Journal of Information Systems Education*, 19(1), 43-53.