ISSN: 2395-1680 (ONLINE)
DOI: 10.21917/ijms.2025.0344

THE AVAILABILITY OF ICT SKILLS IN SOUTH AFRICAN BUSINESS ORGANISATIONS: A LITERATURE REVIEW

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Abstract

Information and Communication Technologies (ICTs) have transformed various aspects of human life today, business included. In business organisations, ICT possess the potential of enhancing organisational processes and could contribute to their bottom-line performance. However, there is a critical shortage of ICT-related skills in South Africa, a challenge which motivated the present literature review. The objectives of the review were to establish the major ICT skills that are in demand within South African business organisations; to determine the causes of ICT skill shortages in South Africa, and to suggest possible solutions for ICT skills shortage in South African business organisations. A systematic review of the literature was done by searching the Web of Science (WoS) and SCORPUS databases. The PRISMA framework was relied on for question development whilst several inclusion and exclusion criteria were applied. A total of seven (7) articles were included in the review. The major findings were that there is a high demand for soft ICT-related skills in South Africa. Some of the major skills that are needed in the job market are graphic designing, automation, content creation, software development and social networking. The major causes of ICT skills shortage in South Africa are skills mismatches, potential costs of integrating ICTs, country effects and a skills-oriented economy. Also, there are various firm-level factors which can lead to ICT skills shortages, including the type of firm ownership, its level of innovation and informality. The strategies which can be used to address ICT skills shortages include the use of PPPs, training and education and attending to the current ICT-related policies. The research carries implications on ICT policy development because the findings directly map the root causes of ICT skills shortage.

Keywords:

ICTs; Skills; Skill Shortages; Skills Demand; Skills Supply; Business Organisations; South Africa

1. INTRODUCTION

ICT is a set of tools enabling, supporting, and reinforcing the sharing of information [81]. ICT is defined as a scientific, technological and engineering discipline and management technique used in handling information, its application and association with social, economic and cultural matters [81] [93]. It includes the internet, wireless networks, cell phones and other communication mediums. ICT is similarly defined as the means of creation, storage, management and dissemination of information by electronic means [47]. ICT comprises of: Capturing technologies (camrecorders); Storage technologies (CD-ROMs, DVDs, Pen drives, etc); [24] [29] Processing technologies (application software); Communication technologies (local area networks); and Display technologies (computer monitors, LCDs).

Technology has become intertwined with the daily lives of modern people and the advent of ICT in particular has greatly changed the landscape of human and organization activities around the world [79]. It follows that the application of technological knowledge has become an important skill in most aspects of life, including in business organisations. In particular, the adoption of Information and Communication Technology (ICT) has various benefits to the business organisation. At the centre of ICT adoption and use lies critical human resources and the need for competent personnel who can transform ICT capabilities into meaningful results for the organisation [34] [38]. However, the shortage of skills is an emergent issue which continues to afflict most business organisations, including those in South Africa. The rationale of this paper, therefore, is to critically review literature on the availability of ICT skills in South African business organisations [50].

1.1 BACKGROUND OF THE STUDY

ICTs have become an integral part of modern business organisations. ICTs include electronic machines and software which assist people to meet their objectives in the capturing, storage, analysis and communication of information or data [18]. Common examples of ICTs in business organisations are photocopiers, computers, printers, scanners and routers [37]. ICTs applied in business also include networking equipment like routers, dongles, disk drives as well as software programs [102]. These technologies facilitate various functions which allow the organisation to effectively carry out tasks for the achievement of their goals [62].

At the central of ICT use is the skill of the user. Skill relates to the comfort level that an employee has in terms of using a given computer program, application or hardware [78]. ICT skills are therefore more than mere computer literacy as they relate to the effectiveness to which someone understands and uses software or hardware [56]. It relates to the capacity of an employee to use ICTs in solving problems that can exists in the collection, storage, analysis and communication of information in digital environments. ICT skills, therefore, can be on the functional or high order levels and their mastery is a prerequisite for one's digital literacy, competence and proficiency [2]. It follows that an employee with good ICT skills will be capable to quickly, easily and effectively navigating a range of ICT-related tools and systems that characterise the digital environment in modern-day workplaces [74] [80].

ICT skills are diverse and cover various aspects or categories. These include information processing, data literacy and management as well as the communication of information using digital methods [72] [94]. ICT skills also include the creation of content, data security and the deployment of hardware for critical thinking and decision-making [59]. Such skills can be used at various levels. At the basic level, ICT skills include operating devices, using emails, navigating webpages and word processing [25]. At the advanced level, ICT skills include performing more sophisticated tasks like developing and applying artificial

intelligence (AI), cloud-based infrastructure, programming and software development [75].

Unfortunately, having employees highly skilled in ICTs is a challenge for business organisations the world over. In the European Union (EU), there are skills shortages in the labour market [31]. Within these countries, it is believed that over 57% of the firms have difficulties in obtaining and maintaining skilled CIT professionals [55]. The shortage of skilled ICT professionals is also a common problem in other countries around the world. For instance, 75% of the job openings in the United Kingdom (UK) require people with ICT skills, who are in short supply [31]. In sub-Saharan Africa, about 65% of job openings require professionals with a basic level of ICT proficiency, yet they are also scarce [45].

At the same time, the supply of ICT skills has not been able to keep up with the demand trends. In Europe, for example, only 58% of the citizens aged above 16 possess basic ICT skills. Similar trends have been observed in many countries, including China, Brazil, Mexico, Indonesia and South Africa [121]. Compounding the situation is the lack of ICT graduates or those from IT-related fields or in apprenticeships [92] [16]. Even though most young people interact with ICTs at home or in social settings, very few of them ae actively enrolled in school, college or university programs or apprenticeships [40].

As a result of the shortage of ICT professionals, firms continue to encounter the problem of skill gaps within their workforce. It is reported, for instance, that over 64% of large firms and 56% of small and medium enterprises (SMEs) report challenges in obtaining the proper candidates for their ICT-related job vacancies [46].

Even though Africa is currently the world's least developed continent, it is largely expected to lead the labour market in the near future. It is believed that a third of the young workforce and a fifth of the total global workforce will be African by year 2030 [71]. It is also believed that Africa currently contributes between 10 and 12 million workers to the global workforce annually [72]. As there are rapid developments and growth in the availability and use of the Internet, mobile phone subscriptions and mobile banking, ICTs will be a key determinant of labour market performance and economic performance both within Africa and globally in the near future [17] [82-84].

In South Africa, there has been an increase in the rate of digitalisation and associated with this increase has been a demand for ICT skills in the market [59]. Hard or soft ICT skills are needed in various sectors of the country, including the government, private businesses and in voluntary organisations [3]. South Africa's ICT sector grew to R248 billion in 2021 and compared to 2018 figures, this was an annual growth rate of 7.7% (). Whilst consumer electronics grew to 7.7%, electronics attained 1.6% growth whilst telecommunications increased in revenue to 6.4% [ICASA].

The South African government considers ICTs to be central in the development of the country. There are various policies which aim to ensure that ICT services are available, accessible and affordable in South Africa. For example, South Africa's ICT sector is guided by various legislation, including the Broadband Policy, the Electronic Transactions Act of 2005 and the Electronic Communications Act of 2005 [8]. The majority of these legislative guidelines are made and regulated by the Department of Communications and the Independent Communications Authority of South Africa (ICASA) [4].

