2021JCSE-IITPSA ICT Skills Survey
Eleventh Edition

Joburg Centre for Software Engineering (JCSE) and IITPSA (Institute of Information Technology Professionals South Africa)

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EXECUTIVE SUMMARY

The JCSE (Joburg Centre for Software Engineering) is a University of Witwatersrand partnership with government and industry, founded in 2005. IITPSA (the Institute of Information Technology Professionals South Africa) is the 64-years old professional body for the sector, recognised by SAQA and accredited by the International Professional Practice Partnership (IP3). This report is the output of a collaborative partnership between the JCSE and IITPSA. It presents the results of the partnership's eleventh edition of its survey of skills trends in the South African information & communications technology (ICT) sector.

In many ways, it is disappointing to realise that the concerns we expressed two years ago (and in some cases, before then) are still valid. In 2019, we wrote in our introduction to the previous Skills Survey that the South African economy was in dire straits. It still is. In spite of the Zondo Commission and other investigations exposing much of the corruption of the last decade, we are still far from dealing adequately with the consequences of State Capture. The financial and institutional damage of the Zuma years continues to hold the entire country back. Add the unexpected burden of coping with the COVID-19 pandemic and it becomes even harder to see how South Africa can dig itself out of the economic pit in which it is languishing. Unemployment has continued to rise, putting the country in the unenviable position of being at the top of the international "leader board" with more than 44% unemployment (extended definition). Youth unemployment is even higher.

In spite of the much-vaunted focus on 4IR (the "Fourth Industrial Revolution") from the President and the Department of Communications & Digital Technologies, much work must still be done before we can harness the true benefits of digital transformation and 4IR technologies.

The COVID-19 pandemic, and the associated lockdowns and move to a work-from-home (WFH) "new normal", has shone a bright spotlight on the glaring gap in data access and connectivity that exists between "digital haves" and "digital have-nots". This digital divide has shown up the glaring inequalities in South African society. The regulator, the portfolio department and the service providers are at loggerheads on how to fairly allocate the required spectrum and we have still not seen the end of analogue TV signals. Eskom's ongoing struggle to keep the lights on adds to the negative outlook facing our economy and limits the opportunities for the neediest communities to join the knowledge economy and leverage digital platforms.

We said in 2019 that although many stakeholder groups are making concerted efforts to improve the competency and employability of young people through some excellent skills development initiatives, the results tend to be counted in terms of hundreds or maybe thousands of candidates when what is needed is opportunities for hundreds of thousands or millions of people. The plethora of such initiatives makes it difficult to judge which are contributing value and which are disappointing learners who cannot use the skills acquired. The continued fragmentation of stakeholder groups in the ICT sector inhibits the ability to take an holistic approach to analysing the data available from the myriad of role-players.

This Survey has repeatedly highlighted the poor state of education in South Africa and in particular the very low number of learners achieving competence in STEM subjects. There are many initiatives attempting to address this issue but they tend to be in relatively small pockets and are not resolving the underlying lack of appropriate curriculum, relevant teaching materials and skilled teachers. This has become even more serious, due to the amount of schooling lost during the pandemic lockdowns, disadvantaging all those children who do not have access to online resources.

While all we have said above focuses on the many difficulties faced by South Africa and its ICT sector, there is a light at the end of the tunnel. In spite of its considerable down sides, the COVID-19 pandemic has given an enormous boost to digital transformation in many sectors. Who would have imagined 18 months ago that millions of South Africans would be working online, buying their groceries, visiting doctors and appearing in court via digital platforms? Our society – or at least that part of it that has decent connectivity – has gone digital and huge opportunities have arisen for companies and professionals that make this all possible.

THE ICT SECTOR

The MICT (Media and ICT) SETA provides the following information in its current Sector Skills Plan. South Africa's nominal GDP at market prices in 2018 was R4,9 trillion, a R220 billion increase from 2017 (StatsSA, 2019). The MICT sector is, however, estimated to have a combined GDP exceeding R300 billion.

At the end of 2018, the overall ICT market in South Africa is forecast to reach R248 billion, and R273 billion by 2021. This represents a compound annual growth rate of 2,9% (IDC, 2017). The IT sector is projected to grow at a rate of 1,6%.

Consumer electronics revenue is expected to show an annual growth rate of 7,7%. The electronics subsector is estimated to reach 1,6% growth in 2020. Total telecommunications revenue increased by 6,4% over the period 2015 to 2018 (ICASA, 2019).

Gartner presented a slightly different view, referring to IT spending of R303,46 billion in 2019 (3,9% increase on 2018). This includes devices at R46 billion, software at R32 billion and the remainder in services and support (IT-Online, 2019).

ICT SKILLS ENVIRONMENT

By Professor Barry Dwolatzky

In introducing the 2019 Skills Survey report we looked critically at the notion of the "Fourth Industrial Revolution", or 4IR. We asked whether it is an evolution on the ongoing timeline of digital transformation, or whether it was indeed a revolution. We concluded that it was, in fact, a bit of both.

Contemplating the digital future and its implications on the world of work, policymakers, parents and young people have started thinking deeply about "jobs of the future" and the skills that will be required to fill these jobs.

Over the past few years I have spent many hours with anxious and confused teenagers and their parents who have come to me to ask for study and career advice. "How do we prepare ourselves for these jobs of the future?" "How do we 'future-proof' ourselves in the face of the impending 4IR storm?". These are very difficult questions to answer and very hard advice to give. It all boils down, however, to two considerations: what to study and where to study?

What to study?

Learning 'coding' seems to have become something of an obsession in recent years. Some have advocated that learning to program should be introduced in Grade 'R' and made compulsory for everyone in our schools and universities. An article in Brainstorm Magazine in December 2019 discusses the pros and cons of plans by the Department of Basic Education (DBE) to introduce a new curriculum in South Africa's schools covering coding and robotics for Grades 'R' to 9, starting with a pilot at 1000 schools in 2020. The article highlights key constraints such as connectivity and access to suitable devices, plus the fact that there are far too few teaches trained in this subject.

We have also seen a mushrooming of coding academies and "Coding Bootcamps" in South Africa in recent years. Some of these are: WeThinkCode, Umuzi, Project CodeX, CodeSpace, Quirky30, CapaCiTi, Tshimologong Skills Academy (started by the JCSE), HyperionDev, mLab CodeTribe, Code College. There are many others. OfferZen (https://www.offerzen.com/blog/exploring-coding-bootcamps-in-south-africa) has done a very thorough review and analysis of these.

I would question whether the mass acquisition of skills in coding and robotics should be our priority in preparing South Africa for 4IR. Coding is hard to master and frustrating if you only learn it superficially. It requires many, many hours of practice on real problems rather than classroom exercises. It is only a very small proportion of those working in the digitally transformed world of the future who will be actively involved in creating the applications and developing the future innovative digital technologies. Learning coding, robotics and other digital skills is appropriate for this much smaller group. In the same way, knowing how to design or repair a modern motor car engine does not really empower the average 21st Century motorist. I believe that, rather than learning coding and robotics, there are other, better, ways to acquire digital literacy and to become competent in dealing with the digital world.

But what about this specialised minority of people who will design, build and run the digital technology of the future? What should they study?

I've always believed that tertiary education is about achieving 4 generic outcomes:

- laying a firm foundation of 'core' knowledge;
- learning how to learn;
- learning how to communicate effectively;
- learning how to sell.

The first three are self-explanatory while the last one sometimes surprises people. I strongly believe that everyone needs to proactively 'sell' themselves and their ideas and that there are specific skills and competencies required to do this. While some people might have a natural flair for 'selling', others need to be taught how to do it effectively.

Achieving these outcomes requires a context which might be anything from English literature or philosophy to dentistry or architecture. I've devoted my life to educating engineers in a university environment. My discipline is software engineering, which, at Wits University, is taught as a stream (called the "information engineering" option) in the electrical engineering programme. For me, the context for helping students achieve those 4 outcomes is software engineering. Within the discipline of software engineering, students need to lay a firm foundation of core knowledge – physics, maths and computer science principles upon which software engineering practice is built. Students are shown how to deal with new methods and technologies – how to learn without being spoon-fed by a teacher. They learn to communicate about software engineering issues in both written and verbal forms. Finally, they work in teams and are encouraged to present (i.e. 'sell') their ideas and convince others – inside and outside the team – to take their contributions seriously.

For many years my advice to those wishing to work in the ICT sector has been to aim to acquire a formal educational qualification at as high a level as they can manage. In ICT these qualifications are undergraduate or postgraduate degrees in disciplines like software engineering, computer science, information systems and IT. Over the past 2 or 3 years my advice has changed, however.

I now advise young people hoping to "go into" a career in the digital economy that achieving the outcomes listed above are far more important than the actual context in which you learn them. Someone studying for a general undergraduate qualification in <u>any</u> discipline in science, commerce or the humanities at a good educational institution should get to learn how to learn, to communicate and to "sell", i.e. the last 3 generic outcomes. The obvious gap is that the first outcome, i.e. 'core knowledge' would relate only to the discipline they have studied.

I will come back to this point later but let's first go on to the second question I asked.

Where to study?

It used to be broadly accepted that studying at a good university was the first prize for a young person after leaving school. The entire South African primary and secondary educational system has set this as the goal.

Teachers, learners, parents, policy makers and public opinion have placed great store in the matric exam as a gateway to university entry

The emergence in recent years of other learning pathways such as online courses and training academies, like some of those coding programmes listed above, has led to questions being asked about the relevance and value of a university qualification.

For someone wishing to work as a digital professional in the world of 4IR some experts are advising young people not to go to university, but to rather follow one of these alternative pathways. I've heard someone say on a public platform, "University does nothing to prepare young people for jobs of the future. A few online courses on machine learning and AI are far more useful." I completely disagree!

I come back to the last 3 of the four generic outcomes I listed above. "A few online courses on machine learning …." or any other topic …. will not teach a young person how to learn, communicate and sell. Nor will it achieve the first of the four outcomes – 'core knowledge'. All of these require a far more intensive and immersive learning experience. The kind of experience and education gained in a university degree programme.

Preparing for a future job … and a future-proof job

This brings me to the advice I now give young people seeking study and career guidance.

Firstly strive as hard as you can to do a university degree – any university degree. Over the three years of an undergraduate programme you will learn to learn, communicate and sell. With a degree under your belt, learn the foundational skills required in the 4IR-related job you may wish to be doing. These foundational skills can be acquired via a good set of online courses or other alternative learning pathways. But remember that technical skills such as software development require many hours of practice. You should either find a way to practice alone ….. with support from an expert advisor, or join an internship programme.

Most importantly, prepare to keep on learning for the rest of your working life. Learning in the ICT sector never stops!

ARE WE MOVING INTO THE GIG ECONOMY?

By Prof Barry Dwolatzky and Tony van der Linden, CIO and Head of R&D at BBD

What is a "job"? The simple answer - without getting bogged down in legal technicalities – is that it's an arrangement between a person, called an "employee", and another person or entity, called an "employer". Through this arrangement the employee agrees to spend about 40 hours every week at a "place of work" assisting the employer in conducting their business. In return the employer provides the employee with the necessary tools, a salary, and (possibly) other benefits and incentives. The arrangement is exclusive – the employee provides services to only one employer.

The employer usually puts processes in place, called "management", to monitor the work of its employees. These processes focus mostly on "time-and-attendance" management. They ensure that the employee puts in – at least – the agreed number of hours per week at the place of work.

The outbreak of the COVID-19 pandemic had many profound impacts on the world of work. Suddenly we were no longer doing our "job" at our employer's workplace. Employers had to find new ways of managing employees who were now sitting at home rather than working at desks under the watchful eyes of managers and co-workers.

For many of those working in the IT sector "working-from-home" (WFH) has been a relatively easy transition. The nature of the work and the personalities of the employees makes the adoption of WFH quite simple.

However, a question that many have asked is: Does the arrangement linking an employee to a single employer still make sense? Shouldn't a "job" be broken down into a sequence of tasks which can then be carried out by anyone able to carry out that task when required. This marketplace of tasks that need doing and agents willing to do them has been called the "gig economy". Isn't the logical consequence of the changes brought about by the pandemic the replacement of "jobs" with "gigs"?

This was one of the questions we hoped to answer when we launched the 11th edition of the JCSE-IITPSA "Skills Survey" in July 2021. We wondered whether we might see a reduction in the <u>number</u> of people employed in the sector (i.e. fewer "jobs") while the amount of work stayed the same or increased. We also asked practitioners directly whether they were now working for multiple employers in a "gig economy" mode of engagement. The results of the Survey presented in this Report show that this change is not occurring in South Africa. Employees remain attached to a single employer even though they now WFH.

However, we are still left with the question: Is a shift to the "gig economy" likely to happen in our local ICT sector in the near future?

At first glance the "gig economy" sounds glamorous. It promises the attractive prospect that we, as employees, have the freedom and autonomy to manage our own time. It provides us with the ever-sought-after flexibility to work when it best suits us. Most importantly, we get to make money doing things we love and things that challenge us - all surgically extracted from a "job" to match our individual strengths and experience. However, once we delve deeper, we realise that this approach is not without its downsides. For flexibility we sacrifice security. The "gig economy" transfers the risk inherently associated with full-time employment from the employer to the employee. Benefits associated with full-time employment, such as paid leave, are no longer part of the deal.

Even though, as our Survey shows, a shift to the "gig economy" has not occurred in the local ICT sector, it is plausible that forces in the industry might change this in the future. New post-COVID-19 work arrangements could fracture the delicate balance between the advantages and disadvantages of adopting this "gig" culture. The question is - what factors are at play and what role do they have in renegotiating the historic and exclusive arrangement between employer and employee?

The COVID-19 pandemic has forced us to reimagine the way we work and live. Its impact has brought about profound transformations that we did not expect and could not anticipate. Suddenly, we have been compelled to adopt ways of working, previously unpopular with corporate South Africa. WFH became the reality and its benefits were instantly realised by both the employer and the employee. Over time, the ICT sector has managed to invent and innovate processes and practices to adopt WFH as a primary way of working. One such change, and arguably a major redefinition of a role, has been the responsibilities of the traditional manager.

The role of the manager has changed from managing time and attendance to managing outcomes and expectations. It requires managers to give up absolute control and share responsibility with their subordinates. With little oversight possible, tasks have been broken up into smaller subtasks independently planned and executed by employees based on their strengths and experience. Employees have become empowered, can take ownership, make decisions and deliver work based on the conditions they find themselves in. Employees are committed and more effective. Employers have been surprised at the increase in the output that has been achieved. Underpinned by forced introspection, the employee has discovered the possibility and importance of a better work-life balance, the ability to deliver quality output from anywhere, as well as the value of good skills.

So, what will give way first to force the adoption of a "gig economy" in ICT? The pandemic has provided the fertile soil in which a "gig economy" could flourish. In these uncertain times and since people are at the core of the business in the ICT sector, employers are forced to be innovative in how they maintain their culture and competitive advantage. As both are vested in the people they employ, employers are at risk. In an attempt to protect what is important, employers are looking at mechanisms to encourage employees back into the office.

This approach may very well backfire since employees are seeing the advantages of WFH. This tension between employers and employees might just be what is required to break the current balance, making the "gig economy" an attractive alternative. With this will come new ways of working and new skills sets.

This is something that will be tracked in future JCSE-IITPSA ICT Skills Surveys.

SURVEY PROCESS

The Skills Survey continues to follow the process established in 2008. Its objective is to identify the most pressing skills needs from the corporate perspective, balanced with the view of current skills capacity of the practitioners and their intentions for future skills development. The questionnaire, devised by the JCSE, is in a consistent format to track trends and is published as an on-line survey. In 2021, as for the previous six surveys, we were assisted in this regard by Eduflex (a Cape Town-based company), who gave us the use of their Virtual Assessor™ survey engine and hosted the on-line access. Our thanks go to their team for great support.

We acknowledge the ongoing partnership between the JCSE (Joburg Centre for Software Engineering at Wits University) and the IITPSA (Institute of Information Technology Professionals South Africa), and the assistance of the ITA (Information Technology Association) in bringing the survey to the attention of their members and ITWeb as our media partner.

The data gathered from the questionnaires is put into context by an environment scan and literature review, supported by informed opinion from some of the sector's leading stakeholders.

Any use of this Report (in whole or in part) must acknowledge "2021 JCSE-IITPSA ICT Skills Survey" as the source. Please direct any queries and requests to director@jcse.org.za or ceo@iitpsa.org.za.

CORPORATE RESPONSES

In this section of the report, we analyse and comment on the responses received from employers, usually from the executives and managers responsible for ICT creation, implementation and support functions. Corporate response levels in 2021 are slightly lower than those experienced in the previous surveys.

PROVINCES
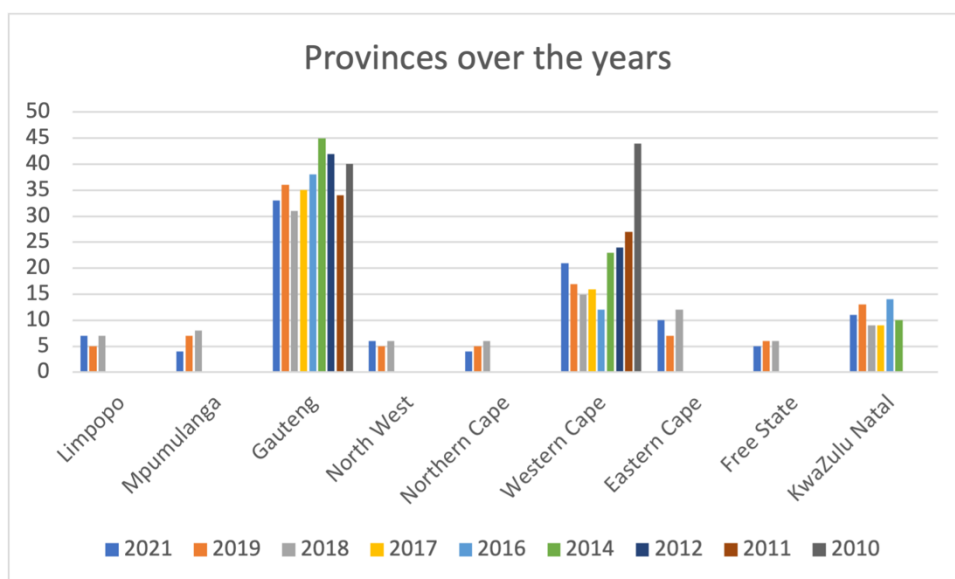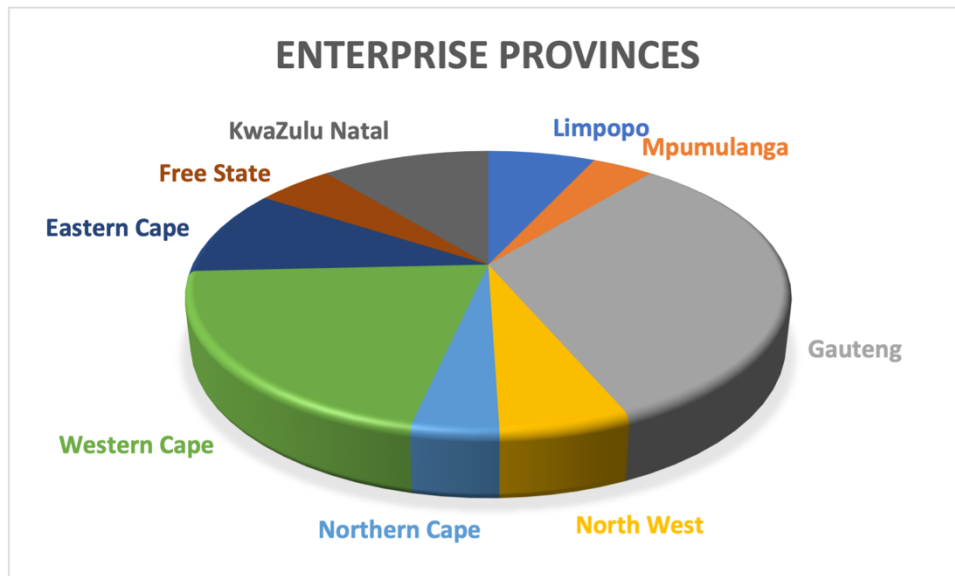
This pattern is a reasonable reflection of the geographical distribution of ICT enterprises in South Africa. Gauteng and Western Cape continue to dominate the sector.

Enterprise respondents over the years
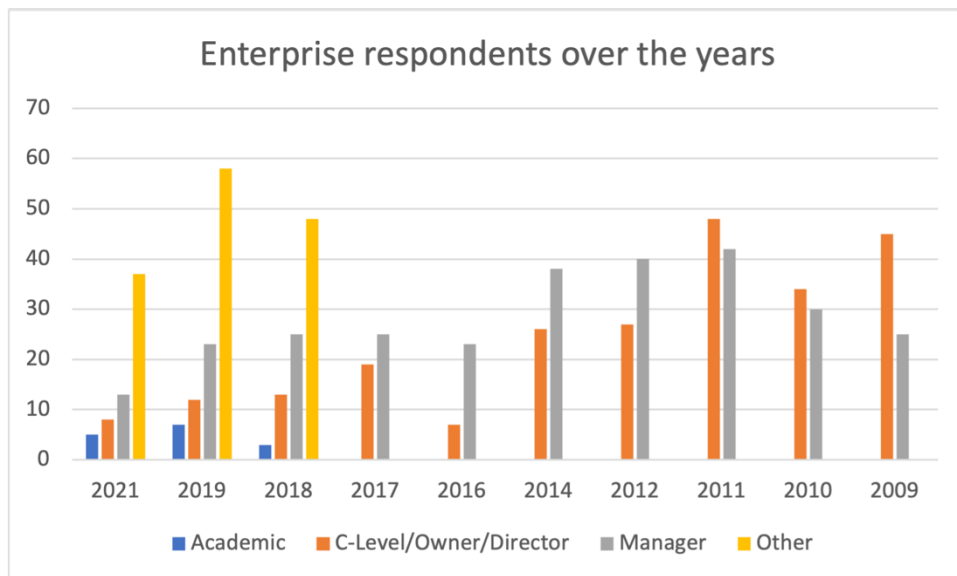
While managerial and executive level respondents have remained reasonably constant for four years(having declined from the high levels of 2009-2011), we see a rise in the number of professional level practitioners telling us about their enterprises (a statistic we began to track in 2018). There has been a small reduction in the volume of corporate responses in 2021. This is not unexpected, as many regular respondents are focused on the issues arising from the pandemic and did not wish to be distracted by the time taken to complete the survey.