1.1 STATEMENT OF THE PROBLEM

Even though it is generally agreed that the successful integration of ICTs requires professionals to make use of best practices, it is also known that basic skills are not sufficient [1]. Critical ICT skills gaps currently exist in most business organisations in South Africa, with most employees possessing only basic ones like knowledge of how to operate computer software and hardware [100] [64]. Studies suggest that South African employees lack in such advanced ICT skills as automation, digital video marketing, data analysis, content marketing and user experience modelling [77] [4] [22] [67].

As a result of having only basic ICT skills, professionals end up only using ICTs to present information and not to effectively use it in generating thoughts or to impart critical thinking for the benefit of their organisations [77]. To make up for the skill gaps, South African organisations are having to hire skilled ICT professionals from other countries, which comes with greater costs and at a disadvantage to local employees [59].

1.2 OBJECTIVES

The following were the objectives of this paper;

- To establish the major ICT skills that are on demand within South African business organisations.
- To determine the causes of ICT skill shortages in South Africa.
- To suggest possible solutions to ICT skills shortage in South African business organisations.

1.3 RESEARCH QUESTIONS

The paper was guided by the following research questions:

- What are the major ICT skills that are on demand within South African business organisations?
- What are the possible causes of ICT skill shortages in South Africa?
- Which solutions can be used to effectively manage ICT skills shortage in South African business organisations?

1.4 SIGNIFICANCE

This paper was of academic importance in many aspects. Academic focus on how ICTs influence the labour market and development has mostly been from the developing country context. Despite how ICTs and the skills associated with them have become important in economic transformation, there still is limited research on the nature, extent and possible impact of these skills on business organisations [17]. Most of the empirical studies that have been done on the issue of ICT skills have tended to focus on developed nations, particularly by emphasising the issues of disruptions within the market [103-104] [108-109]. There is still a limit in the number of studies which focus on ICT skills from the context of developing countries. Given the diverse and different market characteristics of developing countries, as well as demographic distinctiveness within the labour force, it is difficult to generalise from current studies on ICT skills

availability in African countries like South Africa [66]. Developing countries also have higher rates of informal or self-employment and this represents a uniqueness in the organisation of their labour markets and how they can be affected by the adoption of ICTs [75].

The present paper, therefore, serves to fill current the knowledge gap on the state of ICT adoption in developing nations like South Africa. This is achieved by reviewing the literature on the issue of ICT-related skills gaps in South African business organisations or firms. The paper makes unique contributions on the major ICT skills that are in demand within South African business organisations. Another major contribution of the paper is in identifying the context-specific causes of ICT skill shortages in South Africa, as well as possible solutions to the problem of ICT skills shortages in South African firms.

2. LITERATURE REVIEW

2.1 MAJOR ICT SKILLS THAT ARE IN DEMAND IN BUSINESS ORGANISATIONS

The literature shows that there are some skills that are in greater demand over others in the ICT sector. In most developed countries including in Germany, Sweden, Australia, France and the UK, software and applications development skills are in greater demand over other ICT-related skills [117] [2] [118]. It has also been suggested that developed countries have a strong demand for employees with cybersecurity skills especially in the face of disruptive events [55] [32]. The demand for these ICT skills has been tied to economic benefits which vastly differ from one country to another [115] [92]. Clearly, the literature is skewed towards an understanding of skills in demand within developed countries over those that are developing, including South Africa.

The literature also shows that the skills demand in a country relates to the demand needs of the economy [57]. Literature shows that the demand for ICT skills is region specific and depends on the localised contexts. For instance, in the UK, it is believed that the major skills that are in demand are big data analytical skills [112] [5]. The success factors for AI adoption in China are different from those which influence its adoption in others countries of the world, South Africa included [23]. Country effects are also known to influence the type of skills that exist within the labour market [57].

The existence of country effects in the literature relating to the availability of ICT skills makes it important to examine current knowledge from the South African context. Given that there are country effects and context-specific differences in the demand and supply of ICT skills, literature from other regions may be difficult to apply to the South African setting. This was one of the motivations for this paper.

2.2 CAUSES OF ICT SKILL SHORTAGES IN BUSINESS ORGANISATIONS

In the literature, there are various reasons why firms continue to face shortages in competent ICT employees for their workforce. Some studies show that the gaps between an employee's qualification and their actual job competencies are among the major causes for ICT skill shortages [58]. For instance, a study on workforce competency in Thailand showed that most graduates cannot meet job demands as they lack advanced knowledge of ICTS apart from having basic knowledge and familiarity with technology systems [101].

Literature shows general consensus on how most organisational employees lack in such advanced ICT competencies as online collaboration and data analysis (van Laar, van Deursen, van Dijk and De Haan, 2020).

Other studies suggest that ICT skill shortages are a direct result of digitalisation and globalisation. Both rapid digitalisation and globalisation are responsible for the rise in the need for ICT specialists and professions in the first place [105] [13] [26]. The literature also identifies various organisation-level factors which contribute to ICT skill shortages in firms [33]. Studying the case of India, Paul [90] mentions that skills shortages are a result of, among other factors, poor recruitment and selection processes at the organisational level. Firms which fail to properly attract, screen, select and develop ICT professionals are bound to face shortages since some of the people employed will not have the proper skills needed in their job roles [96] [21].

From this review, it is clear that understanding the root causes of ICT skills shortages is not straightforward, particularly given how country-specific and socioeconomic contexts widely vary. This review deals with this challenge by focusing on the specific context of what causes ICT skills shortages in South Africa.

2.3 POSSIBLE SOLUTIONS TO ICT SKILLS SHORTAGES IN BUSINESS ORGANISATIONS

As expected, the literature also contains some suggestions to deal with the shortages of ICT skills in firms. Some studies suggest that vocational education and training (VET) is a more effective alternative to formal education in addressing ICT skills gaps [92] [39]. Other scholars suggest the need for progressive curriculum development and transformation to enhance lifelong learning in ICT fields [51]. This is so because the ICT field is a rapidly evolving field which means that current education or training methods may provide ineffective in the near future. It has been stated that higher education should keep up with changes and advances in the ICTs field [30]. To this end, educational transformation is also a strategy which is widely suggested in the academic literature [120].

In the argument for the redesign of curricula, there is a lack of consensus on when and how such curricula can be redesigned. A significant number of studies suggest that curricula reforms should be attended to at the vocational or university levels, including by infusing blended learning strategies [42] [111] [10] [27]. On the other hand, there is also a significant number of studies which argue on the need for the redesign of ICT curricula from as early as early childhood learning stages [12] [106] [35] [119] [54].

There is also a lack of agreement on the most effective teaching strategies, learning materials and curriculum content [78] [73] [116]. For example, Ibrahim [42] suggested changing from a subject-based to a skill-based curriculum in Abu Dhabi schools, yet the methods of doing so remained vague. This lack of agreement and evidence on the best stage of curricula redesign or transformation complicates the practice and necessitates further studies on the subject. This was among the key motivations for the present paper.

3. METHODOLOGY

3.1 QUESTION DEVELOPMENT

This paper made use of a systematic review of literature with the aim of establishing the availability of ICT skills in South African business organisations. The study used the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) framework to identify the inclusion and exclusion criteria. This framework was used since it helps researchers to understand the reasons for a study being carried out, the activities of the study and its findings [86]. The flow diagram of the PRISMA used in the paper is presented in Fig.1.

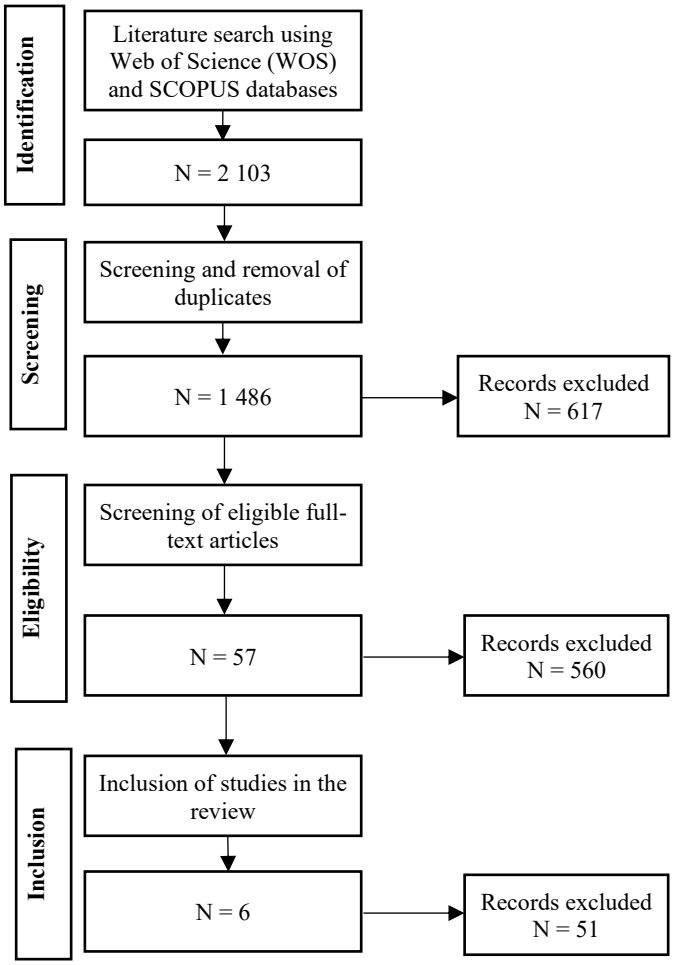

Fig.1. PRISMA diagram

3.2 INCLUSION AND EXCLUSION CRITERIA

Inclusion and exclusion criteria for the review were derived from the research questions and objectives. These criteria were used to establish the key features and characteristics that could be relied on in answering the research questions effectively [89]. For inclusion, the paper used studies which had the following characteristics;

- Those focusing explicitly on the private sector, including both large organisations and SMEs. Excluded were studies focusing on other sectors, such as the public sector or private voluntary organisations.
- Studies focusing on ICTs and not those relating to non-ICT related concepts.
- Studies focusing on ICT use in South Africa only. The review excluded studies done in other countries.
- Papers with full articles. Abstracts, pre-releases and preprints were excluded.
- Journal articles published in the English language between January 2019 and July 2023. Articles in other languages, non-journal papers, books or magazines were excluded from the review.

3.3 SEARCH STRATEGY

The review also followed a well-planned search strategy. Focus of the search was on the inclusion of several databases on emergent, original and published ICTs research. In particular, the review included the Web of Science (WOS) (www.webofknowledge.com) and SCOPUS (www.scopus.com) databases to obtain possible articles for inclusion. The rationale for using these two databases arose from their high global recognition and quality since they possess comprehensive, peer-reviewed and original research articles [91]. The ICT articles from these databases are rich and often up to date, which was of importance in this review especially given the rapid developments that occur in the technological field in time [19]. Combining the two databases was done to enhance the bibliometric quality of the review, as suggested by Kumpulainen and Seppanen [53].

Having selected the databases, the search strategy also included the use of key words. These keywords were derived from the search questions of the review. Among the keywords used in the search for literature were “ICT skills”, “business organisations” and “South Africa”. Boolean operators were included in the search in order to obtain the best output. The Boolean strings were important to structurally join the keywords of the search. The main search terms was South Africa and this was integrated with other terms in order to obtain the relevant literature for inclusion into the review. Table 1 shows that all the search strings comprised of distinct parts and this was done to obtain a wide range of results on the most possible articles for integration into the review.

Table.1. Search strings used.

Database	Search descriptors
WOS	TS (“South Africa”) AND TS (“ICT Skills” OR “Technological Skills”) AND TS (“Business organisations” OR “Firms”) AND TS (“Shortages” OR “Challenges”).
SCOPUS	TITLE-ABS-KEY (“South Africa”) AND TITLE-ABS-KEY (“ICT skills” OR “Technological skills”) AND TITLE-ABS-KEY (“Business organisations” OR “Firms” OR “Companies”).

3.4 SELECTION OF STUDIES

Initially, the literature identification process obtained 2 103 articles from the SCOPUS and WOS databases, 887 of which were from SCOPUS and from 1 216 WOS. Examination of the titles and abstracts was done to eliminate articles which did not meet the inclusion criteria of the review. From this process, a total

of 1 486 articles were removed. The PRISMA approach was also relied on to provide a fixed structure through which to review articles. Application of eligibility criteria led to 57 articles. After further application of the inclusion and exclusion criteria, a total of six (6) articles were included in this review. These were articles that matched the search question and topic by theme and which contained the relevant issues as sought in the search. A summary of the articles obtained and used in the review is presented in Table.2.

Table.2. Summary of studies included in the review

Author(s) and Publication Year	Type of study	Aims	Methodology	Key findings or themes	Recommendations
Avenyo, Bell and Nyamwena (2022).	Survey	Determinants of the adoption of digital technology in South African firms.	Quantitative	Heterogeneous factors affect the adoption of digital technology in the firms.	Need for capital and digital infrastructure.
Gqoboka, Anakpo and Mish (2022).	Desk research.	ICT challenges and coping strategies of SMEs in light of COVID-19.	Qualitative.	Coping strategies include changing marketing methods, laying off workers and changing to highly consumable products.	Need for enhanced complementary role of stakeholders, including government and private players.
Civilcharran and Maharaj (2023).	Survey	Assessing the digital skills requirements of South African businesses.	Quantitative	Digital skills should encompass software development, security and use of information systems.	More time should be spent training employees on digital skills.
Alao and Brink (2021).	Survey	Factors which affect youth employability.	Quantitative.	ICT skills impact on youths' employability.	Need for practical pedagogy in order to prepare young people for the job market.
Osman, Malanga and Chigona (2019).	Survey.	To ascertain SMEs' experiences with using ICTs.	Qualitative.	SMES face government support challenges and lack of information support services.	Need for government support and up-to-date support information.

4. RESULTS AND DISCUSSION

From the review of the literature, several findings and themes emerged. Table 3 contains a summary of the frequency of thematic codes across the seven articles in the review.