Type of Enterprise

OWNERSHIP OF ENTERPRISE
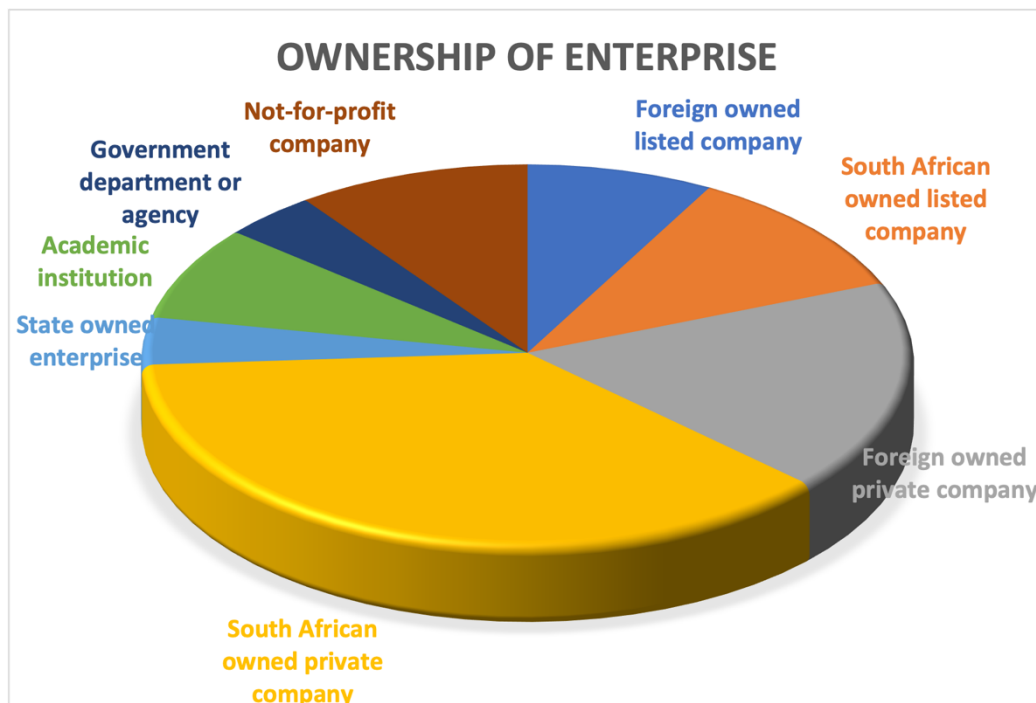
Almost 50% of enterprises responding to the survey are South African private enterprises and in 2021 more than a quarter are foreign-owned private enterprises.

Enterprise ownership over the years

SIZE OF ENTERPRISE

ENTERPRISE SIZE (EMPLOYEES)

ENTERPRISE SIZE OVER THE YEARS (EMPLOYEES)
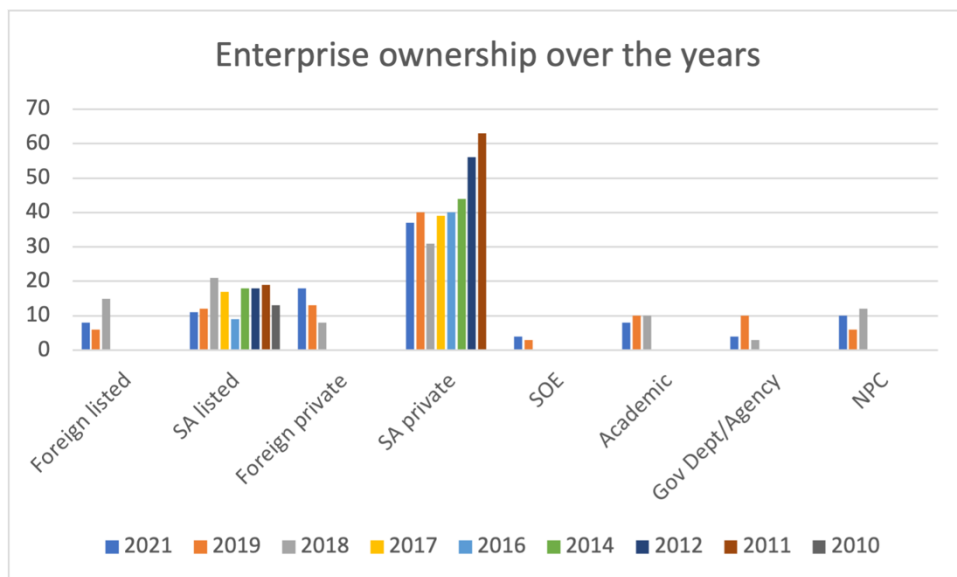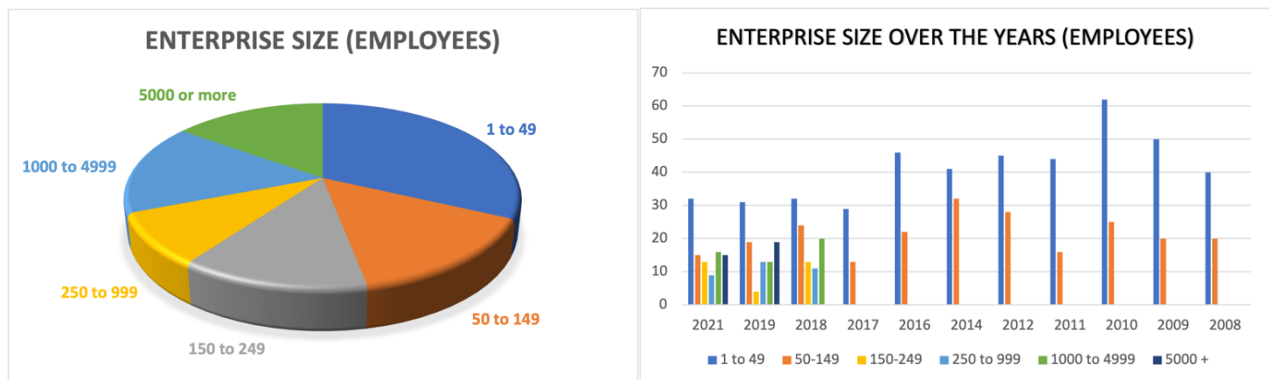
Overall, we can split our corporate enterprise respondents into three slices, for both the overall size of the enterprise and the size of the IT department, when measured by number of employees. One third are small, one third are large and one third falls into the middle.

This is not reflected in the MICT SETA statistics but that is explained by the lack of engagement by the majority of small enterprises in our survey. It is hardly surprising that most small business owners and managers have little time for completing surveys!

ENTERPRISE IT DEPT (EMPLOYEES)

IT Dept size over the years (employees)
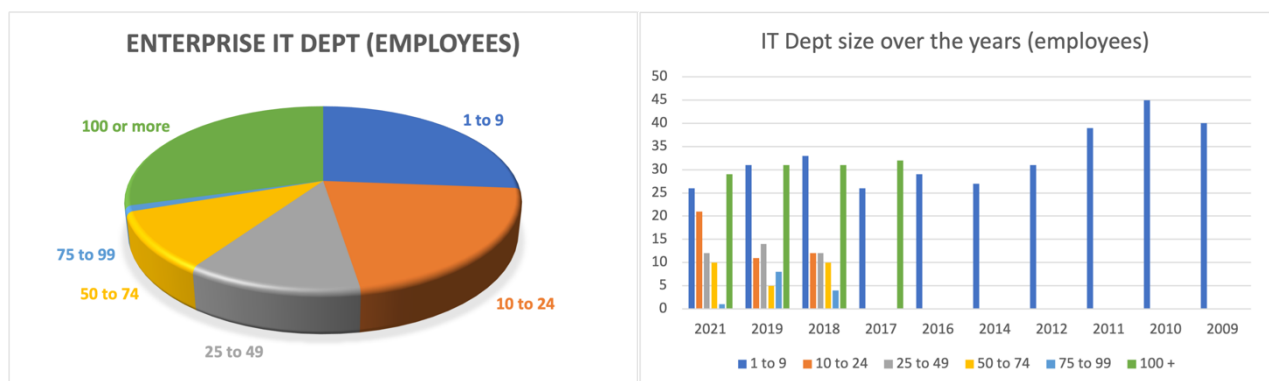
ANALYSIS OF CURRENT MICT SETA ANALYSIS OF THE SECTOR

Table 1: The MICT sector size of employers per Sub-Sector

Sub-Sector	Large (150+)		Medium (50-149)		Small (0-49)	
	2018	2019	2018	2019	2018	2019
Advertising	19	19	52	51	3 029	3 196
Electronics	77	75	113	114	3 173	3 317
Film and Electronic Media	55	55	56	57	2 827	2 983
Information Technology	171	172	357	356	12 881	13 467
Tele-communications	64	65	109	107	2 922	3 274
Grand Total	386	404	687	878	24 832	28 653

Source: The MICT SETA OGS, 2019

As in previous editions of this survey, we include the sector statistics from the MICT SETA in an effort to contextualise our results against the overall state of the sector. The table and figure numbers are from the MICT SETA's Sectoral Skills Plan (SSP).

Sharp-eyed readers will note that the 2019 Grand Totals exceed the sum of the items in the column. The SETA says this is because some employers did not specify their size.

[Note from the authors: We have decided not to include the latest employee numbers given in the MICT SETA SSP. Their researchers changed the basis of calculating the values extrapolated from the levy payers and retrospectively applied this to numbers from 2017 onwards. This dramatically changed the perception of the size of the sector from the workforce perspective. We disagree with the calculation and have requested the MICT SETA to re-evaluate their numbers in the context of the South African working population. The tables below are for the historical data, prior to the MICT SETA rebasing.]

Figure 1: Number of employees by Sub-sector 2017-2018
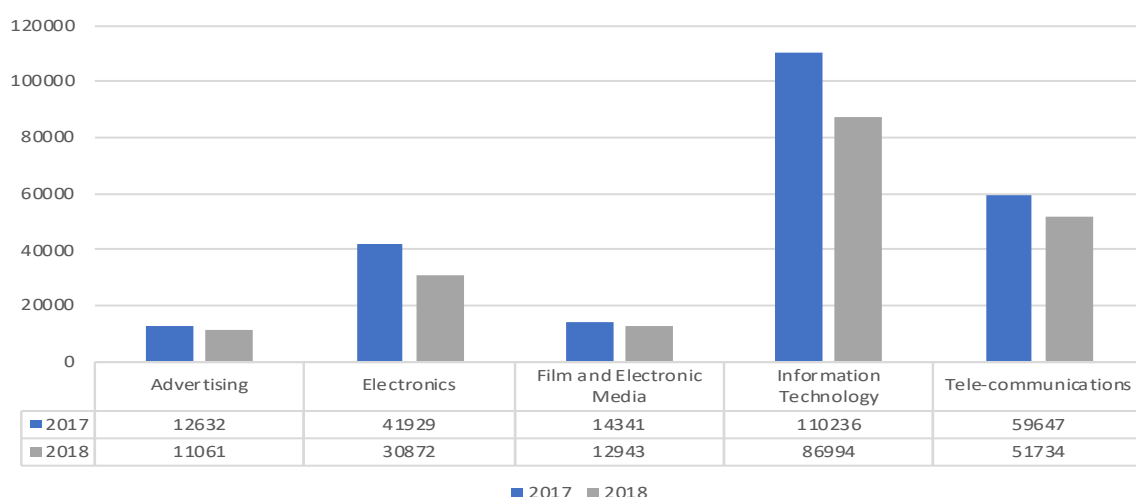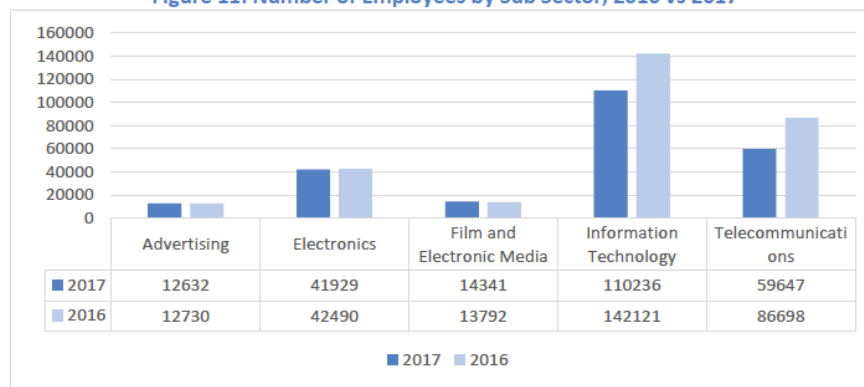

	Advertising	Electronics	Film and Electronic Media	Information Technology	Tele-communications
2017	12632	41929	14341	110236	59647
2018	11061	30872	12943	86994	51734

Figure 11: Number of Employees by Sub Sector, 2016 vs 2017

	Advertising	Electronics	Film and Electronic Media	Information Technology	Telecommunications
2017	12632	41929	14341	110236	59647
2016	12730	42490	13792	142121	86698

Source: MICT SETA OGS, 2017

We note that the current SSP does not include the historical data on employee numbers, so we have retained the charts from the 2017 (above) and 2014 SSPs (see below) for comparison purposes.
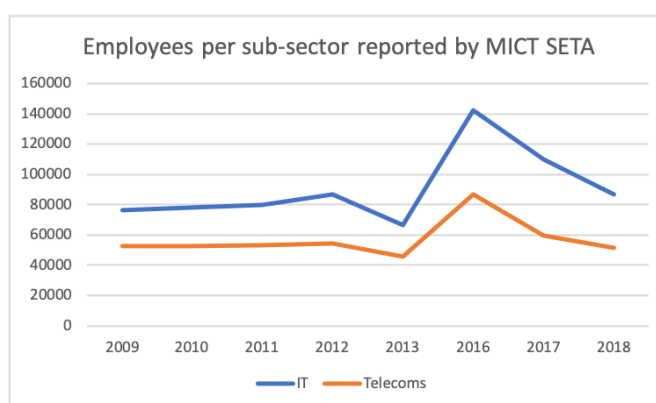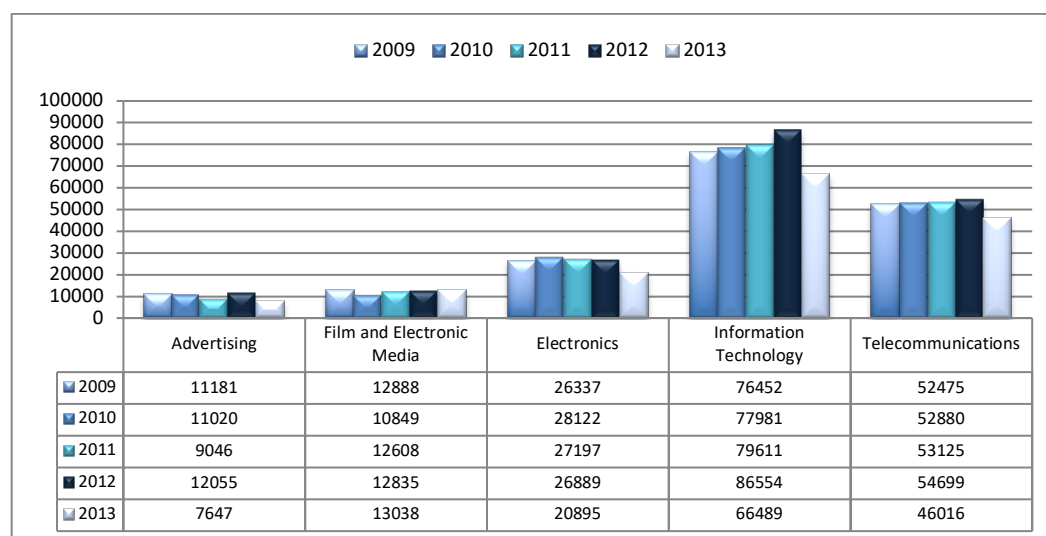

In this chart, we show the fluctuations reported by the MICT SETA during 2013 to 2017 and we are unable to explain why the numbers varied so significantly. The number of enterprises has not reflected this degree of change.

The numbers reported in 2018 appear to be returning to the pattern established from 2009 to 2012. To put the rebasing into context, the MICT SETA SSP increased the number of employees in the IT sub-sector from 110 236 in 2017 to 1 946 064 in 2018. It is our opinion that this is not credible.

Based on historical trends and other sources, we believe there continues to be a steady growth in the number of IT employees, balancing a decline in telecommunications workers (brought about by operations that are less labour-intensive, arising from the growth in fibre and wireless connectivity). It is not clear if the increased adoption of cloud-based services is affecting these employment numbers.

Number of Employees by Sub-sector, 2009 to 2013

|	Advertising	Film and Electronic Media	Electronics	Information Technology	Telecommunications
2009	11181	12888	26337	76452	52475
2010	11020	10849	28122	77981	52880
2011	9046	12608	27197	79611	53125
2012	12055	12835	26889	86554	54699
2013	7647	13038	20895	66489	46016

Source: The MICT SETA OGS

We note that it can be difficult to measure the effect of interventions concerning employment in the ICT sub-sectors, given the variations in employment numbers appearing in these reports.

Based on information supplied by levy payers, the MICT SETA suggests that 41% of employees in the MICT Sector are female but this is not broken down into sub-sectors. This is a very high proportion. Overall, the ICT Sector locally and globally reflects a female proportion around the 20% mark. The MICT SETA also indicates that 34% are White, 43% Black and the remainder almost equally split between Asians and Coloured people.

SECTORS
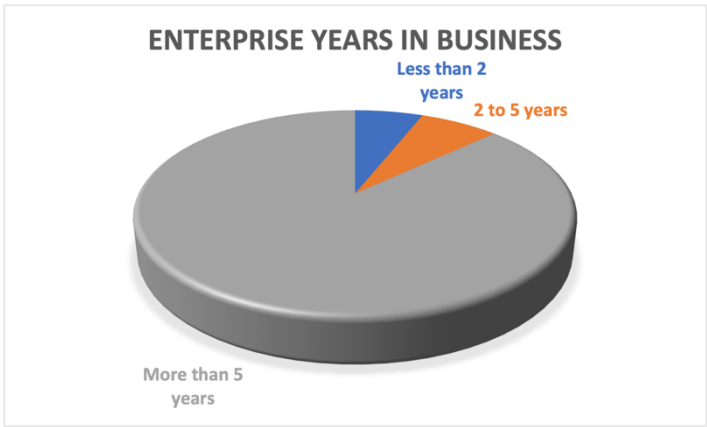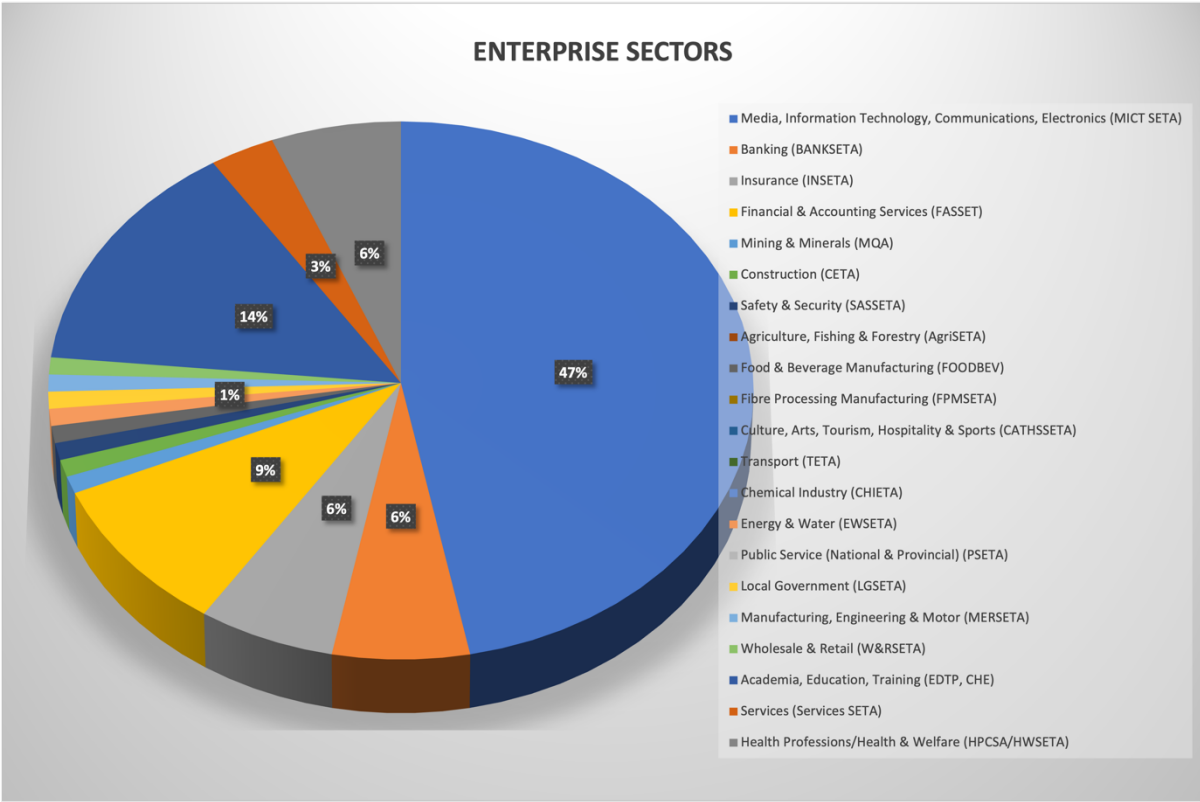
Our corporate respondents represent most of the sectors where ICTs play a significant role in their operations. More than 80% of them have been in business for longer than 5 years.

SECTOR SKILLS PLAN CORRELATION 2021

Our introduction to this section of the Report remains unchanged. We believe it is important to bring together the ICT-relevant information available in all the SETA Sector Skills Plans (SSPs), based on the fact that approximately half of the country's ICT practitioners are operating in non-ICT sectors. We also believe that this is the only report that brings together the various sectors' views on the importance of ICT skills. In the following sections of this report, we extract the information available from the latest published SSPs (acknowledging that some SETAs do not make them available timeously). The focus on the Top Ten Hard-to-Fill-Vacancies (HTFVs) means that there is often no mention of ICT skills in those sectors where they do not make it to the head of the list.

MICT SETA

The following is extracted from the MICT SETA SSP published in August 2019 for the 2020-2025 period.

Sector Profile & Analysis

The MICT sector is currently made up of 30 727 companies spread across the five subsectors. These estimates represent only companies allocated to the MICT SETA through the SARS registration process. 48% of the sector employer base is constituted by organisations in the information technology subsector, followed by telecommunications with 17% and electronics and advertising with 12% each. Contributing the least from the sectors is film and electronic media with 9%. Overall, the number of levy-paying employers has increased by 11,5% in 2019 (7 902 employers), up from 7 089 employers the previous financial year. 26% of all employers in the sector pay skills development levies. [Authors' note: This reflects the predominance of small enterprises that fall below the minimum required to pay Skills Development Levies.]

Economic growth in the MICT sector has been declining. While the telecommunications subsector has been vibrant, the other subsectors have not performed as might have been expected.

Employee data suggests that the labour market has been relatively flat; With an increase of just 1% between 2018 and 2019.

[Note from the authors: We have decided not to include the employee numbers given in the MICT SETA SSP. Their researchers changed the basis of calculating the values extrapolated from the levy payers and retrospectively applied this to number from 2017 onwards. This dramatically changed the perception of the size of the sector from the workforce perspective. We disagree with the calculation and have requested the MICT SETA to re-evaluate their numbers in the context of the South African working population.]

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Skills Demand, Supply and Scarcity

The following is a list of top occupations with hard to fill vacancies in the MICT sector (and the quantity needed):

- Software developer (2 434)
- Computer Network Technician (1 948)
- Developer Programmer (823)
- ICT Communications Assistant (755)
- Computer Network & Systems Engineer (731)
- ICT Security Specialist (713)
- ICT Systems Analyst (676)
- Web Technician (514)
- Systems Administrator (405)
- Programmer Analyst (397)
- Management Consultant (Business Analyst) (359)
- Advertising Specialist (224)
- Telecommunications Network Engineer (164)
- Database Designer & Administrator (114)

The top programming languages were found to be .NET, C#, C++, Java and VB. On the other hand, there has been a decline in demand for people to maintain legacy systems, such as COBOL developers. In addition, many companies were adopting the agile project management methodology. As a result, scrum masters were in demand, though there are very few people in the country that have certified qualifications to work with the method. With regard to telecommunications, which incorporates both the retail side and the technical side, network specific professionals, such as computer network technician and computer network and systems engineer, continued to be in demand.