Table.3. Comparison of number of coding references across articles

Paper	Number of coding references	Number of codes coding
Article 1	37	3
Article 2	27	2
Article 3	3	1
Article 4	3	1
Article 5	15	2
Article 6	7	2

Table 3 shows that the majority of the thematic codes in the review were from Articles 1 and 2. Also, Articles 5 significantly contributed to the themes in the review.

A review of the themes emerging from the review was done in line with the objectives of this paper. The themes from the articles were classified under the objectives of the present paper. Fig.2 presents a hierarchy chart of the major themes that emerged in the review.

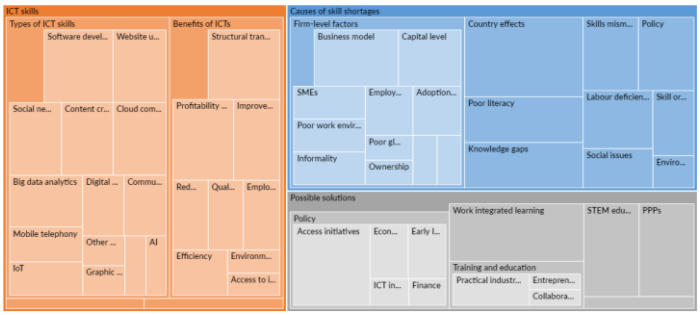

Fig.2. Hierarchy chart showing major themes from the review

4.1 MAJOR ICT SKILLS IN DEMAND WITHIN SOUTH AFRICAN BUSINESS ORGANISATIONS

The major ICT skills that are in demand within South African firms, as obtained from the review, are shown in Fig.3.

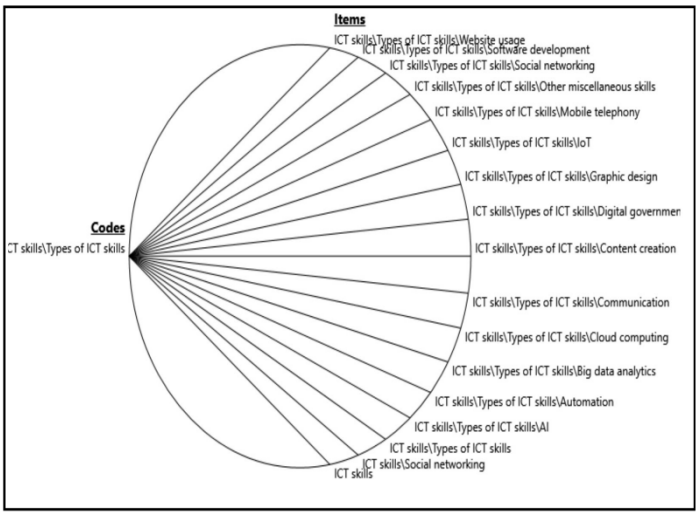

Fig.3. Major ICTs skills that are in demand in South African firms

Findings show that some ICT skills are in greater demand over others within the South African job market. The major skills in demand in South African business organisations include basic website and mobile telephone use. Literature also shows that there is a huge demand for advanced ICT-related skills in South Africa. This was found to include most soft ICT skills like software development, social networking skills and competency in managing IoT systems. To some extent, these findings reiterated the suggestions that there is a high demand for both soft and hard ICT skills [118] [61] [20]. However, a balance between soft and hard skills is commonly required in the labour market as employers demand specific competencies which associated with them [107]. Balancing between these skill types is what determines employability, even though there is a tendency for graduates to possess more of hard skills at the expense of soft skills [41].

Findings were also that there is a high demand for skills in graphic design, cloud computing and big data analytics (BDA). These findings are similar to the same observations highlighted by the ITPSA ICT Skills Survey and Research Report [44] which observed ICT skills gap in Artificial intelligence / machine learning, Big data / data science, Data storage and Information security/cybersecurity. To some extent, there is a demand for soft skills like automation, the management of AI systems and social networking. Content creation is also another skill which was suggested as being in demand among South African business organisations. These skills are among the currently leading ICT skills in most industries and countries, South Africa included [6] [15]. With the development of new technological systems, algorithms and models, the methods of using ICTs have drastically changed to warrant the need for such soft skills as cloud computing and BDA since they appeal more to business organisations over basic skills like knowing how to use a computer [95]. For the modern business organisation, therefore, an employee competent in these soft skills is more valuable than one who is not. This is the genesis of the huge demand for soft ICT-related skills in the South African workforce.

4.2 CAUSES OF ICT SKILL SHORTAGES IN SOUTH AFRICA

As expected, the review of literature reveals varied reasons for the problem of ICT skill shortages in South Africa. Literature shows that the costs potentially involved with learning and using ICT skills are among the major causes for skills shortages in South Africa. There is a limited access to ICTs among would-be employees. High costs of learning and applying ICTs are among the bottlenecks to their adoption in South Africa [11] [24]. Even though some studies argue that there is a high integration of ICTs within South Africa's academic curricula, it is the effectiveness of such programs that remains in question [110] [9]. The theory does not match the practice.

Another major contributor to skills shortages are labour deficiencies, particularly with relations to skilled workers who are capable of imparting hand-on skills and knowledge to their peers. This situation is one of the major reasons for the unfilled need for ICT skills in most South African firms [3] [52]. The labour deficiencies also affect the retention of critical ICT skills in the firms [4].

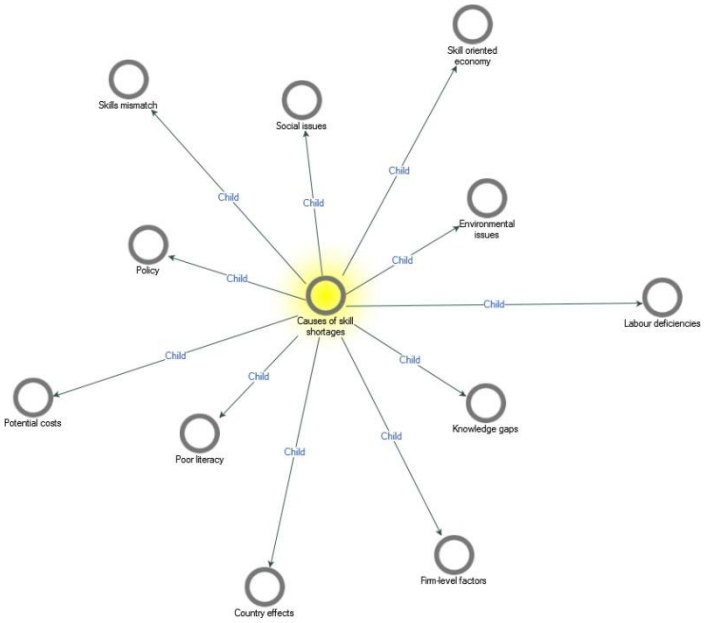

Fig.4. Causes of ICT skills shortages in South African business organisations

Apart from the above, a skill-oriented economy is also among the contributors to the shortage of skills and the rise in demand for them in South Africa. The rise of ICT has an upskilling effect and lead to a decrease in the demand for low-skilled workers [92]. On the other hand, it results in a much greater need for highly-skilled ICT workers [7]. In fact, ICT itself is usually characterised by skill-biased technologies [14]. For example, a software developer based in the C++ programming language may not fit a job role for a developer trained in Java script. There is, therefore, a need for more of vocationally educated ICT workers in South African firms.