Stakeholders in the sector indicated that employers increasingly require people that have more generalist skills such as communication skills, productivity tools and time management, rather than specialist skills. With greater convergence of technologies, people would need to be able to move seamlessly between several differing technologies.

[MICT SSP] Chapter 2: Key Skills Change Drivers

2.1 Introduction

This chapter examines the factors influencing the demand and supply of skills in the MICT sector. The chapter draws on current literature and interviews with key stakeholders within the sector. It identifies 5 change drivers that are a result of the 4IR, outlining how these change drivers may or are already impacting the aspect of skills demand and supply in the MICT sector. The chapter further analyses policies that affect skills demand and supply in the sector.

2.2 Factors Affecting Skills Demand and Supply

While the sector contributes positively to the GDP, the fourth industrial revolution will alter the way communities live and work through a fusion of technologies, blurring lines between the physical, digital and biological spheres. 4IR is a complex application of science, technology, engineering and mathematical (STEM) knowledge. In its simplicity it is an extension of Industrial Revolution 1, 2 and 3 with an addition of artificial intelligence built into machines that can think and do most things that were the sole prerogatives of the human species in the past. With South Africa pushing to be an e-skilled economy as outlined in the National Development Plan, Vision 2030, key change drivers that affect the MICT market and the socio-economic systems are identified and discussed below.

2.2.1 Cloud Computing

Cloud computing is a key driver of digital transformation in South Africa. It is a disruptive delivery model of information technology services that is based on a business model that is flexible and on demand. Microsoft defines cloud computing as the delivery of computing services - servers, storage, databases, networking, software, analytics and more - over the Internet (the cloud). Companies offering these computing services are called cloud providers and typically charge for cloud computing services based on usage, similar to how utility services such as water or electricity are billed.

The manner in which cloud computing evolves puts pressure on (how stakeholders need to approach) skills development. For example, cloud computing has taken another level where, instead of deploying the software on the application, experts have a new type of technology called Kubernetes where a type of container can be quickly deployed on any infrastructure. People with the skills to design and deploy such technology are in high demand and often approached not only in South Africa but by global companies. A study by the International Data Corporation reveals that in South Africa more than 90% of South African organisations are either already engaged in developing these skills or in the process of planning for development of such skills (Nebula, 2018), with a similar 90% having increased their spending on cloud computing (World Wide Worx, 2018).

2.2.2 Internet of Things (IoT)

The Internet of Things is another change driver in the MICT sector that comes with the 4IR. It refers to the ever-growing network of physical objects that feature an Internet Protocol address for Internet connectivity, and the communication that occurs between these objects and other Internet enabled devices and systems. The IoT allows for remote management or monitoring of connected devices. This information can then be supplied to an AI platform, which may be tasked with responding appropriately based on the data received. (MICT SETA opines that the use of) IoT will continue to grow as the cloud computing and cloud apps offering space expands in the coming years. IoT thus links to virtually all of the 4IR change drivers, further expanding the impact of 4IR.

There is limited recognition of emerging 4IR occupations in the OFO (Organising Framework for Occupations), thus limiting funding and formalised training opportunities in new age fields such as IoT. In consultations, stakeholders expressed a need for more IoT specialists. However, currently no such occupation exists in the strictest sense, instead IoT specialists may emerge as specialisations of existing fields such as software development and design.

2.2.3 Big data analytics

With the emergence of the 4IR, properly managing big data has become an important assignment for many organisations. According to experts in the field big data analytics can be understood as a new generation of technologies and architectures, designed to economically extract value from very large volumes of a wide variety of data, by enabling high velocity capture, discovery or analysis.

Big data has grown by more than 50% since 2010. This in turn has enabled AI uptake. In South Africa many organisations have started to realise the potential of big data and analytics. However, limited IT budgets and the dearth of skilled resources impede big data and analytics initiatives across organisations in the country. Many organisations have started to consider internally developing skills by sharing resources, undertaking training programmes and partnering with vendors. This will play a crucial role for organisations to establish a data driven culture and encourage knowledge sharing to develop internal capabilities. The demand for highly qualified big data analysts and artificial intelligence professionals is outperforming supply to the point where it can take many months to fill vacancies. The root problem of this is that big data analytics is a new field and the existing workforce is having to retrain in work with large sophisticated data sets. Competition also plays a role as larger companies recruit graduates as they are graduating, thus making it difficult for small MICT companies to keep up with the changing labour market.

2.2.4 Information Security

Increasing digitisation has come with greater security risks. Given the increasing dependency on ICT systems, and the growing complexity of connected environments, there is strong demand for and diffusion of software and tools to ensure IT systems security at all levels. South African organisations are experiencing challenges with cybercrimes. There are dire financial implications as the affected organisations are spending 10 times more on investigations (than) the original amount lost due to economic crime. The report published by PwC revealed that about 19% of organisations have had to spend between twice and 10 times as much on investigations. The supply of cyber security experts is lagging not only in South Africa but globally. Law enforcement agencies currently lack the ability to swiftly investigate and prosecute these crimes whilst organisations have to constantly improve their security features to fend off potential attacks. Frost and Sullivan therefore expect backup and disaster recovery services to be the fastest growing segment in 2018 and cyber security skills will need to keep pace.

In response to the above-mentioned skills shortages, the SETA is currently developing qualifications related to information security.

2.2.5 Artificial Intelligence and Robotics

Artificial intelligence (AI) can be defined as different technologies that can be combined in different ways to sense, comprehend, act and learn (Accenture South Africa, 2017). The field of robotics is a multidisciplinary study that incorporates mechanical engineering, electronic engineering, information engineering and computer science, amongst others, to develop and operate robotic machines, including AI robots. Robots are often used to automate processes, especially when it is too dangerous or expensive to utilise human workers.

Accenture notes that the growth in the development and use of AI is spurred on by complementary technologies such as big data analytics, cloud computing and the Internet of Things. Examples of AI relevant to the MICT sector include cognitive robots such as autonomous drones, virtual agents such as chat bots and recommendation systems. Common examples of the use of AI are social media "friend" suggestions and Google Suggest, which study behaviour and analyse large sets of data to predict and influence consumer behaviour.

In 2017 Accenture predicted that in five years more than half of consumers and enterprise clients will select products and services based on a company's AI. However South Africa still lags behind in terms of improving the quality of education, research, innovation and infrastructure required to create an enabling environment for AI adoption. This means we are not capitalising on the 1% increase in the economic growth rate predicted in an AI-rich economy.

As with the disruption AI may bring, robotics may invalidate or speed up manual or repetitive tasks performed by humans. An example of the use of robotics in the MICT sector is the use of drones, as opposed to hand held cameras, in filming. Drone and AI technologies may also be integrated to create autonomous drones that are able to perceive their environments and self-operate.

35% of all jobs in South Africa are currently at risk of total automation by robots, with machines being able to perform 75% of the activities that make up these jobs (Accenture, 2018). Of concern to MICT SETA is the anticipated 28 111 electrical and electronics jobs that may be shed. However reskilling workers to develop and utilise robots may decrease job cuts by as much as 6% by 2025. [Note from authors: we believe that the figure of 35% is at the upper extreme of jobs at risk – the South African economy is unlikely to adopt robotic automation at such a pace, especially in its current sluggish mode.]

Skills Implications of Change Drivers

The MICT SETA SSP goes on to comment that the above-mentioned change drivers call for the continued development of technologies and skills. Whilst it may be true that 4IR may invalidate jobs that place emphasis on routine or menial tasks, it also presents an opportunity for the creation and/or advancement of jobs. To this

effect, South African organisations are increasingly investing in 4IR technologies. For instance, 90% of South African companies are developing cloud computing skills and big data has grown by more than 50% since 2010, which in turn has enabled AI uptake. However, the funding, formalised training and overall development of emerging occupations is hampered by limited recognition of emerging 4IR occupations in the OFO. In general, due to the limited number of candidates possessing 4IR relevant skills or an appropriate skills base to expand from, there is increased competition amongst employers for the few relevantly skilled candidates in the sector, thus exerting further pressure to accelerate the development of skills.

Accenture proposes three key interventions to adapt to the increasing use of robotics and automation: accelerating the reskilling of workers, redirecting the workforce to areas that create new forms of value and strengthening the talent pipeline from its source. These suggestions may be adopted for other change drivers and speak to the need for increased research output, technical upskilling (especially for unskilled labourers) and collaboration amongst stakeholders. To this effect the SETA is actively engaged with stakeholders such as the QCTO (Quality Council for Trades & Occupations), training providers and industry in the development of new qualifications and improvement of existing qualifications to meet 4IR demands.

The SSP concludes the change drivers chapter by linking the Presidential Commission on the 4th Industrial Revolution to South Africa following a high skills digital path. The change drivers in the sector suggest ever increasing access (to) digital spectrum and an ever-widening choice of content for entertainment and new apps. Therefore, skills development must follow courses with specialised skills to set up and maintain new technologies. However, that has to be balanced with solving (the issue of) lower end skills. Finding a means to ensure inclusive digital revolution means paying attention to those still becoming literate in electronic technology. Knowing where to focus resources has been a challenge for the MICT SETA in the past. However, with renewed government commitment to leveraging technology for development and to the transformation of the ICT sector, additional resources are to be leveraged for skills development.

Vendor Programmes

In the third chapter the SSP notes that there is significant demand for improving or adding to ICT skills through vendor programmes. These are usually short courses offered by software and hardware companies and designed to introduce new technologies to those already in the industry. However, vendor programmes can also be longer courses that include generic skills and may be offered by TVET colleges and HEIs.

Vendor courses have the benefit of keeping up to date with rapidly changing technology. But for the same reason, these courses can quickly become obsolete if the product turns out to have a short shelf life. There is also a concern that training content is focused on the vendors' products and therefore not generic enough to educate on the underlying principles. Consequently, there has been an apparent increase in the demand for customised training solutions rather than more comprehensive off the shelf training that covers a broader range of technology solutions. At the same time, stakeholders in the sector reported that employers increasingly want employees to cross-certify with multiple vendors. Having multiple skills is lately becoming an inherent job requirement.

To respond to the persistent demands for vendor certificates, the MICT SETA is mapping these programmes, such as Microsoft, CompTIA A+ and N+ and Cisco certificates, against existing NQF qualifications.

Priority Actions

The MICT SETA SSP indicates that their first priority is the enablement of the Fourth Industrial Revolution. In response to the change brought on by 4IR, MICT SETA needs to enable the key role that the MICT sector has to play in the development of technologies and products related to 4IR. This will be achieved through the development of the skills required to research, develop, commercialise, implement and support 4IR technologies and products.

Where the relevant qualifications and training courses exist, the SETA will encourage enrolment, particularly at higher education (e.g. network engineering) and basic education (e.g. mathematics) levels.

Where qualifications and courses need to be developed, the SETA will work with relevant academic institutions, research organisations, public organisations and industry to decide on curricula, teaching methods et cetera.

In recognising and planning for occupations that are on the National List of Occupations in High Demand and linked to 4IR, this priority action fulfils NSDP (National Skills Development Plan) Outcome One which calls for identifying and increasing production of occupations in demand and Outcome Two which speaks to linking education and the workplace.

OTHER SETAS

We have reviewed each SETA's SSP to establish any references to skills relevant to the ICT job roles. Not all SETAs publish updates to their SSPs with any regularity and several fail to make the latest edition available through their web sites. This exacerbates the paucity of comprehensive and current data needed by skills development policy makers and talent managers across the board.

We do note that there is a growing tendency to mention the Fourth Industrial Revolution (4IR) in the SSPs, almost certainly driven by the Presidential focus on this through the Commission on the 4IR.

AGRISETA

The AgriSETA SSP published in June 2019 for the period 2020-2025 has only one mention relevant to ICTs. The Grains and Cereal, Sugar & Tobacco chamber list the 4IR: Technology and Mechanisation as a driver.

Specifically, they highlight:

- Ability to develop and research new innovation, technologies and analysis of large data sets
- Ability to integrate and implement new technologies and innovation in workplaces and
- Increased need for computer skills for employees at all levels

There is no further reference to quantification or interventions in respect of these skills.

BANKSETA

The BankSETA 2020-2025 SSP continues to emphasise the critical role that digitalisation and technology play as change drivers and disruptors in the sector. The SETA Finance Cluster includes the MICT SETA as a partner.

The following is an extract from the SSP on the topic of Change Drivers.

Driver: Digitalisation and Technology

Digital banking is the incorporation of new and developing technologies throughout the financial services sector to provide enhanced customer services and experiences effectively and efficiently. Digitisation in banking is driven by three major factors: technology push, customer experience and economic benefits. Customers' adaptation to the digital environment, forces banks to relook at their products and services. Digital technology is rapidly influencing the way customers engage in banking activities.

'Digital' is a collective term, which refers to an integrated and collaborative platform that allows consumers, suppliers and organisations to transact using various electronic devices or technologies. It brings together emerging technologies, which include social media, cloud, analytics and mobile to provide a cost-effective and convenient distribution channel for consumers to use.

The use of technology to better interpret the complex and evolving needs of customers so as to better engage with them is an area that the banks are expected to continue to invest in with a view to strengthening their

capabilities through smarter and deeper use of predictive data analytics and better harnessing the wealth of information that already exists within their systems.

Technological innovation is revolutionising the banking industry. There is no getting away from the fact that banks are under threat unless they can keep pace with technology. Some of these innovations are great for banks. Cloud computing, for example, can reduce costs and promote low-cost innovation. But some advances disrupt banking in a big way, like crypto-currency, which skips banks in the payment process. The four technological advances that are changing the face of banking, for better or for worse, are social media, mobile banking, cloud technology and crypto-currency.

Banks traditionally operated in silo channels, with different business areas operating independently of one another. The introduction of open banking and PSD2 will see a new way of banking emerge. It will allow the industry to innovate and enhance customer service, and help new entrants (Fintechs) to gain a share of new financial products and services. Large banks have built their technology and data around individual products and channels, and are beholden to legacy systems. To overcome this, banks must invest in technological capabilities and incorporate the right architecture to respond quickly and drive an agile culture throughout the business. In South Africa, there are reports that some banks have reduced headcount and closed some of their branches.

The data challenge becomes more daunting as data integrity increases in importance.

The 2019 Deloitte Report on Banking and Capital Markets Outlook states that some banks have completely replaced their legacy systems, while others are pursuing multi-year modernisation initiatives. Banks were asked to list the most important technology in their organisations and the results indicated that the creation of digital technology capacity came first at 28%, modernisation of legacy systems 23%, management of security, identity and privacy 18%, building the modern workplace 15% and adopt cloud services 10%.

Banks were also asked about their plans to use digital technology in the next 12
months. The digital technology themes measured were as follows:
• Platform-driven architecture through open interfaces/APIs
• Data lakes and big data platforms
• Containers, microservices, and serverless computing
• Artificial Intelligence, bots and machine learning

The implementation phases were categorised as follows:
• Fully deployed
• Trialling
• Planning
• Considering use, but no firm plans
• Not considering

The results show that all banks were trialling these digital thematic areas, followed by planning, followed by fully deployed, followed by considering the use, but no firm plans. Not a single bank was above 5% on not considering the use of these digital thematic areas.

Most Important Technology Areas to the Organisation were to: Create digital Capability; Modernize legacy systems; Manage security, identity and privacy; Build the modern workplace; and Adopt cloud services (Source: ICT Enterprise Insights 2018/19 – Financial Services & Payments: ICT Drivers and Technology Priorities of corporate banks, retail banks, payments, and financial market firms, Ovum.)

Driver: Changing Customer expectations

In his article, 'Technology: Hunting the Big Four' (2019), Mike Brown argues that the global banking industry is evolving in response to economic pressures, digital innovation and – most importantly – the changing way their customers use banking and financial services.

Today's connected consumers have embraced technology to such an extent that it has become an extension of them. Influence of mobile technology, social media, rising customer experience and service expectations, and lower switching costs for customers to take their business elsewhere, have dramatically changed the competitive landscape for banks.

With ready access to information, the influence of online retail experiences and adoption of new technologies, customer expectations are rapidly changing. This is driving a shift in the market and forcing organisations to develop new interaction models that deliver deeper personalised service and improved customer care.

Banks need to put the customer at the heart of the design process and take new products to market quickly. They also need to be more attuned to their customers' needs – determine how they can better engage with their clients, know the products they want and predict what's needed rather than wait and react. This means embracing social media, giving customers more ways to interact with the business, rethinking traditional marketing tactics and mastering analytics. Tech-savvy customers are increasingly seeking a user experience that aligns to their individual needs.

Central to a bank's success in the digital economy is, therefore, the data they accumulate about customers and intelligent ways of processing it. Data is only useful if banks can use it effectively. Banks must ensure they have easily accessible, high-quality data. It is not about the volume of data but the application that will make banks successful. By gathering meaningful insights, they can create audience segmentation and deliver innovative, customised products in a way that appeals to customers. Banks need to reach a point where they understand the needs of the customer, without taking any direct feedback.

Driver: Disruptors in Banking

Mark Brown revealed that new competitors in the banking sector have generally begun by targeting niche markets. More recently, competition has evolved from traditional competitors to Fintech disruptors to "big tech" disruptors. These disruptors are revolutionising the banking experience for clients and, if traditional players do not respond, they will continue to capture more of the banking value chain. Many Fintech players have found it difficult to scale up and are increasingly partnering with traditional banks. But "big tech" disruptors have both the financial muscle and ability to grow, presenting a greater threat to traditional banks that do not embrace change and innovation.

The 2019 Banking and Financial Outlook highlighted the following seven key disruptors in banking and alternative banking sector:

- Unprecedented Change and Opportunity
- Technology is everywhere
- Tsunami of data
- Diversity and generational change
- AI, Cognitive Computing, Robotics
- Jobs vulnerable to automation
- Explosion in contingent work, Change in nature of a career

(Source: Bersin, Deloitte Consulting LLP, 2018)

Skills Planning

The BankSETA SSP goes on to note the implications for skills planning, highlighting the demand for top-level skills in computing technology and the need for policy to support the development of appropriate and accredited short courses and for a new suitable digitalisation tertiary degree. Policy also needs to recognise the inclusion of women.

The following (ICT) roles are highlighted:
- Analysts
- IT systems architects
- Software developers
- Network specialists
- Data scientists and Data engineers
- Robotics engineers and technicians

The SSP also recognises the for appropriate skills to meet the demands of regulatory and compliance frameworks, including Chief Cyber Security Officers and other occupations in Cyber Security. Effective management and leadership also requires Chief Digital Officers and Chief Technology Officers.

Hard-to-Fill-Vacancies (HTFVs)

In tabulating the list of HTFVs, BankSETA's causes show that lack of relevant experience and lack of relevant qualifications are common to all categories. The following ICT roles are included in the list:

- Developer Programmer
- ICT Systems Analyst
- Software Developer
- Data Management Manager
- ICT Security Specialist
- Programmer Analyst

The SSP notes that information technology-related vacancies comprise 20% of the HTFVs and this is a slight decline compared to 25% reported in the 2019/2020 SSP. This slight improvement may be attributed to the interventions introduced as a response to the demands of the 4IR. Again, as the very nature of IT is project orientated, the demand is entirely dependent on the availability of projects.

The Education System

The BankSETA SSP puts forward the following comment on the South African education system, as the pipeline for skills required in industry.

The South African education system has not succeeded in creating a workforce with a high knowledge base as is evident in the graduate data available as provided by the Labour Market Intelligence Project (2018). The data provides an astounding indication that for every one hundred learners who enter the schooling system, only thirty-seven pass matric and only four finally leave with a full complete university degree. A further examination indicates that when these individuals enter the skills supply pool, of a hundred job seekers, only 4 will hold a complete degree, thirty-three will hold a matric certificate and sixty-three will hold some form of schooling. Within the banking environment, where technology is driving employment patterns, these statistics are of serious concern as the sector seeks to employ high-skilled individuals. This is evident from the types of occupations that are in high demand as discussed in the previous section.

The basic education stream is quite significant as it provides throughput for all post-school education and training streams. School performance in Mathematics, Physical Science and Technology impacts the pipeline feeder for university studies in degrees for careers linked to banking. Poor performance in Mathematics, which is key for employment in the banking sector, has been a cause for concern. As a starting point, the low percentage of 30% required for a pass mark is too low for learners to succeed in studying for a career in banking or information technology or any of the other occupations within the sector. 2019 data from the Basic Education Department indicates that there has also been a decline in enrolments for mathematics in 2018 as compared to 2016/2017.

The Department of Basic Education hopes that with the establishment of the new Directorate for Mathematics, Science and Technology there will be some improvement in learner participation and outcomes for mathematics. In respect of the overall pass rate, observers have expressed concern about the lowering of standards, i.e. the 30 percent pass mark. Observers have argued that the higher pass rate can possibly be linked to the lowered passing standards. Furthermore, it has been argued that learners are not adequately prepared for tertiary education and the labour market, and this often leads to some of them dropping out or lower graduate rates.

The majority of the TVET colleges have limited capacity to develop ICT skills required by banking and alternative banking (i.e. finance companies and services which offer more flexible options than traditional financial institutions) – while some institutions offer computer courses these are largely at National Certificate Vocational (NCV) level and very few offer information technology programmes at National Accredited Technical Education Diploma (NATED) level. There is a high failure rate for learners who enrol for the NCV computer skills programme.

Due to lack of lecturers, computer laboratories and the high failure rate (as much as 75%) some institutions have discontinued the NCV computer skills programme.

Digitalisation, technology and innovation are having a major impact on the banking sector and the future skills needs. The shift to incorporating digitisation and technology into product development and banking systems and processes will need a different type of skills set.

The BANKSETA notes that it should consider piloting digital literacy in schools.

Cybercrime has grown exponentially as a risk to banks and there is an increased demand for cyber-security skills.

The reported occupational shortages have largely been attributed to the low standard of education, in particular, the Mathematics, Physics and Information Technology subjects, which are required for entry into a majority of positions in the banking industry.

Imported skills also provide an indication of occupational shortages at the local level. From the list provided, a large number of IT Skills are imported.

- The occupational shortages and PIVOTAL programmes relate to the following top occupations:
  - Developer Programmer
  - Database Designer and Administrator
  - Computer Network and Systems Engineer
  - ICT Systems Analyst

CATHSSETA
The CATHSSETA SSP was compiled for the Culture, Arts, Tourism, Hospitality & Sports sectors in 2019 for the 2020/21-2024/25 period. It includes a significant commentary on the impact of the 4IR, as follows.

The convergence of the various technologies and the subsequent interconnectedness has ushered in the Fourth Industrial Revolution. Most industrial sectors in the public and private domain are gearing themselves in preparation for 4IR. Current industrial activities are dominated by automation, robotics, interconnectedness, the Internet of Things, machine to machine communication, 5G and artificial intelligence to mention a few. Information and communications technology (ICT) is a major driver in conducting business and a critical factor for all sectors and industries in this 4IR.

In a South African context, skills challenges are a combination of simple low-end to complex high-end skills. South Africa has an opportunity to address all while bringing low end skills on board the 4IR. Indications are that the 4IR requires high-end skills in data management and computer programming and would drive a reduction in low skilled jobs or repetitive tasks. Technology is transforming CATHS sector operations; thus, constant reskilling of employees is required to keep abreast with the new technologies that cut across all subsectors. An example of this within the gaming industry is the increase in online betting which has led to operators widening their offerings and attracting new types of customers.