The literature also shows that another key contributor to skill shortages in the country are skill mismatches. This is a common problem in countries like South Africa because the educational traits and qualifications of the employee may not fit their job roles

[39]. Skill mismatches are common especially as a result of differences in curricula's taught elements and job requirements [88] [68]. From this, it is clear that skill mismatches not only lead to unemployment but also to a shortage of ICT skills in South Africa's labour market.

The Fig.4 presents a summary of the major causes of ICT skill shortages in South African business organisations.

Apart from the causes discussed above, firm-level factors were also revealed as being among the major contributors to the shortage of ICT skills in South Africa. Among the major firm-level factors were those associated to the type of the business organisation. A major contributor is the SME nature of the firm, which comes associated with poor ownership structures and low capital levels. Start-ups are usually characterised by the lack of skills, poor ICT strategies low networking [2] [97]. There can also be problems associated with high informality in the SMEs, which can contribute to the lack of innovativeness and serve as barriers to ICT adoption. The result is low demand for ICTs within such firms, which can manifest as low ICT skills demand or the high need for soft, specialised skills in South Africa's labour market [28].

Country effects are a major contributor to the shortage of skills in South Africa. In particular is the level of economic development and sociodemographic issues. Linkages have been identified between ICT adoption and economic growth, including in developing countries like South Africa [32] [115]. ICTs polarise the demand for skills by improving macroeconomic growth [96]. Socially, there are relationships between ICT adoption and the living standards of people [87] [92] [96]. Such characteristics, which are unique to a particular country, tend to influence how ICTs are demand for in the labour market.

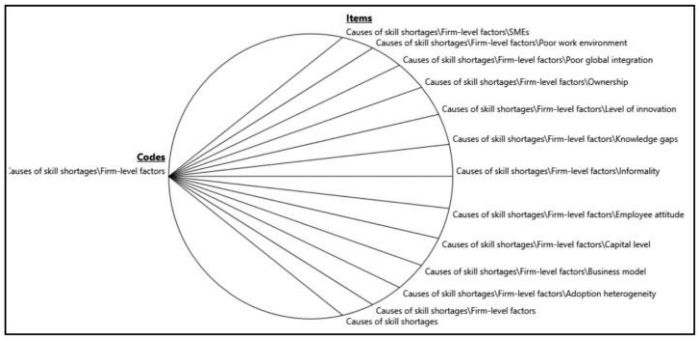

Fig.5. Firm-level factors causing shortages of ICT skills in South African firms

Literature also shows that South African firms can also have the challenges of poor work environments and poor business models which can impact on the integration of ICT skills. The structure of the firm is related to the extent to which it applies technology in its operations, with, most large firms being more capable of integrating ICTs as compared to smaller firms [122]. Apart from this, knowledge gaps and low innovation are also some of the issues which can be faced at the firm level [96].

Literature also shows that most South African firms have a high heterogeneity in adopting ICTs, which significantly influences the demand for ICT skills [43] [49] [69]. Given the high diversity of firms and their industrial contexts, there are associated with the relevant ICTs used in business processes [76] [18]. It follows that firm diversity or heterogeneity in adopting ICTs can serve as a factor that leads to the shortage of ICT skills in South Africa.

Among the factors which cause shortages in ICT skills in South Africa, firm-level factors seemed to be a dominant theme within this review. The Fig.5 shows some of the major firm-level factors leading to the shortage of ICT skills in South Africa.

4.3 POSSIBLE SOLUTIONS TO ICT SKILLS SHORTAGES IN SOUTH AFRICAN BUSINESS ORGANISATIONS

There are also various strategies which are suggested to help resolve the problems of ICT skills shortages in South Africa. Themes that emerged from the review in this regard included the potential of using training and education, STEM education and work-related learning. The basis of these recommendations was the need to improve on the education of would-be employees within schools, vocational learning centres and universities. The rationale for this emerged from the realisation that current ICT learning curricula are challenged especially when it relates to applying learnt material in real-world business settings [22]. Ameliorating this challenge therefore calls for the need to equip learners with practical, hand-on and relevant ICT knowledge [65] [48]. In the present paper, there is a need for training programs to emphasise the soft skills aspect of ICTs. This is because the possession hard skills at the expense of soft ones is among the root causes of ICT skills shortages in South Africa.

Other strategies that were revealed in the review include attending to the policy framework and the use of private-public partnerships (PPPs). Policy attention should emphasises ways of improving ICT competency among would-be employees, particularly through academic curricula. The literature suggests that policies aimed at curricula reform should be put in place [118] [85] [3]. Integrating ICTs in schools, especially in early learning stages, is largely recommended [60]. Policies that enhance job readiness, work-related learning, ICT competency and fine skills should be brought forward [70]. However, policy consistency, effectiveness of implementation and regular reviews are also recommended as the methods of ensuring their utility [36]. It follows that South Africa need to urgently address its current ICT policy framework if skills shortages within the job market are to be managed.

Apart from policies, PPPs are also another strategy that could help manage the ICT skill shortages in South Africa. PPPs can enhance investments in the ICT sector in South Africa and there have been calls for the use of this strategy in the country's major capital projects, ICT included [98]. Given growing fiscal constraints in the country, the viability of ICT policies can be enhanced through PPPs [99]. Even though PPPs are known to have been adopted in such sectors as South Africa's healthcare, public transport and water infrastructure, it is a relatively new domain to use them in the ICTs sector [63] [99]. This calls for more empirical evidence to guide the relatively novel terrain of using PPPs in the area of ICT skills advancement.

The Fig.6 shows a summary of the major solutions that can be adopted to deal with the shortages of ICT skills in South Africa, as obtained from the review.

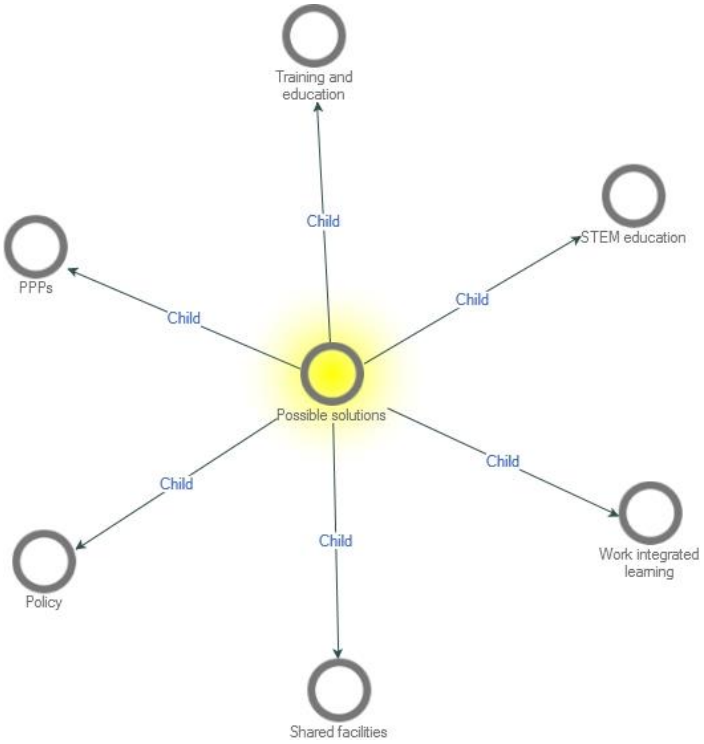

Fig.6. Strategies that can be used to address ICT skills shortages in South Africa

5. CONCLUSION

The aim of this paper was to review the literature on the availability of ICT skills by explicitly focusing on studies done in South Africa. The review reiterated the general position in the literature that indeed there is a shortage of ICT skills within the South African workforce. In particular, it was established that whilst basic ICT skills like computer usage are available, there is a critical shortage of the more important soft ICT skills among employees in most of South Africa's firms.