In the tourism and hospitality sub sectors for instance, technological advances have resulted in the use of electronic tourist passes, global IT booking systems, accommodation booking sites and applications, food hygiene control systems for hotels and restaurants, the equipment and systems to improve accessibility for people with disabilities. The travel and tourism industry has seen the use of remote access technology for tourist guides to easily access information on key points of interest, and the use of remote listening devices that tourist guides used to guide visitors.

In the hospitality sector, hotels are experiencing a sharp increase in web-based bookings. The first implication of this is that established hotel companies are facing relentless competition from facilities that cannot be regulated, particularly for leisure travellers. The impact of the Fourth Industrial Revolution on the CATHSSETA sector, and its related skills implications, requires a deliberate intervention as part of the research agenda.

The sport, recreation and fitness subsector has also become more technologically driven, with advances in gym equipment, fitness and health mobile applications, electronic media and the manner in which sports events are covered. Wearable technology is becoming ingrained in professional sports, allowing adverse metrics to be taken into account and utilised within training and allowing for real time decisions. The use of virtual fitness instructors within the recreation field will likely see a decrease in the use of fitness instructors and fitness facilities. The implication of these technological advancements in the sport, recreation and fitness subsector is the need for new skill sets for traditional occupations. The type and level of skill required is starting to change.

In the conservation subsector, curators and conservation biologists require innovative solutions for information management. As a result, there is a growing demand for cross-cutting transdisciplinary skills. This calls for tailored professional development programmes and information and communication technology strategies and plans to support the traditional higher education curricula, which should also offer programmes of specialisation at postgraduate level. According to an article published by EE Publishers, drones are rapidly changing the face of the conservation industry. They have the potential to revolutionise conservation and spatial technology. The report emphasise is that at the core of conservation is the monitoring of species populations and their habitats.

In the arts, culture and heritage industry there is a move towards increased use of digital communication in editing and post-production tasks, which will likely impact the human resources required. The impact of music and film streaming, YouTube channels and the emergence of apps has threatened the sustainability of the music industry.

Optimistic predictions, based on trends already measured, suggest that the next three years will see half a million more jobs created than those lost. As the global economy moves towards the widespread adoption of artificial intelligence solutions, competition will grow for employees who have the skills to implement, manage and work

alongside the new technology. What is certain is that the future workforce will need to align its skill set to keep up with the pace of the Fourth Industrial Revolution.

CATHSSETA includes the following ICT-related roles in its list of emerging occupations:

- AV 3-D technicians
- Application development practitioners
- Multimedia specialists
- CIO
- Application development manager
- Data analyst
- Website designer

The SSP repeats the prediction that future skills planning must accommodate high demand for computing technology, software development, artificial intelligence and robotics.

CETA

The CETA SSP, published in August 2020 for 2021/22-2025/26 includes the following paragraphs under the heading of technology and innovation, bearing in mind it was compiled in the early months of the coronavirus lockdown period.

For the better part of five months, communication, globally, has relied almost exclusively on technology (Zoom, Facebook, Skype, et cetera). Whilst not all CETA work lends itself to remote performance, there are large swathes of the mandate that can be performed more effectively with less travelling and social contact. There are several computer-based project management applications that allow for regular reporting, monitoring, quality management and oversight. A large chunk of the CETA's work is essentially project delivery. As a strategic response to the current crisis and in an endeavour to enhance efficiency and save costs, the CETA might want to explore the viability of increased deployment of technology in its workings and operations. Outside of the CETA, the sector is increasingly going digital and these innovations need to be invested in and supported and skills would inevitably be required to bring these innovations into practise.

Examples of such change and innovation consist of the emerging technologies such as the fourth industrial revolution, 3D printing of prefabricated walls, artificial intelligence, machine learning and advanced data analytics. These technological drivers are expected to shape the future skills demand in the construction sector, but not in the immediate term, where South African building techniques are expected to remain traditional, with the dominance of bricks and mortar and steel frame methodologies. However, foresight and early investment in the future is critical. After all, the process of producing skills is not instantaneous, instead it calls for advanced planning.

CHIETA

The latest available CHIETA SSP is the update published in August 2020 for 2021-2022. The section on technological development and innovation is a slight modification of its 2018 update:

The 4IR is ushering in a digital revolution, characterised by a fusion of technologies that is blurring the lines between the physical, digital and biological spheres. Some of the critical breakthroughs will be in various fields, such as artificial intelligence, robotics, the Internet of Things, autonomous vehicles, 3D

printing, nanotechnology, biotechnology, materials science, energy storage, and quantum computing (Schwab, 2016). Advanced technology is extremely important in the Chemicals Industry, and continuous improvement, breakthrough and development in technology are the key rudiments of the industry. New technological developments usually require the skills of current staff members to be upskilled or new people with the relevant skills have to be recruited (these skills may not always be readily available). It is, however, not clear whether the chemical manufacturing industry is ready to embrace this revolution. It is against this backdrop that CHIETA commissioned a study to assess the state of readiness among chemical manufacturing companies to operate in the 4IR. The study draws attention to the diversity of subsectors, their knowledge of the 4IR, their level of preparedness and their skills requirements (Quest Research Services, 2020).

There are no further references to ICT skills in the CHIETA SSP update.

EDTP SETA

The latest available EDTP SETA SSP is the update published in August 2018 for 2019-2020.

Commenting on the supply and professionalisation of the ETD workforce, the SSP states that mathematics, science and technology have proven to be fundamental in influencing any country's economy direction and notes the fact that South Africa ranks among the lowest performing countries in terms of mathematics and science achievement. This has long term impact in that it results in a low number and quality of teachers produced by the system.

The SSP goes on to comment on the 4th industrial revolution. It says the influence and use of technology across educational institutions impacts on both the teachers and learners ability to teach and learn. In particular eLearning, multimedia ,social media and technological devices can enhance teaching and learning situations. There is a need for skills development interventions which are tailored to suit the needs of the staff in the context of teaching and learning through technology.

EWSETA

There is no mention of ICT skills in the Energy & Water SETA SSP, published in 2018 for 2019/20.

FASSET

The Finance and Accounting Services SETA (FASSET) SSP update for 2021/22, published in August 2020, follows the example of the BankSETA in highlighting the contribution of ICT skills. These are the extracts from the SSP:

TECHNOLOGY AND FOURTH INDUSTRIAL REVOLUTION (4IR)

Following the pandemic, the FAS sector will have to invest in seamless organisational structures and increased technological connectivity to enable business continuity. Many personnel across sub-sectors are not able to adapt to working from home, due to lack of tech savviness and poor communication skills, which is more evident through virtual and online platforms. This made client interactions difficult and slowed down business. The onus is on organisations to prepare personnel to be flexible and adaptable, particularly in the advent of the 4IR. In addition, the sector must adopt digital communication strategies, re-skill and upskill personnel, equip management with crisis management skills, and normalise virtual interaction such as Zoom, Skype and Microsoft Teams. Business in the sector will suffer without this adjustment. Client's portfolios and investments still need

to be managed, securely and with confidence, more so during a disrupted financial market. The accountancy profession will evolve significantly due to automation, artificial intelligence (AI), the Internet of Things (IoT), blockchain and cloud computing (Jooste, 2019). The spread of digital technologies and its impact on business will transform the practise of accounting and the competencies that professional accountants require. The full integration of technology and 4IR systems will lessen human intervention over time for the financial and accounting services industries (Jooste, 2019).

Technology and 4IR

- Workers need to be virtually competent, and industry must undergo digital transformation.
- Financial technology will cause a dramatic evolution throughout the industry and will require the development of new skills sets for existing occupations and newer or future occupations.
- Data security is becoming crucial, all businesses have to introduce additional measures and controls to safeguard data security and hedge against cyber-crime and risk of data fraud.
- Automation of workflow and processes calls for upskilling of back-office support and a reduction in staff headcount.
- Auditors with high-level ICT competencies will grow to be valued in the sector.
- Auditors will have to embrace the advanced technologies helping them obtain both structured and unstructured data from clients.
- Investment analysts and stockbrokers will need more than just the fundamental and technical analysis skills but also digital technology skills.
- Accountants' roles are shifting from interpreting historical and transactional information to a more strategic advisory role.
- Future accountants will increasingly need education in digital technology (including cloud computing and use of big data), and integrated reporting regulation.

The SSP update includes the following table of hard-to-fill-vacancies (HTFVs) in the iCT Professionals group:

Rank	FASSET Occupation Group	OFO Code	Occupation	Needed	Reasons
1	ICT Professionals	121905	Programme or Project Manager	15	Pool of sufficiently qualified and experienced candidates is very small in the local market
		133103	Data Management Manager	6	The Financial Sector Conduct Authority (FSCA) requires a new skill and expertise to address its expanded mandate
		133105	Information Technology Manager	8	Geographical; not enough African Black; lack of experienced and qualified candidates
		243403	Computer Consultant	2 028	Limited number of individuals with experience in required systems and complex payrolls; lack of EE candidates
		251101	ICT Systems Analyst	38	Absolute scarcity; lack of EE candidates; lack of financial services experience
		251201	Software Developer	102	Lack of specialised experience within FAS; inexperienced SQL Developers; remuneration; difficult to retain and attract
		251202	Programmer Analyst	2 073	Lack of required qualifications in sector; scarcity of EE candidates with relevant experience (15+ years exp required); extensive architectural implementation experience needed which graduates lack
		251203	Developer Programmer	41	Lack of relevant qualifications and experience
		251401	Applications Programmer	5	Shortage of developers in market; inexperienced SQL Testers; EE lack
		252101	Database Designer and Administrator	2 072	Lack of EE candidates; lack of exceptional mathematical and creative abilities; inadequate number of graduates with necessary Engineering/Business Mathematics/Informatics skills; not enough specialists in SA, new industry
		252301	Computer Network and Systems Engineer	28	Not enough specialists in SA; limited number of people with certifications
		252901	ICT Security Specialist	65	Lack of suitable candidates with required experience and qualifications, affordability
		214101	Industrial Engineer	6	Relative scarcity; lack of experience
	Total needed			6 487	

There is an interesting disparity between the three occupations with more than 2 000 vacancies and the others with small numbers. It is worth noting that the lack of EE candidates is common to the three. FASSET has planned interventions to address some of these gaps at relevant NQF levels. These include bursaries, learnerships and bridging programmes relevant to ICT Systems Analysts, Database Administrators and Software Designers.

FOODBEV

The FoodBev SETA's latest available SSP update was published in 2018 for the period 2019-2020 and includes the following comment on Technology.

A 2018 prediction (in *Food Engineering*) is that automation and robotics will rapidly be adopted by the food and beverage manufacturing sector. The sector's manufacturing plants are increasingly moving toward automation to reduce human error and increase productivity. This direction taken by the sector confirms the transition of business from the 3rd to the 4th industrial revolution. The 3rd and 4th revolutions highlight technology and electronics as key change drivers for automation of production. However, the distinction between the 3rd and 4th revolutions is the pace of change, i.e. breakthroughs are happening at a rate unprecedented in history and industries are being transformed at an accelerated speed. The drive for automation increases the level of complexity associated with such technology and the need for operators or low-level skills that currently operate machines will become redundant. Stakeholders highlighted the need for highly skilled employees and training of current staff to operate new or upgraded machines. However, in subsectors like poultry the level of automation is not as pronounced, and it is still labour intensive.

Virtual reality (VR) is the method or techniques used to simulate the feeling or experience of being inside simulated or artificial environments which are usually generated by computer or machine. VR can be effective and efficient with regards to the delivery of training for the employed and unemployed learners in the food and beverages manufacturing sector. It is envisaged that the current methods of implementing training will soon be replaced by VR based type of training. Developed countries are already using VR as means of delivering training. Careers linked to VR include occupations such as VR specialist / VR consultant, systems analyst, programmer / software developer, trainer / lecturer / facilitator. Those responsible for providing training in the sector may have to be trained on soft skills to enable them to use VR effectively.

Other skills implications for increased automation are, firstly, the need to upgrade the skills of operators who need to operate complex machinery. Secondly, the need for instrumentation control and automation capability skills amongst artisans is necessary. Finally, skills in laboratory analysis need to be developed in order to adhere to regulations associated with technological advancements.

FP&M SETA

As with many other sectors, the Fibre Processing and Manufacturing SETA acknowledges the impact of technologies as drivers of change in its 2018-2022 SSP (FP&M SETA, 2018). The following is extracted from that document (and is unchanged from our 2019 report):

Drivers of change

Rapidly advancing technology and innovation has had profound impact on certain FP&M sub-sectors. There are new technologies being developed in textiles, clothing and new natural fibres are being explored. Existing technology used throughout the sector in manufacturing companies in packaging, printing and print media, paper and pulp, textiles, clothing are now designed to operate faster and more efficiently. Training on new machinery and maintenance is often sourced internationally. Increased mechanisation may reduce the demand for labour.

At the same time, technological changes are the biggest drivers of demand for skills, as workers have to continuously upgrade their skills to keep up. Electronic media usage has expanded and is expected to change the face of the printing and publishing sub-sectors. Social media provides an additional source of valuable consumer data. Both national (IPAP and NDP) and sector-based industrial strategies are driving technological advancement and innovation through customised sector programmes and other initiatives.

Factors Impacting on Skills Demand and Supply: Technological Advancement and Innovation

Innovation results in change and change almost invariably has a structural component. Regardless of their size, companies in the manufacturing industry face many of the same challenges – increased competition within their sector, evolving managerial and technical skills and workplace cultures, and a greater need to become more responsive to fast changing markets. To overcome these challenges, manufacturing companies must find effective solutions that allow them to proactively manage changes in their competitive landscape while keeping Research and Development (R&D) costs at a minimum. Productivity technology and public-sector policy on R&D investments have been, and will continue to be, major determinants of comparative advantage and competitive position.

Technological developments do not have a uniform effect on the demand for labour. On the one hand, the mechanisation and computerisation of processes may reduce the demand for labour. While, at the same time, technological changes are the biggest drivers of demand for skills in the sub-sector and all levels of workers have to continuously upgrade their skills if they are to keep up with technological changes. The use of electronic media is increasing at a rapid rate and is expected to change the face of the printing and publishing sub-sectors locally and internationally. Paper products used for communication purposes, such as newspapers, are under threat from digital technologies and have dropped substantially over the past few years. Existing technology in large manufacturing companies in packaging, printing and print media, paper and pulp, textiles, clothing, for example, are designed to operate faster and more efficiently. Through the development of automation, robotics, and advanced manufacturing, the global manufacturing sector has bounced back along with the overall economy."

In spite of the foregoing commentary, only one ICT occupation is included in the hard to fill vacancies in the FP&M sector:

2015-216603 Multimedia Designer (90) Technological improvement.

Skills Gaps in the Sector

Skills gaps refer to areas within an occupation where a worker is not fully competent to perform a particular task. These can include cognitive skills, such as problem solving, language and literacy skills. These "top-up" skills can be specific to a particular occupation resulting in skills gaps, which might arise because of phenomena such as improved technologies or new forms of work organisation.

All FP&M SETA sub-sectors report investments in new technology and training new staff to use such technology is therefore a key critical skills driver for the sector. Similarly, managers are required to lead the sub-sector in new business directions, to achieve the required industrial restructuring. Managers are therefore also an important focus for critical skills development.

Many sub-sectors are competing in a global arena currently, and improved labour productivity is becoming an increasing priority. This too is a major critical skills driver. Included in the prevalent skills gaps that exist across all the major groups in the FP&M sector are:

- Clerical Support Workers Information Technology expertise
- Service and Sales Workers Information Technology expertise

One of the biggest challenges with regards to skills gaps is the increased utilisation of latest technologies in the sector. Often new machinery requires technicians to be retrained in countries like Germany or Sweden where such machines are produced. That means technology related expertise is a major skills gap. Moreover, where local expertise exists for servicing or repair of machinery, often this is limited to major cities and towns, leaving the small towns where industry is located not having qualified technicians capable of working on the new machines.

There are people in the sector who are losing jobs due to the introduction of new technologies. That also creates a requirement for retraining staff to use the new technology and retooling others to be redeployed elsewhere.

HWSETA

The Health & Welfare SETA published an update in August 2020 for 2021-2022 and included the following comments on technological change:

New technologies have a profound effect on the sector. In some instances, it allows for the automation of processes, which leads to a reduction in employment. Simultaneously, technological developments also have a constant effect on treatment methodologies and interventions. Studies have shown that the 4IR requires changes in the skills requirements for certain occupations in the health sector. This creates opportunities for inclusion of technology modules in certain undergraduate curricula and the up-skilling of the current workforce through tailored skills development training courses.

Medical staff need training in computer skills and the use of new computerised information systems. IT staff need training in medical terminology and health-related information in order to set up and maintain computerised information systems.

INSETA

In similar fashion to its "sister" sectors in banking and finance, the insurance SETA's 2020-2025 SSP discusses the influence of technology in some depth, as follows:

Technology is disrupting the insurance sector. This disruption is referred to as the 4th Industrial revolution and involves the increasing use of artificial intelligence, robotics, big data, digitisation, digital marketing, blockchain, predictive analytics and machine learning. There are desirable career opportunities for graduates who can work in these technology areas in the insurance sector.

The Top 10 occupations on the Sectoral Priority Occupations List are insurance agent; insurance broker; actuary; **data analyst**; insurance loss adjustor; financial investment advisor; fraud examiner; **developer programmer; ICT security specialist**; and organisational risk manager.

There was a 31% growth of technicians in the insurance sector. Technicians are broadly representative of IT professionals in the sector. As the sector adopts digital platforms, social media marketing channels, AI and informatics, there is a demand for IT professionals such as software developers, systems analysts, cloud specialists, IT technicians, database administrators and network professionals.

The INSETA recognition of ICT change drivers is encapsulated in these tables:

2.2 KEY CHANGE DRIVERS

The following have been identified as key change drivers in the sector:

CHANGE DRIVERS	IMPLICATIONS FOR SKILLS DEVELOPMENT
TECHNOLOGY	

■ Technology is disrupting insurance companies. This disruption is referred to as the 4th industrial revolution (4.0) and involves the application of artificial intelligence, robotics, big data, digitisation, digital marketing, blockchain, predictive analytics and machine learning.
■ Clients wants seamless, quick and transparent interactions, and this requires a new kind of marketer (salesperson) that it is tech-savvy.
■ 4.0 presents opportunities for first-time entrants into the insurance sector to acquire in-demand skills and pursue non-traditional career paths.
■ Companies need to offer faster and cheaper products; create online tools to "sweat" their distribution channels; develop digital portals, customer self-service and automation of back-end processes.
■ Online social networking has emerged as an active component of social interaction. Financial institutions are looking to gain a competitive advantage while also trying to mitigate the threats posed by social media. Many companies are now using social media to revolutionise the traditional business models.
■ Financial technology companies (FINTECHs) are start-ups trying to disintermediate incumbent economic systems and challenge traditional corporations. The FinTech market is booming and captured over US$12 billion investments since 2015. New start-ups are popping up at an increasing pace, and large banks and insurance companies are being pushed toward increasing digital operations to survive.
	■ There are attractive career opportunities for graduates who can work in technology areas such as cyber-security, blockchain, AI, predictive analysis, social media, digital marketing, open-source and machine learning.
	■ The critical success factors for insurance companies are developing workforce skills that can:
	  • use "big data" to manage client relationships, design new insurance products, and reach new markets.
	  • find the right "young" talent.
	  • give clients a superior relationship experience.
	  • create innovative products.
	  • digitise business operations.
	  • attend to cyber-security risks.

CHANGE DRIVERS	IMPLICATIONS FOR SKILLS DEVELOPMENT
FUTURE WORK	
■ Insurers find it challenging to hire specialist IT experts, data scientists and actuarial talent. ■ Robotic process automation and artificial intelligence that can automate manual tasks are rapidly infiltrating the sector, remaking or eliminating jobs that are labour intensive. ■ The time and attention of actuaries, underwriters, claims adjusters and other key players will likely be freed up for higher-level tasks. ■ Employees should ultimately be spending more time on ideation and decision making—and far less on computation and distillation. ■ Insurers are also putting plans in place to respond to broader, fundamental employment shifts as more professionals join the open talent economy—a blend of full- and part-time workers, short-term contractors, and freelancers.	■ Insurers will likely be challenged to retrain and repurpose workers impacted by tech upgrades to make more productive use of their time and talent. ■ Most insurers are analysing jobs, determining which capabilities should be automated, and establishing what new skill sets may be required to maximise the value employees can bring in the wake of automation. ■ This requires the development of new qualifications in the sector.

LGSETA

The Local Government SETA's SSP published in January 2020 for the period 2020/21-2024/25 was compiled before the arrival of the pandemic. The SSP refers to Technological Change and Digitisation as follows:

Technology is a ubiquitous driver of change in almost every facet of the economy. In local government, the adoption of new technologies has varied across municipalities. The bigger metros have introduced new technologies in the delivery of municipal services in areas such as water and electricity metering. Apart from customer interfaces, the role of technology in modern municipal infrastructure is likely to gain importance as aging equipment gets upgraded and replaced. Another aspect to consider with regard to technology is the Fourth Industrial Revolution (4IR). The 4IR alters the way communities live and work through a fusion of technologies, blurring the lines between the physical, digital and biological spheres. Key areas of the 4IR include, but are not limited to, virtual reality, robotics, big data analytics and cloud computing. The 4IR will result in new roles being assigned, which will require new, higher-level skills and knowledge. People will therefore need to be upskilled to fill any gaps created by the 4IR. Key occupations identified as critical for the 4IR with regard to the Local Government Sector include, data analysts, cyber security specialists, drone engineers, virtual meeting specialists and software programmers.

MERSETA

The SETA for Manufacturing, Engineering and Related Services published its 2021/2022 SSP update in August 2020. The SSP has a more muted comment on the impact of the 4IR than previously:

In the Fourth Industrial Revolution (4IR), steel and metals manufacturers have an opportunity to transform their operational model by implementing digital technology, to improve operational efficiency, customer service, inventory levels and profit margins (World Economic Forum, 2019).

Economic pressures and emerging technologies have placed pressure on organisations and workers in terms of skills, requiring updated curricula and an increase in worker flexibility. From a skills development perspective the implications are that the propagation of the 4IR could undermine inclusive growth due to negative growth, high unemployment and scarcity of relevant high-tech skills. Lower-skilled workers will become more vulnerable, requiring re-skilling or up-skilling to stay relevant.

Therefore, in order for the government to create jobs, the integration of new technologies such as artificial intelligence should be introduced, while preparing the existing workforce for the type of work which will be required in an automated economy (Mabasa, 2019).

From a skills development perspective the sector will have to keep pace with rapid advances in technologies such as AI, robotics and big data. In addition, new technologies require significant research and development which can be costly as this will require the skilling and re-skilling of the country's labour force, as well as investigating new manufacturing potential to ensure a smooth transition. South Africa also continues to face stiff competition from low wage, high-productivity countries in vehicle production. Supportive policies and regulations, incentives and boosting investor confidence will remain key in ensuring that South Africa remains an attractive investment for the automotive sector.

The SSP went on to list emerging occupations and skills challenges, including these ICT-related roles:

- Software and applications developers and analysts (Analytical thinking and innovation)
- Data analysts and scientists (Complex problem-solving)
- Data analysts and scientists (Big data analytics, block chain development, AI, software)
- Robotic engineers
- Software engineers and coders
- Block chain, cyber security, AI specialists, forensic investigators, app developers

MQA

The mining and minerals sector (MMS) published its SSP in August 2019 for the period 2020-2025. They, too, bring the 4IR into their commentary on the changing technological landscape.