There is a high demand for soft ICT-related skills in South Africa. Some of the major skills that are needed in the job market are graphic designing, automation, content creation, software development and social networking. However, there is a low demand for hard and basic skills like the mere ability to use a computer. Among the major causes of skills shortages in South Africa are skills mismatches, potential costs of integrating ICTs, country effects and a skills-oriented economy. The review also shows that there are various firm-level factors which can lead to ICT skills shortages, including the type of firm ownership, its level of innovation and informality. Despite the current ICT skills shortages in the country, various strategies can be used to address the problem. These include the use of PPPs, training and education and attending to the current ICT-related policies.

The research findings carry broad implications on ICT policy development in South Africa. The ICT skills availability that were mapped out in the study give a clear picture on the state of ICT skills prevalence to policy makers. The causes of ICT skills shortage that were identified by this research also directly inform strategies that can be developed to upgrade ICT skills that are on demand so that they serve the industry and national needs.

In general, this review shows that even though the challenge of ICT skills shortages in South Africa is real, it can be addressed by using several strategies. In fact, the current skills shortages challenge is associated with some opportunities since its management can come with various economic benefits like reducing unemployment and enhancing economic performance through more vibrant business organisations and firms.

REFERENCES

[1] A. Ade-Ibijola and C. Okonkwo, "Artificial Intelligence in Africa: Emerging challenges. Responsible AI in Africa. Palgrave MacMillan, 2023.

[2] K. Ali Alam, M.A. Erdiaw-Kwasie, M. Shahiduzzaman, M. Velayutham, E. Murray and P.A. Wiesner, "Impact of ICTs on Innovation and Performance of Firms: Do Start-Ups, Regional Proximity and Skills Matter?", *Sustainability*, Vol. 14, No. 10, pp. 1-12, 2022.

[3] A. Alao and R. Brink, "Strategies for using ICT Skills in Educational Systems for Sustainable Youth Employability in South Africa", *Sustainability*, Vol. 14, pp. 16513-16525, 2022.

[4] R.W. Albertus and D. Hamman-Fisher, "Investigating Information Technology Skills Retention Challenges in South Africa's Public Sector", *African Journal of Science, Technology, Innovation and Development*, Vol. 13, No. 5, pp. 1-13, 2021.

[5] A. Alibasic and M.A. Omar, "Evaluation of the Trends in Jobs and Skill Sets using Data Analytics: A Case Study", *Journal of Big Data*, Vol. 9, No. 32, pp. 1-13, 2022.

[6] Al-Jumaili, A.H.A. Muniyandi, R.C. Hasan and M.K. Paw, "Big Data Analytics using Cloud Computing based Frameworks for Power Management Systems: Status, Constraints and Future Recommendations", *Sensors*, Vol. 23, No. 6, pp. 781-789, 2023.

[7] F. Alshubiri and S.A.F. Jamil, "The Impact of ICT on Financial Development: Empirical Evidence from the Gulf Cooperation Council Countries", *International Journal of Engineering Business Management*, Vol. 14, No. 2, pp. 1-11, 2019.

[8] K. Aruleba and N. Jere, "Exploring Digital Transforming Challenges in Rural Areas of South Africa through A Systematic Review of Empirical Studies", *Scientific African*, Vol. 16, pp. 119-128, 2022.

[9] M.K. Asamoah, "ICT Officials' Opinion on Deploying Open Source Learning Management System for Teaching and Learning in Universities in a Developing Society", *E-Learning and Digital Media*, Vol. 18, No. 1, pp. 1-8, 2020.

[10] M.A. Ashraf and M.I. Asghar, "Fostering ICT Competencies in Blended Learning: Role of Curriculum Content, Material and Teaching Strategies", *Frontiers in Psychology*, Vol. 33, pp. 21-42, 2022.

[11] E.K. Ayenyo, J.F. Bell and J. Nyamwena, "Determinants of the Adoption of Digital Technologies in South African Manufacturing: Evidence from a Firm-Level Survey", *DSI/NRF South African Research Chair in Industrial development, Pretoria*, Available at https://www.uj.ac.za/wp-content/uploads/2021/10/sarchi-wp-2022-13-avenyo-e-k--bell-j-f--nyamwena-j-october-2022.pdf, Accessed in 2022.