The fourth industrial revolution is described as a world where individuals move between digital domains and offline reality with the use of connected technology to enable and manage their lives (Miller, 2015). It integrates cyber-physical systems and the "Internet of Things", big data and cloud computing, robotics, artificial intelligence-based systems and additive manufacturing (MCSA, 2019). This digital revolution does not only impact the mining sector, but its effects are evident across all sectors globally and nationally.

In the MMS, key informants reported that South Africa's mining industry are slower adopters of technology compared to other countries such as Australia and Canada. South Africa lags behind in terms of the fourth industrial revolution as mines are said to be less digitised than those in many other regions as a higher proportion of its operations are underground, and thus, technology ramp-up will be more challenging to be undertaken.

According to the Deloitte 2018 Tracking the Trends Global Mining Study, the mining industry's success will be determined by the border of analytics and artificial intelligence (AI) which will be used to leverage data generated to sharpen planning and decision-making across the mining value chain. This will also be accompanied by the digitalisation of mining supply chains and, driving sustainable shared social outcomes where mining

organisations will become interdependent of other sectors and judged based on their relationships with their employees, investors, regulators as well as their impact on society at large.

Furthermore, the implementation of sophisticated technologies is transforming the sector's operations in terms of the type, level and mix of skills required, thus starting to transform occupations such as rock drill operator, blaster, drill rig operator as well as most of the artisan trades. Upskilling and reskilling programmes are needed so that employees are trained in new mining processes that will extend the lifespans of mines and to also ensure the smooth transition to embracing the fourth industrial revolution and to meet new digital demands (Moodley, 2019). As mining becomes more automated, physical strength and stamina will become less important than fine motor skills, dexterity and problem solving – all of which are more easily acquired by new entrants to the workforce will generate opportunities to attract more females and therefore, redress gender inequalities in the sector.

Key informants also emphasised the need to place focus on integrating technology in AET (adult education and training) programmes up to level 4. This is more particularly imperative for uneducated employees as a way of improving literacy, technological and numeracy levels to prepare them to operate new machinery and coordinate new processes that emerge with the introduction of the fourth industrial revolution. At a supply level, the integration of technology can be incorporated in the curriculum of Higher Education and Training (HET) institutions as a delivery mechanism, as a complement to instruction, and as an instructional tool for training novice employees in the sector.

The diagram on the next page indicates how automation and new technologies will impact skills demand and supply in the MMS:

The workforce coming into the industry currently (Millennials) are all digital natives. In their personal lives they require rapid measures to function menial tasks and want to spend more time focusing on experiences. This doesn't translate into the workspace in mining presently. Key informants asserted that the sector has not fully embraced the fourth industrial revolution-especially those in deep level mining. There is a significant gap between companies that have fully embraced technology compared to those who are running conventional operations. As a result, some millennials find it challenging to be attracted to the sector. Those that do get absorbed in the sector find it challenging to adapt to conventional modes of operations. As a result, the sector loses talent to other industries that can accommodate their needs. The MMS also needs to rebrand its image to increase its attraction among the millennial talents. This could be done by embracing the fourth industrial revolution notwithstanding the cost implications for digitally revolutionising production. Mining companies must consider not only the shifting nature of work, but how to attract a new variety of workers and tailor their workplaces accordingly. This will also lead to the retention of those that are already absorbed.

On the other hand, as the typical workplace progresses towards keeping up with sprouting technological trends, there are expectations for older employees to adjust to these developments. Skills development programmes will need to educate existing workforce about the new world of work, through innovative training; re-training/ re-skilling important for smooth transition for new types of tasks. Moreover, considering that many older employees are employed in managerial positions, there will be a need for the old to mentor the young in managerial skills as they will be the next wave if management once the old employees retire. This will ensure that the sector retains skills and has enough skills for future generations.

Figure 2-1: Projected implications of technology on skills development in the MMS
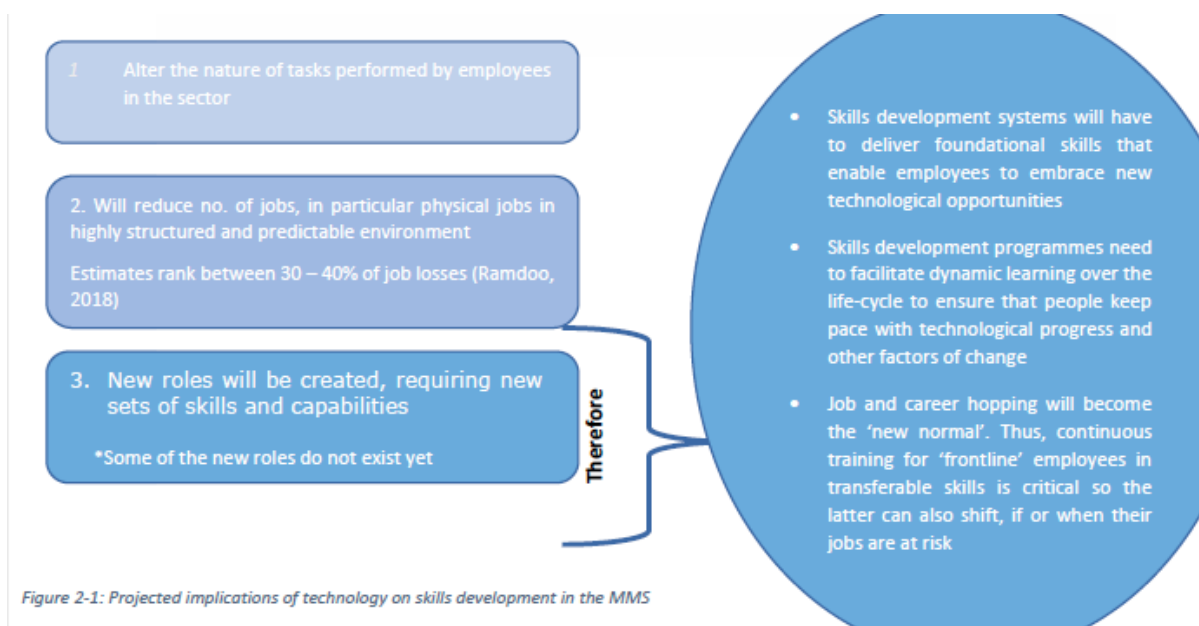
PSETA

The Public Service Seta published its SSP update in July 2019 for 2020-2021. It brings the 4IR into the discussion.

The emergence of the Fourth Industrial Revolution (4IR) has a profound effect on the Public Service Sector and has been identified in this SSP as a key change driver which is impacting on skills demand and supply in the sector.

Information and Communications Technology (ICT) advances impact on the nature of work profoundly by shaping the types of skills required, and the modes of service delivery in the Public Service. The 4IR has enhanced digitalisation, big data, artificial intelligence, online platforms, and the Internet of Things which are some of the major drivers of skills change in the Public Service. The 4IR provides the opportunity for greater government efficiency and effectiveness in providing services to its citizens. The digitisation of the Public Service Sector through e-government forms part of the move towards improved ICT systems within the sector.

Factors Affecting Skills Demand and Supply

Understanding the major factors impacting on skills demand and supply in the Public Service Sector provides an opportunity to better analyse why skills shortages exist. The major factors impacting skills demand (in terms of the number and type of skills demanded) in the South African Public Service Sector are described below.

The Fourth Industrial Revolution and Technology

The Fourth Industrial Revolution (4IR) advances impact the nature of work profoundly by shaping the types of skills required, and the modes of service delivery in the Public Service. The National e-Strategy Digital Society South Africa sets the foundation for advancing digital technologies which encompass the 4IR and other emerging technologies as follows:

a. The 4IR and ICT have enhanced digitalisation, big data, artificial intelligence, online platforms, and the Internet of Things, which are some of the major drivers of skills change in the Public Service. The 4IR provides the opportunity for greater government efficiency and effectiveness in providing services to its citizens. The digitisation of the Public Service Sector through e-government forms part of the move towards improved ICT systems within the sector.

b. South Africa's e-government strategy provides the policy framework for incorporating ICT as a key enabler in modernising government services and improving accessibility and convenience. Examples of e-government services in the Public Service include e-filing, e-health, e-education, e-commerce, and eNatis (an online vehicle and transport management system implemented by the Department of Transport). Other examples include the recent launch by the DPSA of e-recruitment, with the aim of introducing a paperless administration across the Public Service.

c. It is expected that robotics, in combination with the Internet of Things, could lead to more effective, leaner and cost-efficient governments in the not-so-distant future. The NDP recognises the access to and application of ICT as key enablers in fighting poverty in the country.

d. While the sector has progressively moved toward implementing ICT across its systems and processes and the government's e-strategy has progressed in its implementation, evidence still points to a lack of adequate skills to develop e-government services and solutions. A PSETA study conducted by the HSRC in 2018 found that most government departments do not currently have the human and physical resources to optimise the role of ICT in the Public Service Sector.

The 4IR and Technology

• The increasing emergence of ICT in the Public Service Sector is coupled with the need for new tools, systems, platforms and the related skills required to operate them. The introduction of new technologies may require the Public Service to expand its personnel complement (especially in terms of technical support roles) and enhance training and education of current staff, with a need for ongoing re-skilling and/or up-skilling.

• ICT requires employees to be skilled in technology-related skills, big data analytics, related fields and other forms of information relevant to the 4IR. There is thus a need for constant skilling and re-skilling and the development of appropriate human resources to integrate emerging ICTs in the Public Service. ICT appears to be one critical area in which the Public Service Sector needs skilled personnel, yet the overall shortage of technicians nationally means that government departments struggle to compete with the private sector for these skills. A lack of skills in this area could hamper the government roll-out of priority projects that need ICT skills.

• In the Public Service space, technology in the form of e-learning has been identified as a crucial mechanism for delivering skills development in a cost-effective and efficient manner. This delivery mechanism allows for skills development to evolve, especially in terms of being more accessible and available to employed people within the sector.

PSETA specifically mentions ICT Systems Analysts, IS Auditors and ICT Security Specialists among its skills shortages.

SASSETA

The Safety & Security SETA reflects on the changing nature of crime and the criminal justice environment in its SSP Update for 2019/20 (SASSETA, 2018).

They state that shortages of skills and lack of urgency in implementing measures to tackle cybercrime are still a challenge in South Africa. "Technological advancements and data protection laws are driving the need for specialist IT technicians and IT professionals, as well as the operational IT skills needed by all attorneys. The Criminal Justice Revamp plan will also drive particular IT skills needs as well as skills required by operational personnel who will be required to make use of new IT processes. Within the private security sector special skills will be driven by the environment where IT is playing an increasing central role in the provision of effective security services.

"Cybercrime investigations are complex and time-consuming and require highly skilled human resources. The sector needs to develop the technological and professional capacity to address cybercrime. Law enforcement agencies, prosecutors and public sector cyber professionals must receive training on current and anticipated cybercrime trends and techniques."

The SSP also notes that there is an ongoing need for an integrated information system for the justice cluster, supported by upgraded ICT infrastructure, emphasising the negative impact of the prolonged duration of the ICT system integration problems.

The SASSETA SSP for 2019-2024 includes ICT Security Specialist and Computer Network Systems Engineers in its PIVOTAL List Top Ten and also includes ICT in its five skills priority actions.

SERVICES SETA

The Services SETA SSP Update for 2020-2021, issued in August 2019, also emphasises technological change as a significant driver. They introduce the topic in this way:

Rapid changes in technology due to high paced and disruptive innovation remains the biggest driver of change for the services sector economy. Industries mostly affected by technological change include marketing, real estate, postal services, contact centres and funeral services. Implications are that the labour force needs to be constantly acquiring the requisite skills, while the education and training institutions ensure the relevance of qualifications on offer. Efforts are underway at the Services SETA to develop qualifications that address skills demand driven by technological change, especially management of big data.

The SSP goes into more depth, with ICT as a change driver in the various sub-sectors:

Information and Communications Technology

Research on the impact of technology in terms of how current products and services are developed as well as how people interface with an industry is well-documented and the services sector is no exception. OECD (2016, p. 35) suggests that by 2030 "firms will be predominately digitalised, enabling product design, manufacturing and delivery processes to be highly integrated and efficient"; adding that digital technology will "make the services sector a more dynamic part of the economy." Research (Cedefop, 2016; OECD, 2016; Pew Research Centre, 2014) suggests that while technology is replacing routine tasks within most jobs through higher levels of automation, it is making jobs more challenging. This, in turn, requires employees to acquire and/or develop skills to cope in more technology-centred work environments.

In response to this, the Services SETA commissioned a research study on future jobs and skills which was completed on 31 March 2019. The findings thereof identified technology as one of the major change drivers to influence the future job market, with many reports now focusing on its impact and the Fourth Industrial Revolution.

It is important to state that the influence of the drivers of change varies across Services SETA sub-sectors. For the real estate industry, technology has had an impact on the design, form and nature of interaction between sellers and buyers of property on the one hand, and/or between rental agent and lessor, on the other, as more people turn to various websites and applications (Apps, as they are commonly known) to access, compare and utilise information. This has necessitated real estate and property management agents to use technology to provide high quality and useful information to increase traffic to their websites and Apps, in order to facilitate sales. The implications of this trend is that real estate agents and property managers not only require information about the product that they are selling, but now need to have knowledge about brand management, digital sales, marketing and social media.

A major consequence of technology for business services is that companies, now more than ever before, have access to more data about their customers. This 'big data' requires that managers and professionals acquire higher levels of analytical skills to use data strategically. The introduction of disruptive technologies and solutions has had a significant impact on the traditional business models, resulting in businesses having to adapt to remain economically viable.

For the labour and collective services, the internet presents new means for recruiters to communicate to personnel through videos that advertise jobs. On the other hand, jobseekers are also relying less on traditional resumes to advertise their skills as social networks provide platforms for online profiles and portfolios for recruiters to consider. This has resulted in the emergence of new ways of organising work.

Marketing services enterprises in South Africa need to operate within the ambit of the Consumer Protection Act of 2011, which places stringent requirements to protect consumer information during marketing activities. Firms focused on improving their services will increasingly need to adopt social media and multi-channel solutions for customer service, and for getting closer to consumers (Buchner, 2013). Research participants highlighted that a major trend was the shift to digital marketing due to increased use of social media, and their integration into traditional marketing activities.

The participants further highlighted that this is also evident for public relations where print media is under threat and there is a growing trend of accessing news online as opposed to traditional ways of buying newspapers and magazines. As such, some printing companies are closing down as demand for their services declines. Firms in the marketing services sector recognise that smart phones are a game changer. These devices bring the firm closer to consumers and open new marketing opportunities. This means firms need to adapt to new ways of working to remain relevant.

General consulting services benefit from advancements in technology in two ways, namely, increased flexibility for work to continue outside of the traditional working hours and work outputs which are increasingly computer-generated. Skills in the use of information technology (IT), including social media for desktop and online research, will be increasingly needed to ensure that firms become competitive.

Changing consumer preferences have brought about a demand for e-services in postal services around the world. The addition of information, communication and technology (ICT) infrastructure into post offices in rural areas is a major step forward in bridging the divide between urban and rural areas. It is anticipated that postal services will benefit from being able to connect users to broadband services and thereby encourage adoption of digitised mail for the revival of postal services. Auxiliary services such as parcel delivery and logistics may also be launched off a wider broadband infrastructure which will enable technology to connect people to goods as well as reinvigorate postal services by shifting revenue generation to logistics and parcel delivery. Skills needs in this sector include IT and logistics.

Despite technological advancements that allow automation software to simplify the process of accessing a large database at predictable intervals, there is growing discontent with contact centres among millennial audiences who have a greater interest in multi-channel communications with businesses as opposed to voice-to-voice communication (Rouse, 2014). This has implications for direct marketing. While voice-to-voice communications will remain a feature of sound practice, the status of voice will be supplanted by the unique advantage of digital communication and its growing weight on the buying choices of consumers in a fast-changing globe (Holmes, et al., 2013).

In the contact centre environment, as far as technological trends are concerned, the emergence of speech analytics and call-categorisation is creating greater efficiency and control over quality of work. Research participants also highlighted that the contact centre industry was seeing higher levels of automation of certain tasks, and with customers becoming more technologically savvy, there was a growing trend in the reduction of the number of contact centre call agents.

The cleaning sector is likely to be impacted by technology as well. The findings revealed that cleaning machines are required to perform a variety of tasks such as cleaning and are able to operate faster and cheaper than humans. It can be argued how far machines will replace human beings. It is therefore expected that some tasks will be fully automated and certain tasks or activities will be partly automated. As a result, new occupations will be introduced and the anticipated skills for the subsector will/could include robot maintenance and repair. Table 11 summarises the impact of technology on various service sub-sectors.

Table 11. Impact of Technology on Services Sub-sectors

Subsector Affected	Nature of Impact	Occupations Affected
Business Services	Ability to access and use big data	Quality Managers, Consultants/ Business Advisors
Cleaning Services	Robotics are likely to take over cleaning chores	Cleaners
Contact Centre	Automation of certain tasks	Contact centre call agents
Labour Recruitment	New means for recruiters to communicate to personnel	Recruitment Managers
Marketing Services	Use of digital channels	Sales Marketing Managers, Publishers, Editors
Postal Services	Increased access to broadband services resulting in digitised mail	Delivery drivers, postmen, Mail-sorters
Real Estate	Changing nature of interaction between sellers and buyers	Estate Agents, Property Managers, Valuers

The Services SETA has devised a number of initiatives to respond appropriately to challenges posed by before the end of 2019. Key role players will be invited to share inputs on the best way to respond to this need. In addition, the Cleaning and Hiring, and Communication and Marketing Services Chambers have initiated research studies that look at the impact of technology on these sectors in more detail, proposing actionable recommendations. These research studies are expected to begin by the last quarter of 2019/20 and will be completed by the second quarter of 2020/21.

HTFVs in the sub-sectors include:

- Data Analyst
- Information Security Officer
- Software Developer, Engineer
- IT Developer
- IT Specialist

TETA

The Transport SSP for 2020-2025 (published August 2019), includes the following on factors affecting skills demand and supply – implications for the future:

The most common key skills drivers revealed by the literature are increased adoption of new technologies; advances in artificial intelligence; increasing availability of big data; shifts in national economic growth; advances in energy supplies and technologies; advances in mobile Internet; advances in cloud technology; expansion of affluence in developing countries; expansion of the middle class; expansion of education; increasing frequency of new working arrangements; advances in computing power; and advances in devices bridging the human-machine divide. However, based on the research process, five key skills change drivers and implications for future skills planning are highlighted. Among them is technology and innovation.

Technology and innovation is another important driver of skills demand and supply in the transport sector. Technology innovation shapes the nature and direction of skills development needed for today's a transport sector. Most of the changes within the sector in the last decade are driven by technological innovations. While most role players in the sector respond in a way favourable to business growth and development, others are shrinking in the face of competition and demand for new skills. Technology and innovation for the sector has meant that operators are now able to gain real time information about goods and all people in transit, and customers are able to enjoy the flexibility, convenience, security, time efficiency, and reduction in price of services. At the same time technological innovation has created a critical shortage for skilled transport workers. It has transformed the nature and direction of jobs with available jobs now requiring both basic and advanced skills in computer literacy, in automation and artificial intelligence. The supply of tech savvy staff is not matching the required demand for this level of skill needed in modern transport operations. As such, this challenge has given rise to the concern about the fairness of the transition to new technology. In many reported cases, there is recognition of conflict between the excitement for new technological opportunities and the loss of jobs for low skilled workers. This way, the transition might not be deemed a "just transition". Further studies of the effect of the transition for better skills planning are required.

W & R SETA

The Wholesale & Retail SETA published its 2020-2025 SSP in August 2020. Its comments include the following:

Technology advancements and increased access to information: Technological advancements are significantly changing the Wholesale and Retail Sector. These advancements include mobile applications, online shopping, big data, social media, cyber-crime, mobile phones and internet usage.

The following are new and emerging top-up skills:

- Digital marketing skills
- Digital customer communication skills
- Problem solving skills
- Financial literacy skills
- Data analytics skills
- Ethics & discipline, and
- Information Communication Technology (ICT) skills such as Software Developers, Business Analysts and Computer network and Systems Engineers.

Technology Advancements and Access to Information

The wholesale and retail industries are rapidly changing due to technological advancements. These advancements offer wholesalers and retailers opportunity to increase their efficiency and revise their business models.

However, these advancements have also given consumers more power in relation to retailers. This power is often through constant connectivity, communication and access to information. Furthermore, consumers are more inclined to support businesses who operate ethically with a sustainable ecological footprint. With the rise in access to information consumers can easily seek out retailers who demonstrate these characteristics.

Implications of technology for Skills Planning in the sector include the following:

- Mobile Applications: Smartphones, tablets and wearable devices present retailers with new opportunities for engagement with customers. Retailers can build personal relationships with customers based on their preferences, shopping styles, and mobile interaction.

- Online Shopping: Online shopping is growing rapidly in popularity. Companies are increasingly marketing online in order not to be outdone by rivals.
- Big Data: Large, complex datasets from multiple sources. Provides information on consumer behaviour and is a strong predictive sales indicator. Social Media: A platform for retailers to expand marketing to a wider range of consumers. Major platforms are Facebook, twitter, LinkedIn and others. Conversely, social media offers Consumers an opportunity to gather information about retailers. This includes negative publicity (e.g. retailers being accused of unethical conduct, poorly thought out marketing campaigns, etc.).
- Cyber Crime: Retailers are a target for cybercriminals. Retailers experience nearly three times as many cyber-attacks as those in the finance sector with 77% of organisations being affected.
- Mobile phones and Internet Usage: Africa's claim to be the "mobile continent" is even stronger than previously thought, with researchers predicting internet use on mobile phones will increase 20-fold in the next five years. This will double the rate of growth in the rest of the world. Retailers are taking advantage of that by increasing the online shopping and marketing.
- Ethical issues: Apart from saving, consumers also consider ethical issues when buying i.e. Buying from sweatshops; workshop or factory where manual workers are employed at very low wages for long hours and under poor condition is considered a vote for worker's exploitation which most consumers are against.
- Eco Friendliness: Consumers are now concerned with the natural environment; they prefer buying products that are with minimal detrimental impact on the natural Environment.
- Greening sustainability: Businesses are becoming more conscious of protecting the environment. Increased legislation and consumer pressure are driving the demand for eco-compliance. Businesses must show that they are environmentally friendly in their business processes and in the products and services they offer.

Other uncategorised implications include the following:

- The future of work is changing as technology is rapidly advancing towards latest trends such as automation and artificial intelligence, which will change the traditional roles leading to some jobs becoming obsolete.
- Employers and employees will require skills in the ICT and data analytics space.
- Re-capacitation and reskilling of workers is critical to ensure their readiness to embrace the new technological changes.
- Retailers may have an increased need for environmental managers, social corporate managers, public relations managers and HR Managers. Furthermore, it is increasingly important that companies have the skills to make the correct decision quickly (both in terms of business sustainability and ethically).
- Should the business make a decision that is unpopular (as was the recent case when a major retailer was accused of appropriating someone's product idea as their own) it is imperative that they have the required public relations skills to mitigate the negative impact this incident may pose.

The Skills Gap Needs that were identified include ICT, analytics, graphic design, photography, programming, cloud computing, web development, data mining, statistics, research, forecasting, marketing and sales, management, networking, mobile device management, cyber security and ICT law. Re-capacitation and reskilling of workers is critical to ensure their readiness to embrace the new technological changes.

The occupational needs include Software Developer/ Web Designer/ Web Administrator/ ICT Security Specialist/ Graphic Designer/ Analyst/ Researcher/ Marketing and Sales Manager Digital skills/Cognitive based work/ Programming/ machine device management/ Customer Service optimization.