[12] K. Bati, "A Systematic Literature Review Regarding Computational Thinking and Programming in Early Childhood Education", *Education and Information Technology*, Vol. 27, pp. 2059-2082, 2022.
[13] P. Beer and R.H. Mulder, "The Effects of Technological Developments on Work and their Implications for Continuous Vocational Education and Training: A Systematic Review", *Frontiers in Psychology*, Vol. 56, pp. 1-15, 2020.
[14] A. Beerli, R. Indergrand and J.S. Kunz, "The Supply of Foreign Talent: How Skill-Biased Technology Drives the Location Choice and Skills of New Immigrants", *Journal of Population Economics*, Vol. 36, pp. 681-718, 2023.
[15] L. Belcastro, R. Cantini and P. Trunfio, "Programming in Big Data Analysis: Principles and Solutions", *Journal of Big Data*, Vol. 9, No. 4, pp. 1-18, 2022.
[16] M. Bettiol, M. Capestro, M. Di Maria and S. Micelli, "Disentangling the Link between ICT and Industry 4.0: Impacts of Knowledge-Related Performance", *International Journal of Productivity and Performance*, Vol. 71, No. 4, pp. 1-25, 2021.
[17] H. Bhorat and C. J. Rooney, "*Digitalisation in Africa: An Empirical Profile*", Global Economy and Development, 2023.
[18] J. Birt, M. Safari and V.B.M. De Castro, "Critical Analysis of Integration of ICT and Data Analytics into the Accounting Curriculum: A Multidimensional Perspective", *Accounting and Finance*, Vol. 35, No. 2, pp. 1-12, 2023.
[19] W.M. Bramer and O.H. Franco, "Optimal Database Combinations for Literature Searches in Systematic Reviews: A Prospective Exploratory Study", *Systematic Reviews*, Vol. 6, pp. 245-269, 2017.
[20] J. Brown and A. Parr, "ICT Skill Frameworks: do they achieve their Goals and Users' Expectations?", *Advanced Journal of Professional Practice*, Vol. 1, No. 2, pp. 81-102, 2018.
[21] G. Brunello and P. Wruuck, "Skill Shortages and Skill Mismatch: A Review of the Literature", *Journal of Economic Surveys*, Vol. 35, No. 4, pp. 1-13, 2021.
[22] S. Bvuma and C. Marnewick, "An Information and Communication Technology Adoption Framework for Small, Medium and Micro-Enterprises Operating in Townships in South Africa", *Southern African Journal of Entrepreneurship and Small Business Management*, Vol. 12, No. 1, pp. 1-18, 2020.
[23] H. Chen, L. Li and Y. Chen, "Explore Success Factors that Impact Artificial Intelligence Adoption on Telecom Industry in China", *Journal of Management Analytics*, Vol. 8, No. 1, pp. 36-68, 2021.
[24] S. Civilcharran and M.S. Maharaj, "Digital Skills Requirements of the Real Estate, Finance and Business Services Sector in South Africa", *South African Journal of Higher Education*, Vol. 37, No. 3, pp. 73-99, 2023.
[25] G. Cutuli and A. Tomelleri, "Returns to ICT Skills Use and Labour Market Institutions", FBK-IRVAPP Working Papers. Research Institute for the Evaluation of Public Policies, Bruno Kessler Foundation, 2023.
[26] J. Darmont, B. Novikov and L. Bellatreche, "Advances on Data Management and Information Systems", *Information Systems Frontiers*, Vol. 24, No. 1, pp. 1-12, 2022.
[27] A. Dilekci and H. Karatay, "The Effects of the 21st Century Skills Curriculum on the Development of Students' Creative Thinking Skills", *Thinking Skills and Creativity*, Vol. 47, pp. 1-12, 2023.
[28] S. Dixit and P. Singh, "Study of Enabling Factors Affecting the Adoption of ICT in the Indian Built Environment Sector", *Ain Shams Engineering Journal*, Vol. 12, No. 2, pp. 2313-2319, 2021.
[29] R. Dlamini and A. Dewa, "Beyond Optimistic Rhetoric: Social and Cultural Capital as Focal Deterrents to ICT Integration in Schools", *International Journal of Education and Development using Information and Communication Technology*, Vol. 17, No. 3, pp. 19-37, 2021.
[30] O. Doherty and S. Stephens, "The Skill Needs of the Manufacturing Industry: Can Higher Education Keep Up?", *Education and Training*, Vol. 63, No. 4, pp. 1-12, 2021.
[31] European Commission, "Digital Economy and Society Index (DESI) 2020: Human Capital", Available in: https://digital-strategy.ec.europa.eu/en/policies/desi-human-capital, Accessed in 2023.
[32] O. Falck, A. Heimisch-Roecker and S. Wiederhold, "Returns to ICT Skills", *Research Policy*, Vol. 50, pp. 1-7, 2021.
[33] S. Garbellano and M.D.R. Da Veiga, "Dynamic Capabilities in Italian Leading SMEs Adopting Industry 4.0", *Measuring Business Excellence*, Vol. 23, No. 1, pp. 1-4, 2019.
[34] G. Gcezengana, B. Peter, T. Rulashe and Z. Coka, "An Investigation of a Nexus between Employee Skills Development and Competence in the Eastern Cape Department of Education", *Africa's Public Service DPR*, Vol. 10, No. 1, pp. 1-18, 2021.
[35] M.K. Goddu, T. Lombrozo and A. Gopnik, "Transformations and Transfer: Preschool Children Understand Abstract Relations and Reason Analogically in a Causal Task", *Child Development*, Vol. 91, pp. 1898-1915, 2020.
[36] H. Gqoboka, G. Anakpo and S. Mish, "Challenges Facing ICT use during COVID-19 Pandemic: the Case of Small, Medium and Micro Enterprises in South Africa", *American Journal of Industrial and Business Management*, Vol. 12, pp. 1395-1401, 2022.
[37] F.D. Guillen-Gamez and M.G. Garcia, "Digital Competence of Teachers in the use of ICT for Research Work: Development of an Instrument from a PLS-SEM Approach", *Educational Information Technology*, Vol. 15, pp. 1-21, 2023.
[38] F.T. Gunzo, "Teachers' Perceptions, Experiences and Challenges Related to using ICTs in Teaching Social Sciences in Marginalised Classrooms in the Eastern Cape Province, South Africa", Master Thesis, Department of Management Studies, Rhodes University, pp. 1-87, 2020.
[39] A. Habiyaremye, T. Habanabakize and C. Nwosu, "Bridging the Labour Market Skills Gap to Tackle Youth Unemployment in South Africa", *The Economic and Labour Relations Review*, Vol. 33, No. 4, pp. 1-4, 2022.
[40] T. Hamaluba, "An Assessment of Computer and ICT Skills at Botswana Open University: Implications of ICT Business Subjects", *Journal of Learning for Development*, Vol. 9, No. 1, pp. 104-116, 2022.

[41] N. Hoque, M. Uddin and A.H. Alam, "The Desired Employability Skills and Work Readiness of Graduates: Evidence from the Perspective of Established and Well-Known Employers of an Emerging Economy", *Proceedings of International Conference on Industry and Higher Education*, pp. 1-7, 2023.

[42] Y.A. Ibrahim, "*Moving Form the Subject-Based Curriculum to the Skill-Based Curriculum in Abu Dhabi Schools: Does It Lead to Reform? A Theoretical Analysis and Case Study Paper in one of Abu Dhabi Private Schools*", Lecture Notes in Civil Engineering, Vol. 320, pp. 97-106, 2023.

[43] J.I. Igwilo, "ICT Adoption and Stock Market Development: Empirical Evidence using a Panel of African Countries", *Risks*, Vol. 10, No. 2, pp. 81-97, 2021.

[44] Institute of Information Technology Professionals South Africa (IITPSA), "ICT Skills Survey and Research Report", Available at: https://www.iitpsa.org.za/wp-content/uploads/2024/10/2024-IITPSA-ICT-Skills-Survey-and-Research-Report.pdf, Accessed in 2024.

[45] International Finance Corporation (IFC), "Digital Skills in Sub-Saharan Africa: Spotlight on Ghana", Available at: https://www.ifc.org/wps/wcm/connect/ed6362b3-aa34-42ac-ae9f-c739904951b1/Digital+Skills_Final_WEB)5-7-19.pdf, Accessed in 2023.

[46] International Labour Organisation (ILO), "Skills Shortages and Labour Migration in the Field of Information and Communication Technology in Canada, China, Germany and Singapore", Available at: https://www.ilo.org/sector/Resources/publications/WCMS_755663/lang--ja/index.htm, Accessed in 2023.

[47] T. Iorfa and T.R. Iorver, "Information and Communication Technology Skills Possessed by Reference Librarians for Service Delivery in Universities in Nasarawa State, Nigeria", Available at: https://ssrn.com/abstract=4759135, Accessed in 2024.

[48] J.N. Jere and N. Ngidi, "A Technology, Organisation and Environment Framework Analysis of Information and Communication Technology Adoption by Small and Medium Enterprises in Pietermaritzburg", *South African Journal of Information Management*, Vol. 22, No. 1, pp. 1-17, 2020.