SECTOR CONSOLIDATION

The lack of consistency in the approach and timing of the various Sector Skills Plans makes it very difficult to extract an holistic view of the demand for ICT skills nationwide. At the very best, the data is based on reports

from levy-paying enterprises, leaving a large number of unreported needs from the mass of SMMEs found in many of these sectors.

What is apparent from the Sector Skills Plans is the general recognition that the advance of digitalisation and the concomitant amassing of data resources is placing enormous pressure across the board for the skills necessary to implement and maintain the new technologies that are driving these changes. Although the specific skill sets and job roles derived from the 4IR environment have yet to be identified in Workplace Skills Plans, it is evident that many SETAs are aware of the potential impact on their initiatives in the future.

At a more foundational level, several of the SETAs have highlighted the problems in the education pipeline, where South Africa is (so far) tackling the critical need for vast improvement in curricula for STEM subjects and in learning methodologies in only fits and starts.

Because the SSPs were prepared before or during the early months of the pandemic lockdowns, there is little on which to base any analysis of the SETAs response to the changes in working environments, particularly among the white collar occupations. We can predict the growth in requirements for support technologists to address the implementation, support and security of working from home and the increase in demand for e-commerce services.
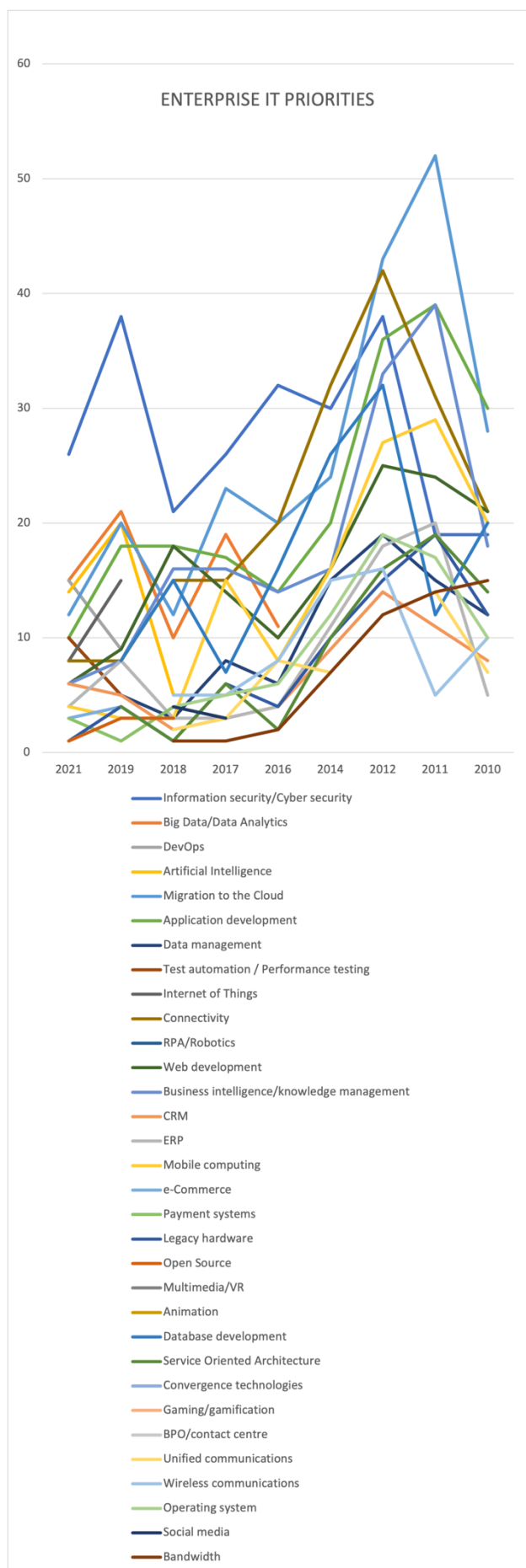
ICT PRIORITIES SINCE 2008

The 2008 Survey identified the top 6 priorities overall, based on the selection of their own top 3 by each respondent. That analysis showed **Business Intelligence/ Knowledge Management** to be the top-ranked priority, followed by **Application Development** and **Software as a Service**. These were supported by Service Oriented Architecture, Web Development and Mobile Computing.

In 2009, the data was revised to include all identified priorities, and the chart showed that **Application Development** was that year's top priority, with **Business Intelligence/ Knowledge Management** being pushed into third place by the entry of **Network Infrastructure** in second place. CRM, Information Security and the Operating System were the supporting cast, although there was little difference between many of these "other" priorities.

We thought that the emphasis on Network Infrastructure in 2009 reflected the realisation that effective broadband access is essential if enterprises are to benefit from the technology innovations becoming available. The **2010** survey was revised to indicate what each respondent thought was their 1st, 2nd and 3rd priority for the coming year. **Application Development** retained its top spot for the second year, with **Web Development, Software as a Service** and **Business Intelligence/ Knowledge Management** just surfacing above several other contenders for the next most significant issues. We observed that the spread of interest among the second and third tiers of "priorities" indicated the wide range of challenges facing enterprise decision-makers who need to keep their information systems capable of delivering services that support the changing business needs. We also commented that if we compare the changes over the three year period, we could see a significant drop in the importance of **Business Intelligence/ Knowledge Management** and a significant increase in the interest in **Web Development.** We felt the lowered interest in **Software as a Service** (SaaS) in 2009 seemed to have been an anomaly and this opinion was confirmed by the 2011/12 and 2014 results.

In **2011**, we showed the Priority Progression picture over the four years of the Survey. We could see that **Software as a Service** was definitely high on the agenda, albeit as a second priority, while **Application Development** was still the firm favourite as first priority. Managers continued to face a wide range of challenges in applying technology to support business needs and it is notable that **Mobile Computing** emerged from the

ENTERPRISE IT PRIORITIES

Legend:
- Information security/Cyber security
- Big Data/Data Analytics
- DevOps
- Artificial Intelligence
- Migration to the Cloud
- Application development
- Data management
- Test automation / Performance testing
- Internet of Things
- Connectivity
- RPA/Robotics
- Web development
- Business intelligence/knowledge management
- CRM
- ERP
- Mobile computing
- e-Commerce
- Payment systems
- Legacy hardware
- Open Source
- Multimedia/VR
- Animation
- Database development
- Service Oriented Architecture
- Convergence technologies
- Gaming/gamification
- BPO/contact centre
- Unified communications
- Wireless communications
- Operating system
- Social media
- Bandwidth

"also ran" ranks in 2011. The popularity of tablet computers and "smart" phones was cementing the demand for the adaptation and implementation of systems that offer safe, secure and reliable facilities for mobile workers.

The **2012 results** follow a similar pattern to that established in 2011, with **Software as a Service/Cloud Computing** now leading the field. **Network Infrastructure** and **Information Security** move into second and third place respectively, pushing **Application Development** into fourth slot. However, the differences between these rankings are not great and we can add **Business Intelligence/Knowledge Management** and **Database Development** to complete the Big Six of priority issues in the year ahead.

In **2014**, the Big Six became the Big Five. The ranking of the top five priority areas remained unchanged from the previous survey – in descending order, they are **Software as a Service/Cloud Computing, Network Infrastructure, Information Security, Application Development** and **Business Intelligence/ Knowledge Management** (which now includes Big Data/Analytics). It was almost impossible to separate the next five areas of priority attention – they were: Database Development, Mobile Computing, Web Development, Data Storage and Operating System.

In **2016**, we were able to again identify six leading priorities. **Information Security** had become the clear leader, followed by **Network Infrastructure, Software as a Service/Cloud Computing, Database Development** and **Application Development.** Because of its growing profile, we separated **Big Data/Internet of Things** from the **BI/KM** category, and it now appears in seventh place. Had we left it combined with sixth place **Business Intelligence/ Knowledge Management,** this category would have been a close second to the highest priority.

Our **2017** results showed two "top" priorities, **Information Security** (still the leader) and **Software as a Service/Cloud Computing** (up from 3rd place in 2016). Then, there was a group of 6 priority areas that all received similar ratings from our respondents. They were: **Big Data/Internet of Things** (up from 7th place in 2016), **Application Development, Business Intelligence/ Knowledge Management, Network Infrastructure** (down from second place in 2016), **Mobile Computing** and **Web Development.**

2018 reinforced **Information Security/Cyber security** as the leading priority, with familiar faces among the next group of five – **Development (Applications, Web and Database), Business Intelligence/Knowledge Management and Network Infrastructure. Software as a Service/Cloud Computing** had retreated from its giddy heights of 6 or 7 years ago. Up-and-coming and newcomers include **Big Data/IoT, Artificial Intelligence and Payment Systems. IoT** and **Big Data** were also reported by Brainstorm's *CIO Survey* in 2018 as focus areas for CIOs.

Slipping out of the priority zone, as the technologies become less of a challenge and easier to implement are areas such as Wireless and Unified Communications, Operating Systems, Mobile Computing, Data Storage, Hardware, SOA and Bandwidth.

In 2019, clearly still the top priority, **Information security/Cybersecurity** received even more attention than in 2018. Then there was a cluster of second level priorities made up of **Big Data/Data Analytics, Software as a Service/Cloud Computing, Artificial Intelligence** and **Application Development.** Web development, Database development and Business Intelligence/Knowledge Management fell into the third level on the priority scale, well below the first and second levels.

The **2021** graphic (see previous page) shows the latest rankings on the left, with the historical data extending to the right. With **Information Security/Cybersecurity** continuing to be the top priority by a significant margin, it appears that the globalisation of data and networks exposes most enterprises to the considerable risk of data breaches and data loss. The tightening of laws around the protection of data (eg POPIA and GDPR) put the defence against such incidents high on the IT executives' agenda. **DevOps** has joined the cluster of second level priorities, which include **Big Data/Data Analytics, Artifical Intelligence, and Migration to the Cloud.** The third tier of priorities includes **Application development, Data management and Test automation.**

South Africa must factor in the global demand for these priority skills. Australia is estimated to need 18 000 more cybersecurity practitioners by 2026 but can only graduate 500 such specialists each year, so will look to the international markets to close the gap. In the same territory, a recent RMIT study found that an additional 156 000 new technology workers are required to meet current demands and that failure to do so will jeopardise AU$10 billion in economic growth, However, our Australian colleagues in ACS noted that only 7 000 students graduated with an IT degree in 2019. This is only one of the attractive emigration destinations available to skilled South Africans.

Staff Dynamics

ENTERPRISE STAFF RETENTION POLICIES
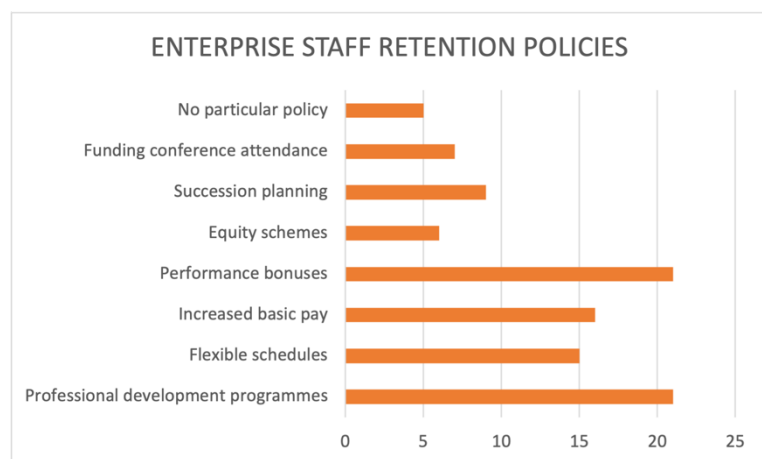
The demand for skills generally and for ICT skills in particular is subject to a wide range of influences. These include the depressed state of the economy, uncertain political stability, fallout from exposure of corruption and introduction of new and improved technologies. In this section, we look at the ways in which employers approach the skills pool conundrum.

The pattern of staff retention policies in 2021 continues the practices of previous years. Professional development programmes and performance bonuses continue to lead the preferences, with flexible schedules

and increased basic pay grouped together. The other incentive approaches are much less utilised. Comments from respondents place the emphasis on developers and programmers as the toughest to retain.
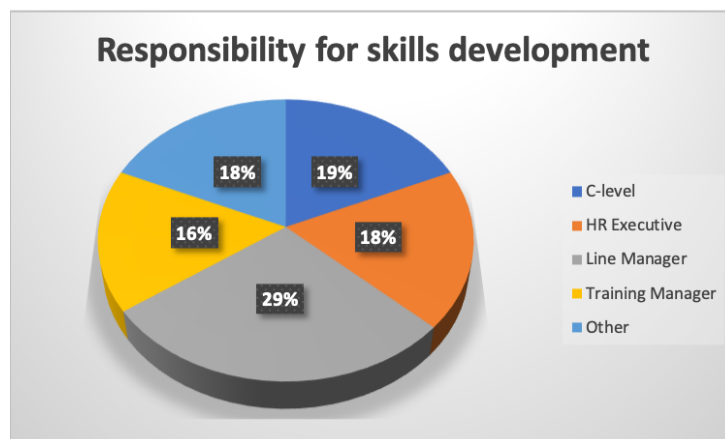
There continues to be a mix of line managers and senior executives holding the responsibility for training, with the 2018 respondents moving away from 2017's equal share (just more than 20% each) between senior executives (C-level and Directors) and specialist HR talent and training managers towards 35% at the senior level and 25% within the HR/training camp. JCSE suggests that line managers should be able to identify training needs among their teams but the responsibility for executing the training programmes should rest with a manager whose role is focused on this activity.

The percentage of respondent employers recruiting overseas in 2021 has followed the longer term trend, now approaching 40% of respondents. With the very high level of unemployment (particularly among young people), this is a disturbing trend, as South Africa is not making inroads into the opportunity to skill and employ locally. In spite of the lockdowns arising from the pandemic, there continues to be a steady stream of applications for "critical skills visas" via the South African embassies and consulates, as the country remains a desirable destination for ICT practitioners from some of our African neighbours and from India. It also remains to be seen if the proposed revisions to the "critical skills list" used by the Department of Home Affairs have any significant effect on the type and level of immigrant skills. The new list has yet to be published (as at end August 2021), meaning that immigrants are being evaluated against the perceived needs of 2014.

RECRUITMENT VALUE

IMPORTANT QUALIFICATIONS WHEN HIRING STAFF

Graph showing values for qualifications (approximate):
- Vendor certificate: 13
- Industry association certificate: 18
- Educational certificate: 8
- Diploma: 11
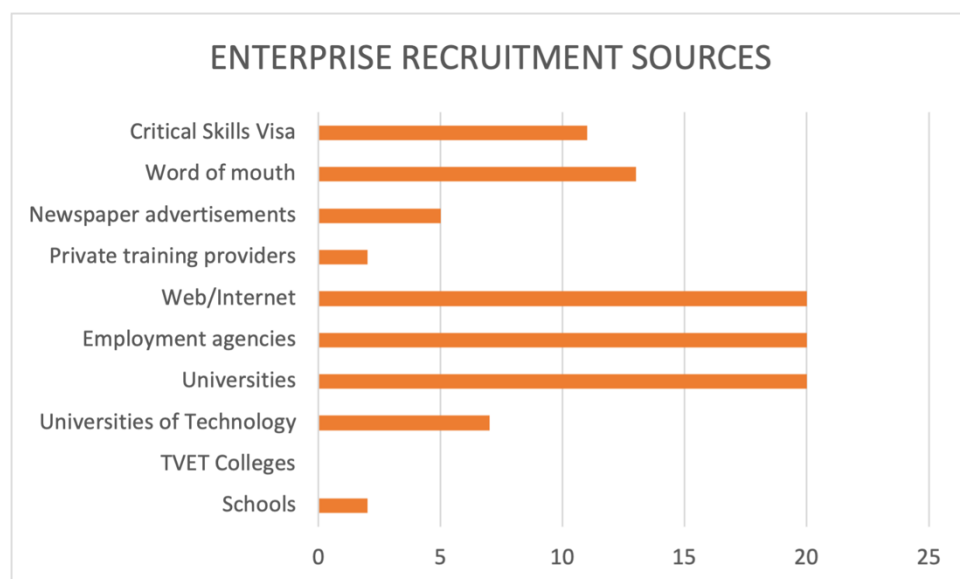- Graduate degree: 22
- Post-graduate qualification: 17
- Not certain: 4

Graduate degrees continue to be the top preference when setting recruitment criteria (as was the case in our last four reports). Post-graduate qualifications are still valued, as are the certificates of competence issued by industry associations and vendors.

LOCAL RECRUITMENT

Since 2010, when this question was introduced, employment agencies have been the most preferred source, except in 2010, 2016 and 2019 when on-line was at the top. Universities have joined these two in the top three in our 2021 results. This suggests that graduates are still an important source of "new" skills but also that the traditional role of the employment agency is still valuable in assessing candidates. The increased value from online services indicates that services such as LinkedIn are proving worthwhile "hunting grounds" for new talent.

ENTERPRISE RECRUITMENT SOURCES

Graph showing values for recruitment sources (approximate):
- Critical Skills Visa: 11
- Word of mouth: 13
- Newspaper advertisements: 5
- Private training providers: 2
- Web/Internet: 20
- Employment agencies: 20
- Universities: 20
- Universities of Technology: 7
- TVET Colleges: 0
- Schools: 2

Word of mouth and critical skills visas are also important sources of new recruits.

ENTERPRISE PREFERRED TRAINING APPROACHES
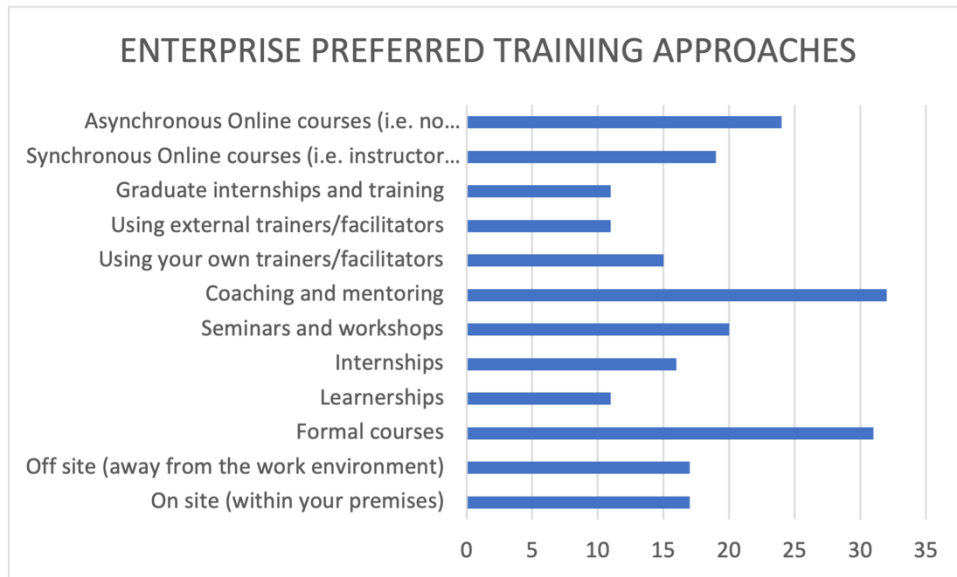
The pattern of preferences for skills transfer in 2021 from the employers' perspective shows a new focus on coaching and mentoring, while continuing the balance between on-line and formal courses.

Management Development

ENTERPRISE MANAGEMENT TRAINING
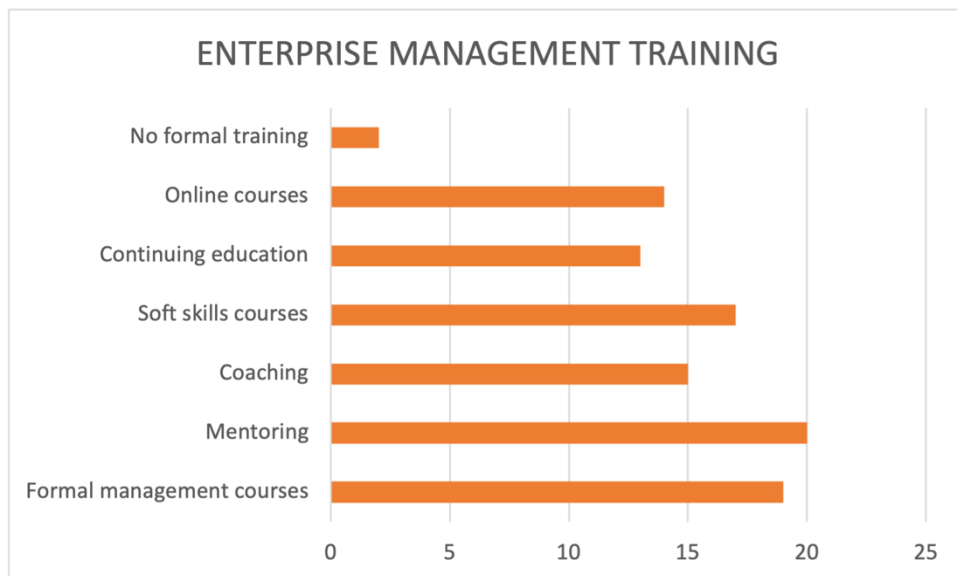
This year, mentoring and coaching return to lead formal courses as the preferred approach to management development.

BEE RECOGNITION FOR TRAINING
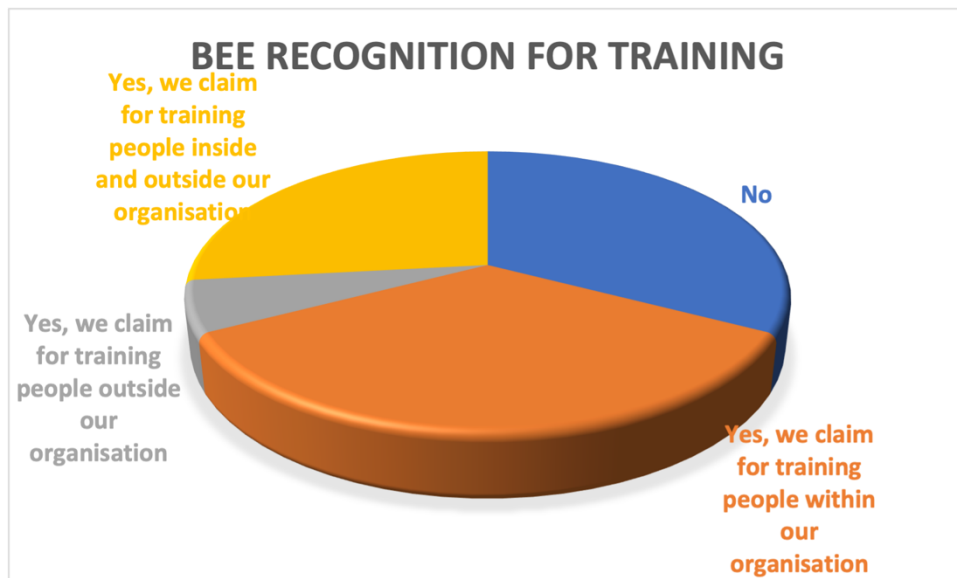
It is now six years since the appointment of the B-BBEE ICT Sector Council, and five years since the implementation of the Amended ICT Sector Code. The annual monitoring reports from the Council have yet to show significant progress in the development of Black managers in the sector. However, the majority of enterprises are claiming BEE recognition for their training efforts. As with the Generic Codes, the Sector Code was meant to be amended before the end of 2019 to shift the emphasis between the elements of BEE. At the time of writing (August 2021), the revised ICT Sector Code has yet to be published.

SKILLS NEEDS

The chart below shows our respondents' view on which skills are most needed now and which in a year from now. The indicators to look for are where the blue (now) and grey (next year) lines are clearly longer than the orange and yellow lines, which suggest a sufficiency of those skills.

Significant shortages are indicated in the following areas:

- Information Security / Cybersecurity
- DevOps
- Big data design / analytics
- Artificial intelligence / machine learning
- Blockchain
- Test automation / performance testing and
- Internet of Things

ENTERPRISE SKILLS NEEDS, NOW AND NEXT YEAR

Legend: Enough 2022 | Lacking 2022 | Enough now | Lacking now
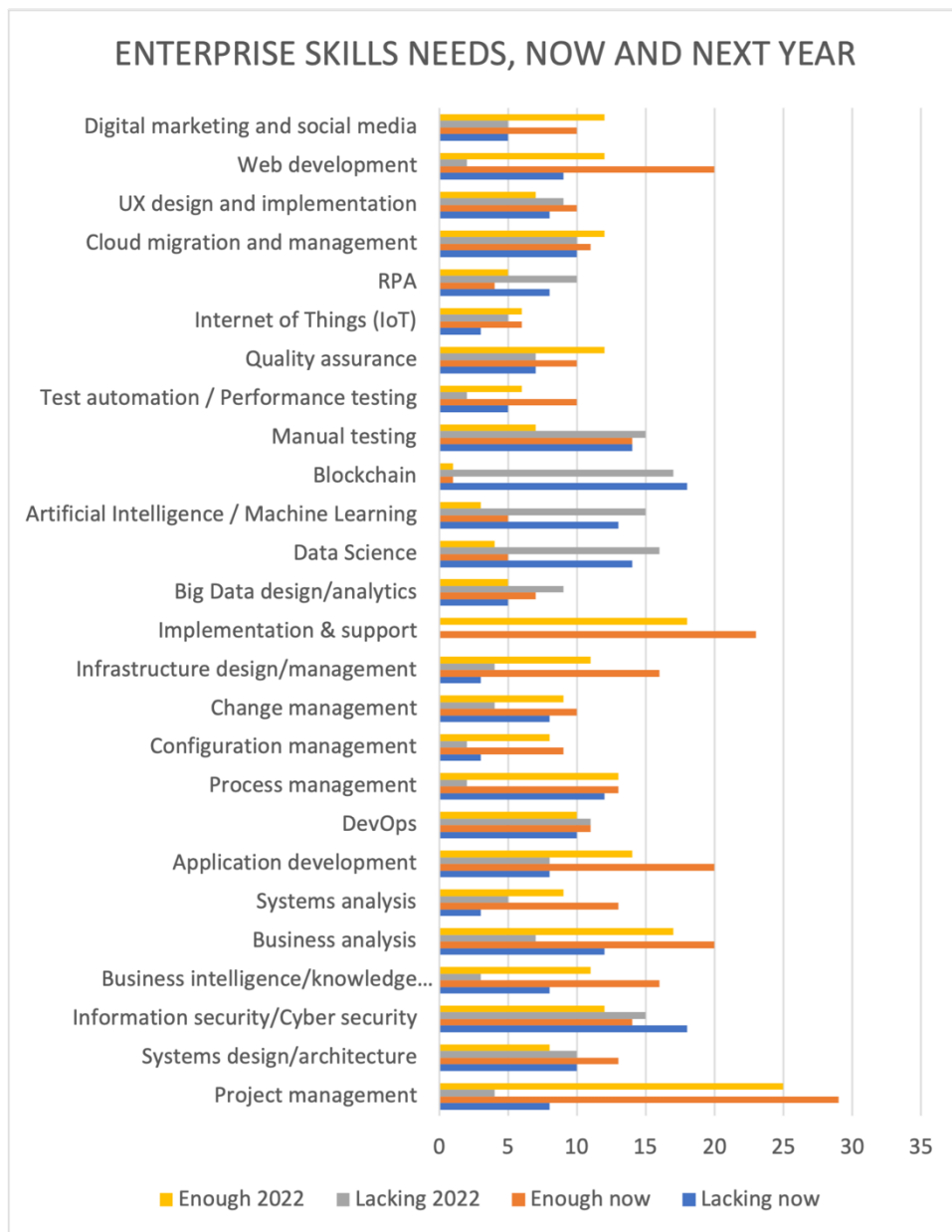
In six of the skills areas listed, the demand exceeds supply by a clear margin. Manual testing, Blockchain, AI/Machine Learning and Data Science stand out, together with Information security/Cyber Security and (to a slightly lesser extent) Robot Process Automation (RPA). In other areas, although many respondents indicated sufficient supply of skills, there are still significant shortages anticipated, such as DevOps and Systems design.

Top programming languages
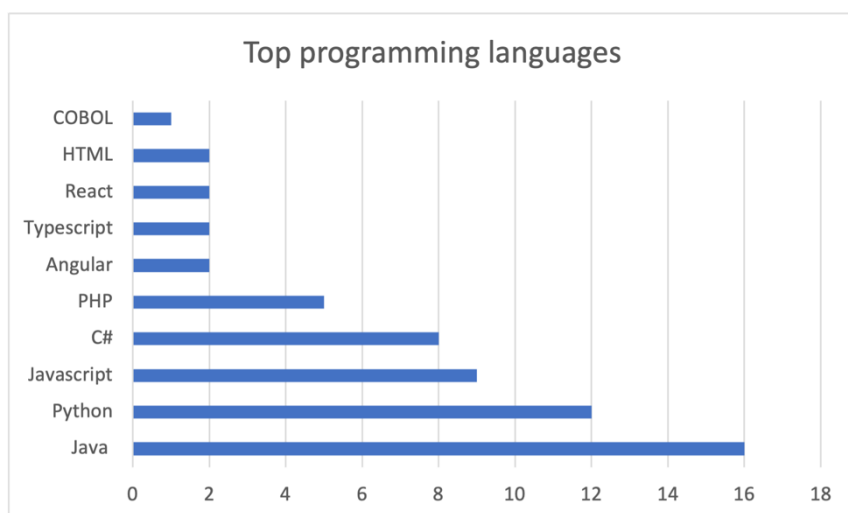
The pattern of demand for programming languages in 2021 continues the pattern from 2019 which saw **Python** move into second place behind **Java** and ahead of **C#**. Javascript nudges C# into 4th place. .NET slips into the "also ran" group of half a dozen less noted languages.

In 2018 **Java** was in the lead, followed by **C#** and **Python. .NET, C++, HTML** and **SQL** followed.

In 2017 was **Java** the clear leader and **C#** in second place, unchanged from 2016. **Python** moved into third spot, with **.NET** and **C++** tied for fourth. Of equal but lesser popularity, R, PHP, COBOL and Delphi all get mentioned.

In 2016 the leading languages were also **Java** and **C#**, followed by VB.NET and PHP. 2014 was very similar to 2012, with Java, C#, .NET, C++ and VB the most popular.

IMPACT OF SKILLS SHORTAGE ON BUSINESS
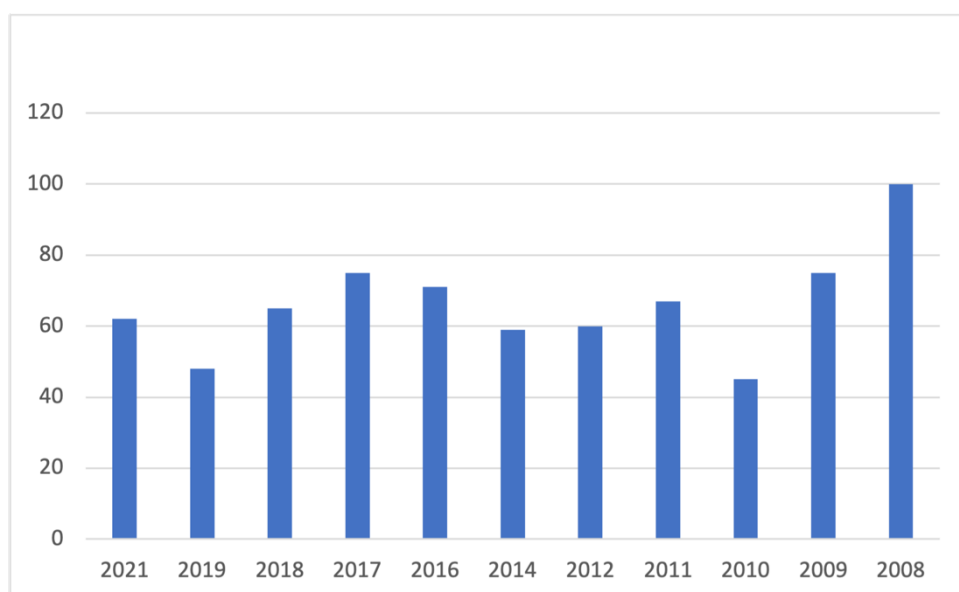
In continuing to track this opinion from our respondents, it is worth noting the improving trend of the last three years has not continued into 2021, with the percentage of concerned respondents returning to the previous level.

In 2008, all respondents indicated that the skills shortage was having at least a major effect on their business. On average, the picture is better since then. Several factors can influence this trend. On the negative side, the stagnant economy and the pandemic has reduced the business prospects of some of the employers, thus reducing the demand for skills, although that is not borne out by the number of respondents saying the opposite.

On the positive side, the various initiatives to close the skills gap are bearing some fruit, whether the new resources are coming from immigrants, private sector / NGO skills programmes or better output from the education pipeline.

EFFECT OF COVID-19 ON SKILLS AVAILABILITY

Almost 60% of our employer respondents felt that the pandemic had not affected skills availability (or they had stopped recruiting), while the remainder were fairly evenly divided between it making it easier or harder to recruit. The latter may be due to the restrictions on travel, reducing the number of immigrant skills coming into South Africa,

EFFECT OF LOCKDOWN ON WORKFORCE

Overall, there seems to be a recognition that the restrictions imposed by the lockdowns have resulted in a positive view on the impact of the enforced changes in working arrangements. It is significant that employees have adapted to WFH and that many companies report an improvement in productivity and that the enforced changes will likely stay in place on the long term. It will be interesting to establish in future surveys if such positive views are sustained.

Our findings are supported by the results of the ITWeb Remote Working Survey (ICT Insight, August 2021), where only 9% of respondents indicated that returning to the office was the only way forward. Issues of managing a remote workforce, team-building and cybersecurity were included in the challenges facing employers in this WFH environment.

Re-Skilling for the Digitalised Age

Our respondents were asked a new question in 2019 – do they feel a responsibility to assist their employees to reskill to meet the challenges of the new era of digitalisation?

The answer is still an overwhelming "yes" in 2021.
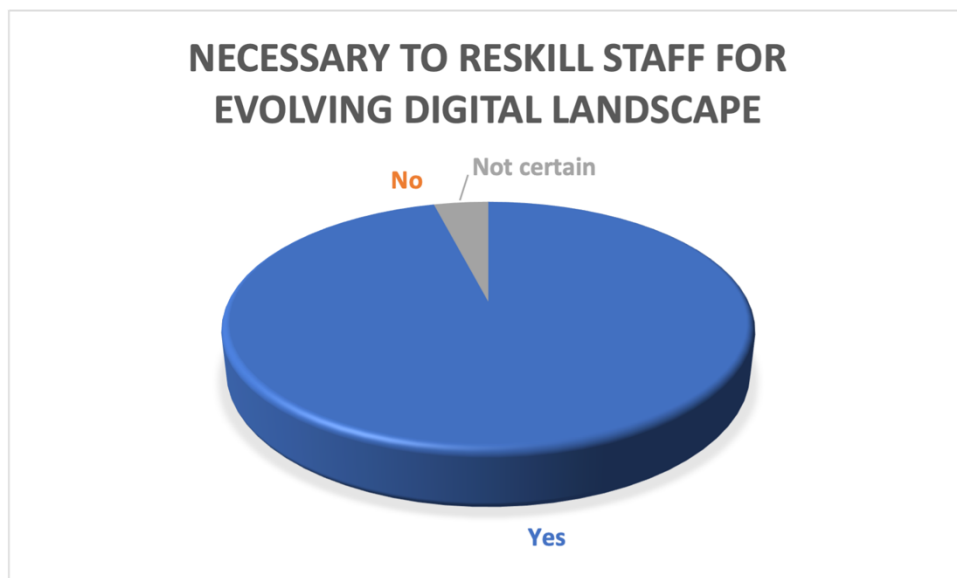
Corporate Summary

Should we change what we wrote two years ago? The ICT skills field from the employer perspective continues to show muted demand for skills but that the ongoing pressure from the introduction of new and innovative technologies continues to ensure that the skills gap is not closing.

The market continues to be overshadowed by the impact of non-technological factors – local and international politics, local and international growth rates and local societal issues of violence and crime, all now in the context of fighting the COVID-19 virus.

The common thread is the urgent and persistent need to raise the game in the education pipeline and it is incumbent on the private sector to drive the required changes through partnership with government and expansion of the many initiatives taking place.

Equally important as strengthening the skills pipeline is the creation of work opportunities for the newly-skilled. Without some serious government re-thinking on rebuilding the economy, it is not easy for the private sector to increase the number of jobs and other value-add economic opportunities. We continue to see myriad schemes driven from the private and NGO sectors and there is an over-abundance of providers offering certifications and qualifications. That these initiatives are not creating the required resources must be seen as the trigger for a re-think on a grand scale.

MICT SETA Postscript

In September 2021, the MICT SETA announced it has registered 11 "4IR future skills qualifications", including: artificial intelligence, cloud computing, cyber security, data science, design thinking lead, design thinking practitioner, Internet if things, robotic processing automation, quality engineering automation, systems development and e-waste. We look forward to assessing the impact on their objective of bridging the current shortage of skilled labour within the ICT and digital industries.

PRACTITIONER RESPONSES

Our pool of practitioner respondents remains fairly constant in numbers and we are satisfied that the sample is large enough from which to draw valid conclusions. In this section of the report, figures in (brackets) are the 2019; 2017; 2016; 2014; 2012; 2011; 2010; 2009 results, respectively.

PRACTITIONER PROFILE
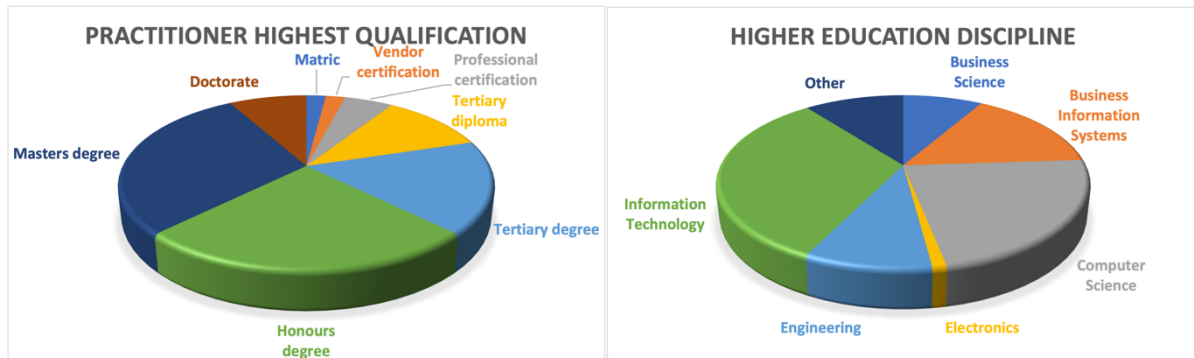
Our "average" practitioner respondent has changed a little in the last 13 years. He's now in his early-30s, lives in Gauteng, is highly qualified, has more than 5 years' experience (not quite as well established as in earlier reports) but has only been with this current employer and in this current role for 3 years, working as a manager or a developer in a small to medium sized enterprise.
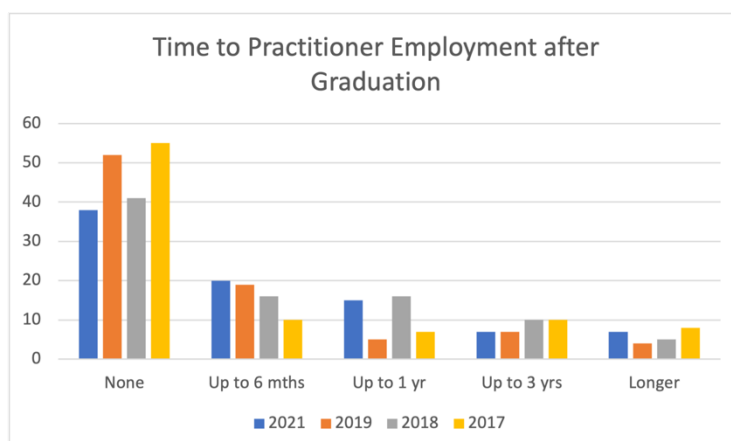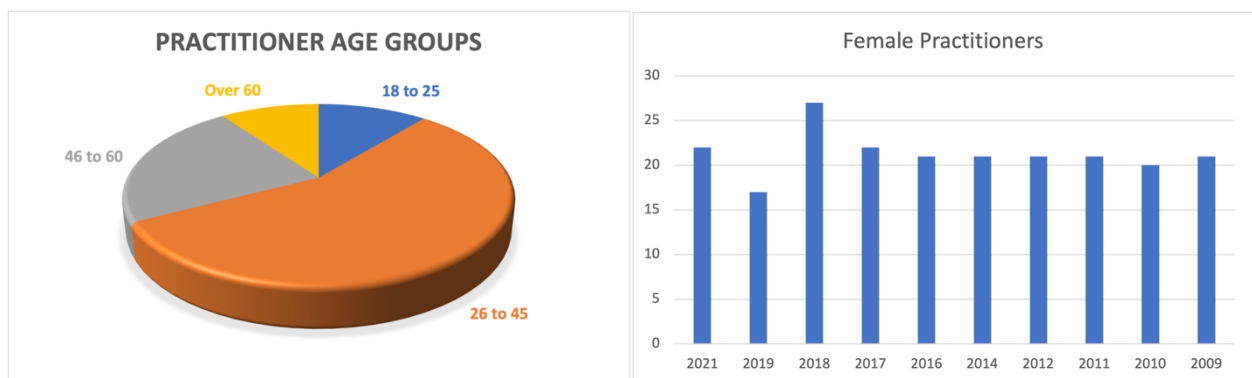
We inserted this question into the JCSE-IITPSA ICT Skills Survey in 2016, asking practitioners how long it took them to become employed, after they had completed their studies.

It is disappointing to see that fewer graduates are finding immediate employment and that a significant proportion are having to wait up to one year.

Employer and IT Dept sizes (employees)
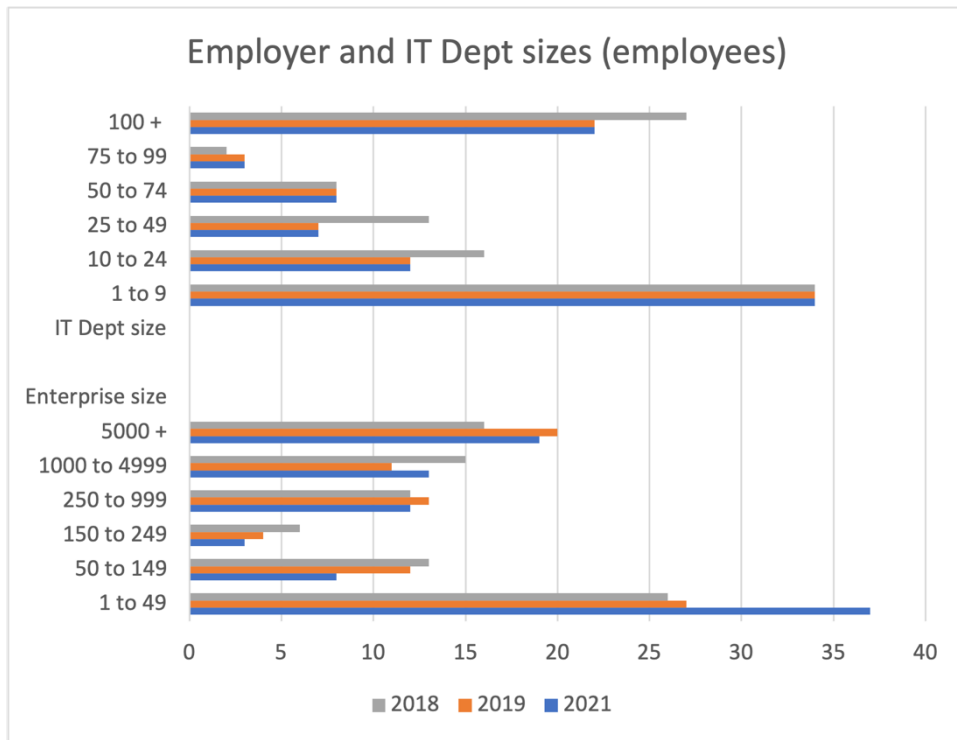
There is no change to the fact that most respondents work in a small (1-9) department or a large one (100+).

Practitioner length of service
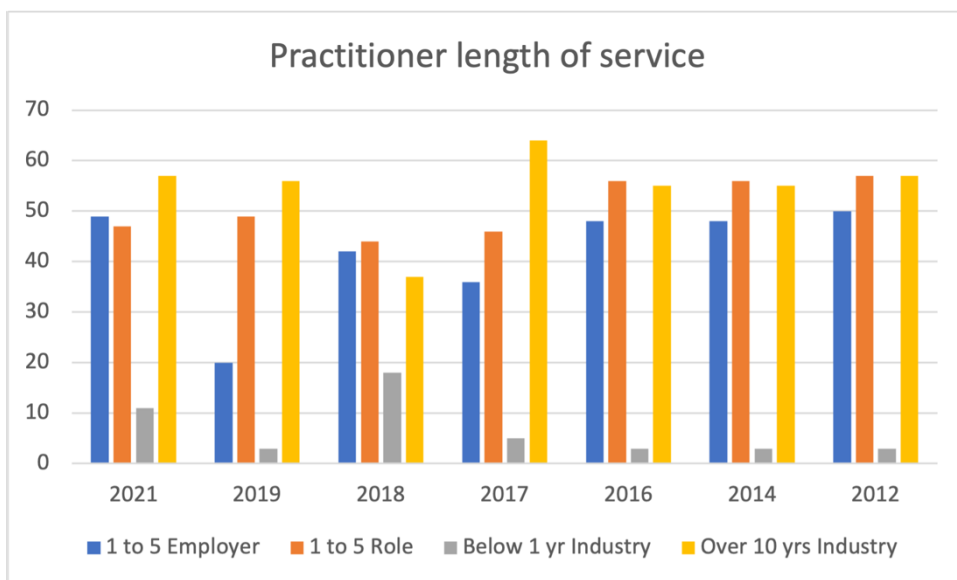
Almost half have performed their current role for between 1 and 5 years, After the 2019 anomaly where only 20% (about half of the average for the preceding years) had worked for their current employer for between 1 and 5 years the 2021 results have reverted to the trend shown during 2010-2017. Over 55% of responding practitioners have been in the industry for more than 10 years.

TYPE OF EMPLOYMENT
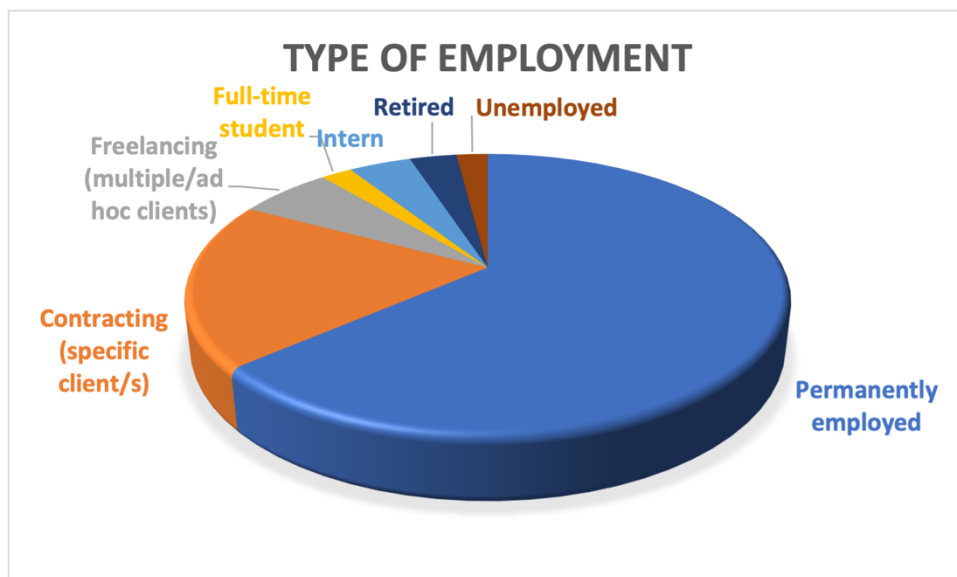
Two-thirds (58%; 51%, 69%; 77%; 78%; 79%) of practitioner respondents are in permanent employment. This proportion was almost unchanged from 2009 until 2016 but was noticeably lower in 2017 - 2019. 2021 showed the higher values of the earlier years of our survey.. The flexibility of skills resourcing offered by the existence of the contractor pool now at 20% (20% ;25%; 15%; 17%) is a long-standing vital component of the ICT industry's ability to apply labour where and when it is needed.

SECTOR OF EMPLOYMENT

Working in the MICT SETA Sector
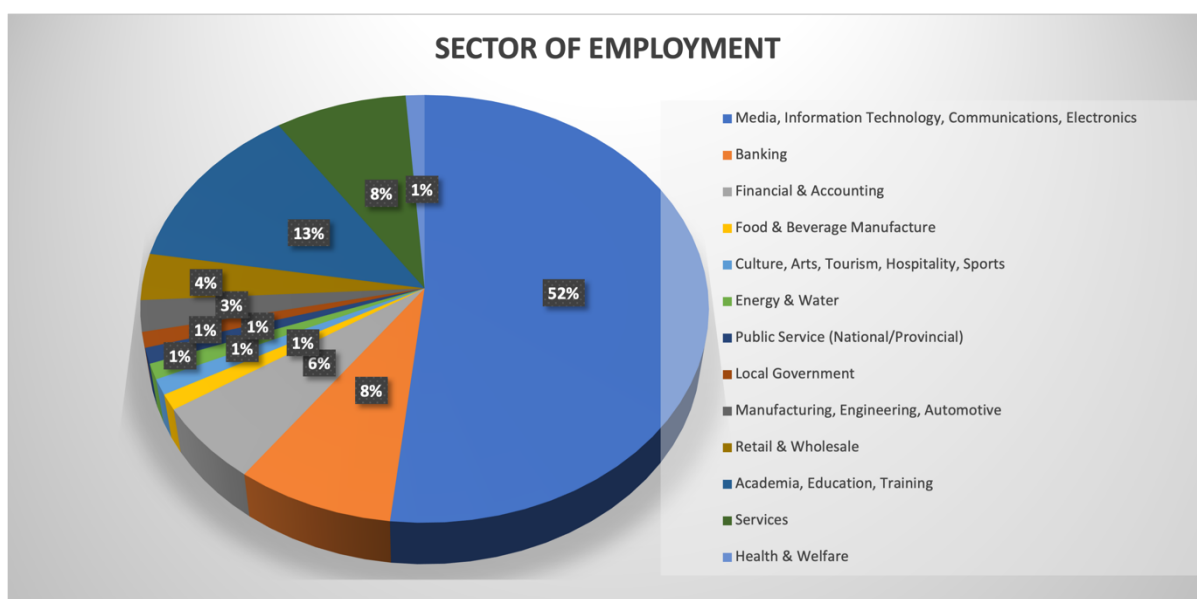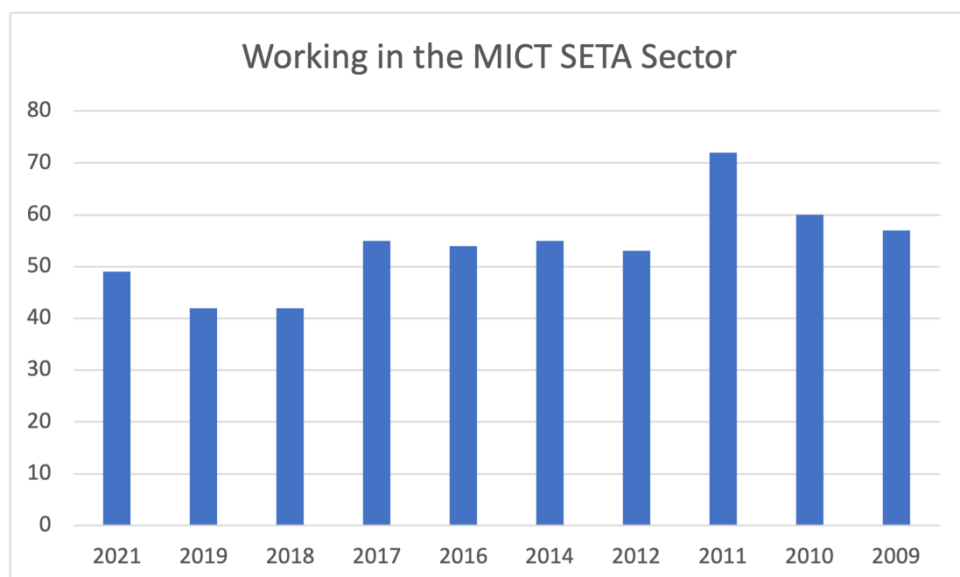
With more than half of practitioners working in other (i.e. non-MICT) sectors, this underlines the pressing need for the coordination of data from ALL stakeholders in a formal, credible methodology. We continue to suggest that the SETAs set up a trans-sector mechanism that acknowledges the pervasive nature of ICTs and the skills required to support the various technologies.

We continue to hope that there can be urgent progress with standardising the nomenclature of job roles and functions across sectors to make the planning of skills interventions more meaningful. Reliance on the inaccurate and misleading OFO codes can lead to poor policy and decision-making.

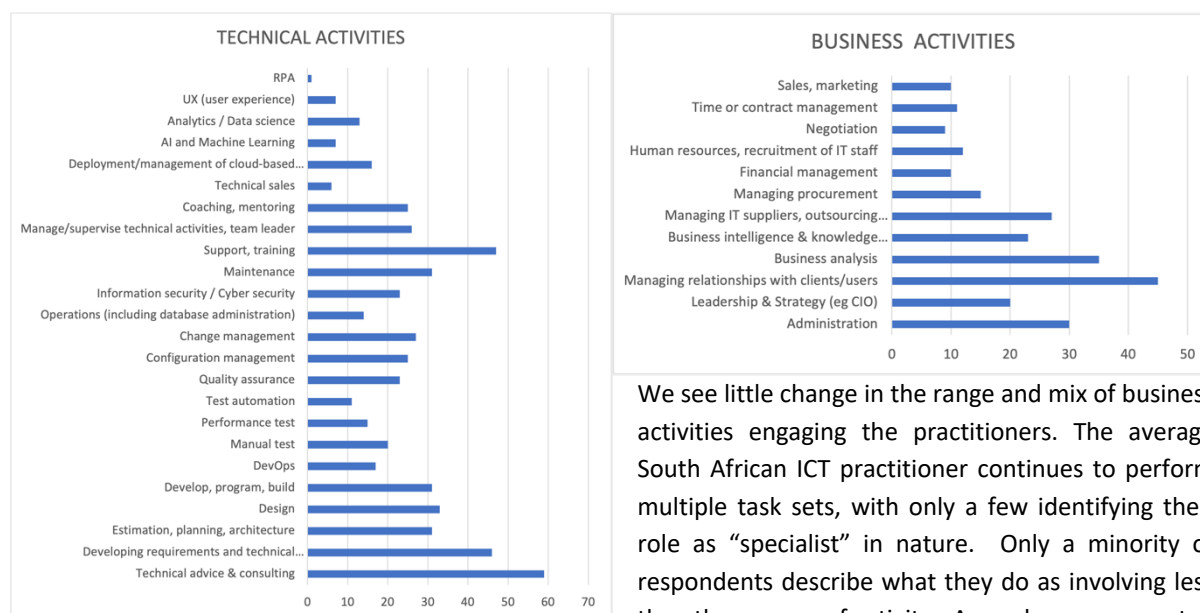## PRACTITIONER PRACTICES

Practitioners role groups
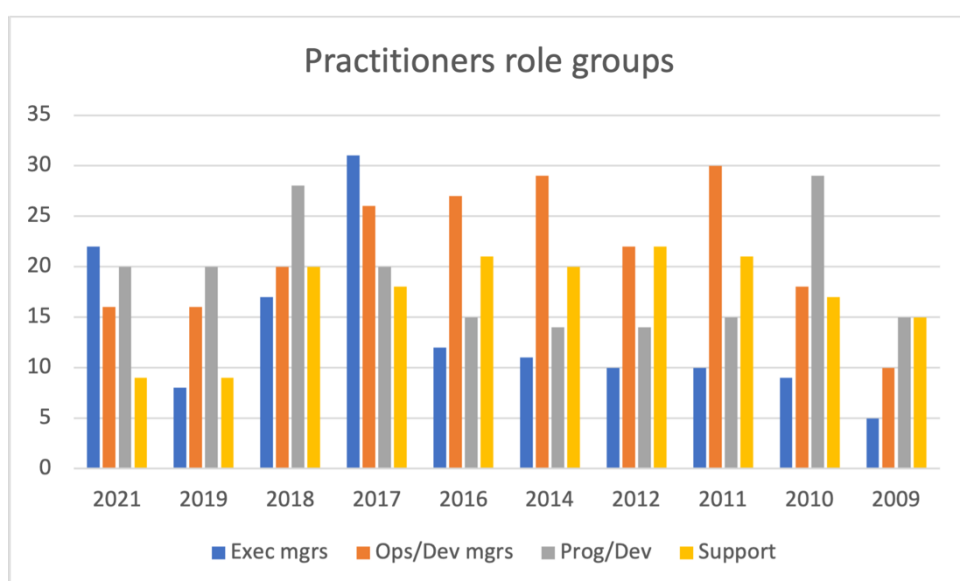
There are some inconsistencies between how respondents view their level in the enterprise and the job title that they hold. This issue further emphasises the need for rationalisation of the job titles and job roles used in industry and the Organising Framework for Occupations (OFO) codes used by the SETAs and DHET.

## PRACTITIONER HARDWARE PLATFORMS
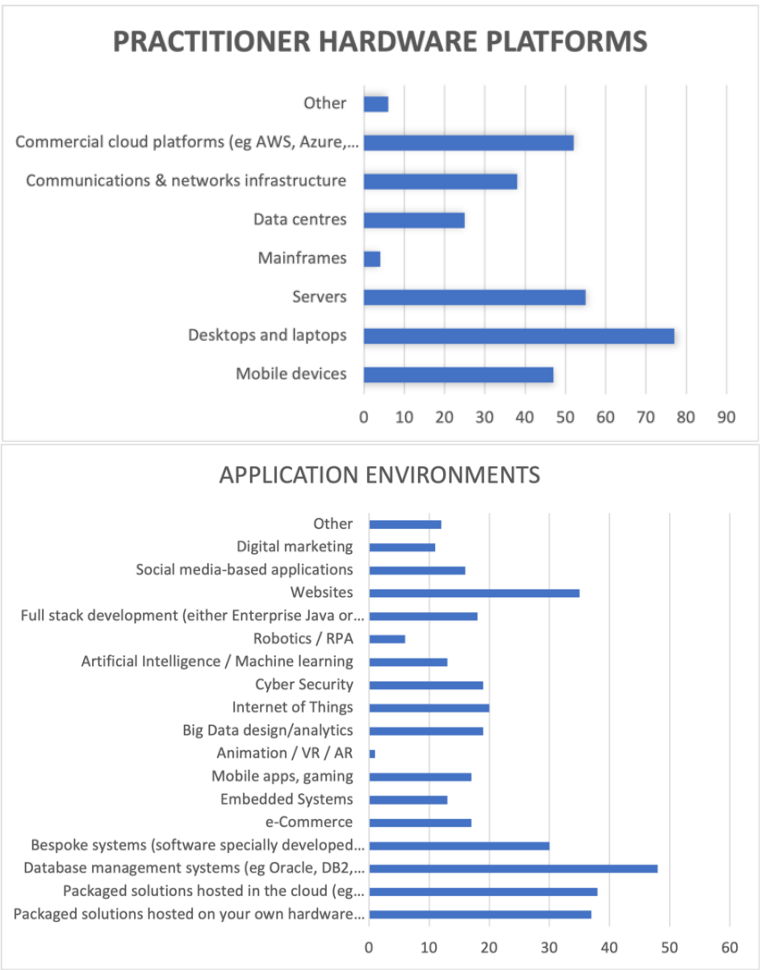
Most of our practitioner respondents are working in the PC/laptop and mobile device environments, linked to server and cloud platforms. A growing number are engaged in applications that are perceived to be in the 4IR domain, such as Big Data, IoT, AI/Machine Learning and Robotics. The mainstream of practitioners are still engaged in what may now be described as traditional applications – enterprise solutions, databases and bespoke systems.

APPLICATION ENVIRONMENTS

Multi-tasking

TECHNICAL ACTIVITIES

BUSINESS ACTIVITIES

We see little change in the range and mix of business activities engaging the practitioners. The average South African ICT practitioner continues to perform multiple task sets, with only a few identifying their role as "specialist" in nature. Only a minority of respondents describe what they do as involving less than three areas of activity. As we have commented before, we understand that it is appropriate for complementary roles to be performed over time, such as design, developing requirements, programming, testing and maintenance. In small enterprises, skilled practitioners will be responsible for all phases of management, administration and systems development.


Practitioners multi-tasking
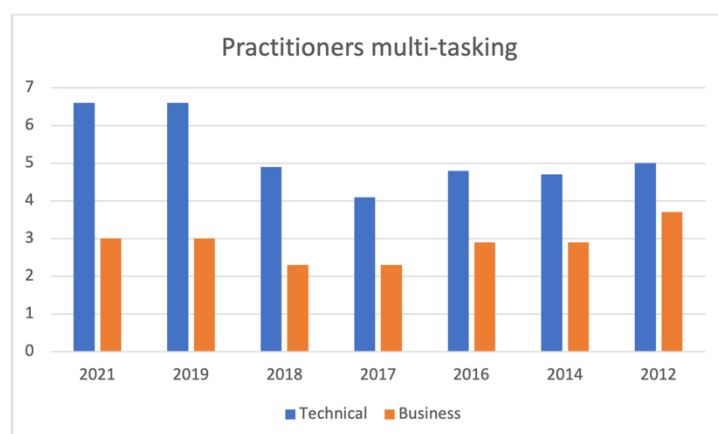
We have raised the flag of the multi-tasking issue in every report. If a practitioner perceives that they are performing several different roles, from technical consulting to administration, from programming to client management, from business analysis to outsourcing arrangements, it is difficult to see how they can maintain focus on specific objectives while juggling these responsibilities. It is unlikely that they have the required strengths in all these activities or the time available to carry them all out, which would lead to a degree of underperformance in some areas. It also leads to over-dependence on the individual concerned, who may be perceived as "irreplaceable".

However, while there is an economic case for greater division of labour, the multi-tasking phenomenon is entrenched as a fact of ICT practitioner life in South Africa and shows little sign of changing.

Skills Acquisition

As in all the previous surveys, respondents showed how they had acquired their skills in the past, to qualify them for their current post, and how they intended to acquire skills in the future, to maintain their value in the job market.

Practitioners with Tertiary diploma +

PAST & FUTURE SKILLS ACQUISITION
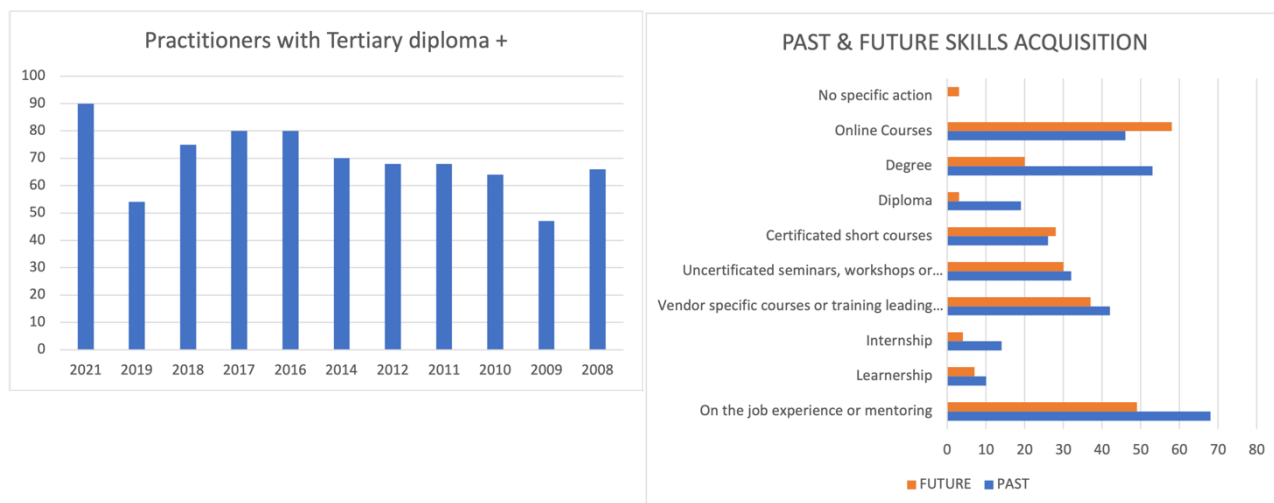
In 2014, we changed the presentation of this response to indicate the primary contributor to past skills development of the practitioner. The predominance of "on the job experience or mentoring" has been fairly constant, reported by 20+% of respondents in previous editions. This year (similar to 2019), it is close to 70%. Outside of the work environment, the need is for "proof of learning" in the form of a certificate, diploma or degree for almost half of our respondents.

Looking ahead, there is very little change from the last four years. Skills acquisition through experience, supported by short courses that lead to certification (whether vendor-specific or not) are preferred by practitioners. Pressure of work makes less time available for continuing academic studies, even on a part-time basis. In spite of the preference for on-site learning, almost as many respondents indicate that the transfer of knowledge is best suited to an environment outside of the actual workplace. The move to WFH since March 2020 will also be a factor.

LEARNING PREFERENCES
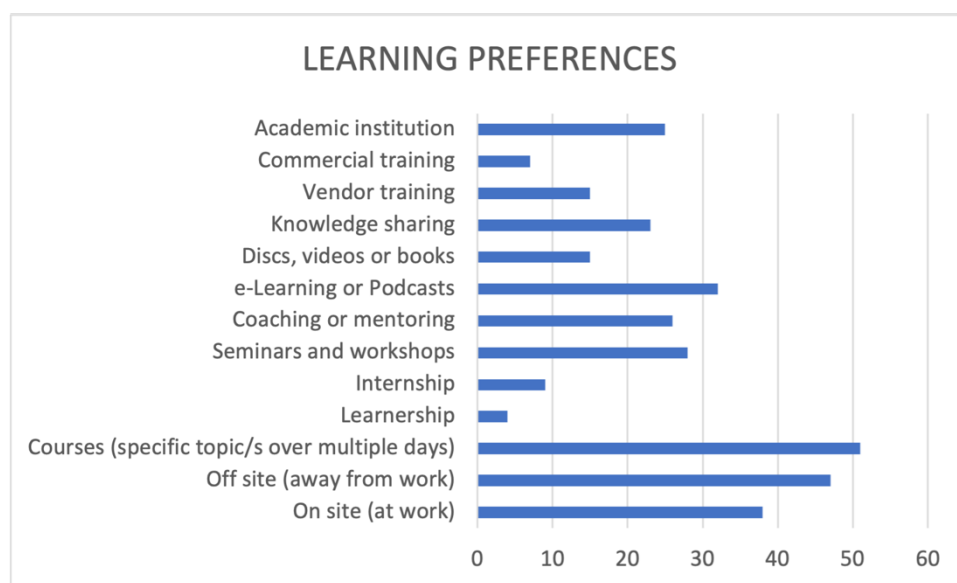
In 2017, we observed a shift away from on-site learning to offsite, when 53% of respondents preferred the latter. In 2018, the pendulum swung, and we show 57% of respondents favouring on-site again. In 2019, the pendulum swings again with 51% preferring off-site. This trend is repeated in 2021. There is still a high level of interest in courses and seminars/workshops. The shift away from commercial and vendor training remains, with ongoing support for e-Learning/Podcasts and knowledge sharing. As previously, there is still a strong interest in academic offerings.

In 2019, as we did with the Corporate respondents, we asked the practitioners if they felt they needed to reskill themselves in view of the changing digital environment. Again, the overwhelming answer was "yes". This has not changed in 2021. This represents a major opportunity for a dialogue between enterprises and practitioners, facilitated by professional bodies and training providers, to embark on a sustained reskilling programme for the foreseeable future.

CONCLUDING REMARKS

This is the eleventh edition of our Survey. The framework of questions directed to the employers of ICT skills and to the practitioners of ICT skills that we devised in 2008 remains the core of our Survey today, enabling us to identify trends through the consistency of the information. This is a significant achievement, as we reflect on the dynamic nature of the ICT industry and the dramatic shifts in technology development and application that have occurred in the last 13 years.

Between us carrying out our previous survey in 2019 and this, our current edition, the whole world has changed! Who would have predicted that within a few days in March 2020 we would change from working in offices, sitting in traffic jams and globe-trotting around the world to working from home and living our lives on digital platforms? While the long-term consequences of these changes are still to be fully understood, everyone will agree that there is very little prospect of the world reverting to the pre-COVID-19 "old normal". ICT has been at the forefront of the changes we've seen. Alongside the heroic health workers and vaccine developers, ICT professionals have kept businesses running, families together and society connected. Network engineers, application developers and data centre operators all deserve praise for what they have done … and continue to do.

In this, our first post-COVID-19 ICT Skills Survey, we tried to gain some initial insights into the new world of work and the skill sets required. The surprising finding is that there are no surprising findings! The findings in our survey show that the ICT industry has coped well in these disruptive times without needing to change much or re-invent itself. ICT companies and ICT professionals have coped well with new working conditions. They have not needed to scurry around hunting for new technologies and skill sets. Everything required for the "new normal" was already in place. Prophets of doom in the pre-COVID-19 world had much to say about how difficult is digital transformation. Although there is much more still to be done, "digital transformation" in multiple sectors and in organisations large and small simply happened in March 2020. We now have the opportunity to make it stick by ensuring that ICT continues to evolve. This will require the ongoing development of innovative technologies and growth in our skills base to meet increasing demands.

The JCSE and IITPSA will continue to track these changes in future editions of our Skills Survey.

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