[49] O. Johnson and T. Iyamu, "Framework for the Adoption of E-Commerce: A Case of South African Retail Grocery Sector", *The Electronic Journal of Information Systems in Developing Countries*, 85, No. 1, pp. 1-5, 2019.

[50] T. Johnston, "Training Teachers to Bridge the Digital Divide", *William and Mary Educational Review*, Vol. 3, No. 2, pp. 15-17, 2015.

[51] J. Kim and C.Y. Park, "Education, Skill Training and Lifelong Learning in the Era of Technological Revolution: A Review", *Asian-Pacific Economic Literature*, Vol. 34, No. 2, pp. 3-19, 2020.

[52] M. Kirlidog, M. Zeeman and W. Coetzee, "Unfilled Need: Reasons for Insufficient ICT Skills in South Africa", *Information Development*, Vol. 34, No. 1, pp. 23-39, 2016.

[53] M. Kumpulainen and M. Seppanen, "Combining Web of Science and Scopus Datasets in Citation-Based Literature Study", *Scientometrics*, Vol. 127, pp. 5613-5631, 2022.

[54] E. Kupers and P. Van Geert, "Children's Creativity: A Theoretical Framework and Systematic Review", *Reviews in Education Research*, Vol. 89, pp. 93-124, 2019.

[55] L. Li, "Reskilling and Upskilling the Future-Ready Workforce for Industry 4.0 and Beyond", *Information Systems Frontiers*, Vol. 26, pp. 1697-1712, 2024.

[56] Z. Li and O.A. Anaba, "Information and Communication Technology and Organisational Performance during COVID-19 Pandemic: The Role of Organisational Commitment, Growth Mindset and Entrepreneurial Orientation", *Frontiers in Psychology*, Vol. 12, pp. 1-18, 2021.

[57] C. Lloyd and J. Payne, "Rethinking Country Effects: Robotics, AI and Work Futures in Norway and the UK", *New Technology, Work and Employment*, Vol. 34, No. 3, pp. 208-225, 2019.

[58] P.G. Lovaglio, M. Cesarini, F. Mercorio and M. Mezzanzanica, "Skills in Demand for ICT and Statistical Occupations: Evidence from Web-Based Job Vacancies", *Statistical Analysis and Data Mining: The ASA Data Science Journal*, Vol. 11, No. 2, pp. 78-91, 2018.

[59] J.B. Mabula and M. James, "The Impact of African Firms' Utilisation of Financial and Technology Resource on Innovation: A Simple Mediation", *Sage Open*, Vol. 13, No. 1, pp. 1-13, 2023.

[60] L. Mahlo and Z. Waghid, "Examining Information and Communication Technology use in Public Primary Schools in South Africa from the Capability Approach", *The Journal for Transdisciplinary Research in Southern Africa*, Vol. 18, No. 1, pp. 1-17, 2022.

[61] M.M. Mahmud and S.F. Wong, "Stakeholders' Perspectives of the Twenty-First Century Skills", *Frontiers in Education*, Vol. 7, pp. 1-23, 2022.

[62] W. Maisiri and L. Van Dyk, "Industry 4.0 Skills: A Perspective of the South African Manufacturing Industry", *SA Journal of Human Resource Management*, Vol. 19, pp. 5617-5625, 2021.

[63] T. Mandiriza and D.J. Fourie, "The Role of Stakeholders in the Adoption of Public-Private Partnerships (PPPs) in Municipal Water Infrastructure Projects: A Stakeholder Theory Perspective", *World*, Vol. 4, No. 3, pp. 416-430, 2023.

[64] C.M. Maponya and L.D. Naidoo, "Investigating the Leaders' State of Readiness in the Department of Telecommunications and Postal Services in South Africa to Develop Policy for the Fourth Industrial Revolution", *Journal of Public Affairs*, Vol. 23, No. 1, pp. 37-54, 2022.

[65] R. Masenyetse and M. Manamathela, "Firm Growth, Exporting and Information Communication Technology (ICT) in Southern Africa", *Journal of Innovation and Entrepreneurship*, Vol. 12, No. 1, pp. 1-8, 2023.

[66] H. Matebese and C.M. Govender, "Exploring Global Unionism to Inform South African ICT Sector Union Strategy", *African Journal of Business Management*, Vol. 16, No. 5, pp. 117-129, 2022.

[67] W. Matekenya and C. Moyo, "Innovation as a Driver of SMME Performance in South Africa: A Quantile Regression Approach", *African Journal of Economic Management Studies*, Vol. 13, No. 3, pp. 1-3, 2022.

[68] S. McGuinness and P. Redmond, "Skills Mismatch: Concepts, Measurement and Policy Approaches", *Journal of Economic Surveys*, Vol. 32, No. 4, pp. 985-1015, 2018.
[69] M. Mkansi, "E-Business Adoption Costs and Strategies for Retail Micro Businesses", *Electronic Commerce Research*, Vol. 22, pp. 1153-1193, 2022.
[70] A. Moloto and M. Muchie, "Factors that Affect the Effective use of E-Government Procedures in Limpopo", *Journal of Service Science and Management*, Vol. 16, No. 3, pp. 1-12, 2023.
[71] J. Munga, "To Close Africa's Digital Divide, Policy must Address the Usage Gap", Carnegie Endowment for International Peace, 2022.
[72] C. Munyati, "How Africa can Lead to an Inclusive, Cohesive and Sustainable Pandemic Recovery", Available at: https://www.weforum.org/agenda/2021/01/how-africva-can-lead-an-inclusive-cohesive-and-sustainable-pandemic-recovery/, Accessed in 2023.
[73] J. Murithi and J.E. Yoo, "Teachers' Use of ICT in Implementing the Competency-Based Curriculum in Kenyan Public Primary Schools", *Innovation and Education*, Vol. 3, No. 5, pp. 1-12, 2021.
[74] G.J. Mushi and E.J. Munishi, "The Role of ICT Business Infrastructure in the Provision of Business Development Services to Tanzanian Small and Medium Enterprises", *African Journal of Applied Research*, Vol. 9, No. 1, pp. 1-12, 2023.
[75] B. Mutsvairo and M. Ragnedda, "*Comprehending the Digital Disparities in Africa. Mapping the Digital Divide in Africa: A Mediated Analysis*", Mapping the Digital Divide in Africa, pp. 13-26, 2019.
[76] K. Mwantimwa, "ICT Usage to Enhance Firms' Business Processes in Tanzania", *Journal of Global Entrepreneurship Research*, Vol. 9, No. 1, pp. 46-58, 2019.
[77] N.R. Ngobeni, M.I. Chibambo and J.J. Divala, "Curriculum Transformations in South Africa: some Discomforting Truths on Interminable Poverty and Inequalities in Schools and Society", *Frontiers in Education*, Vol. 8, pp. 1-13, 2023.
[78] A.Y. Niyazova, A.A. Chistyakov, N.Y. Volosova and S.E. Chirkina, "Evaluation of Pre-Service Teachers' Digital Skills and ICT Competencies in Context of the Demands at the 21st Century", *Journal of Communication and Media Technologies*, Vol. 13, No. 3, pp. 1-12, 2023.
[79] A.N. Nzewi, "Information and Communication Technology (ICT) Skills and Usage of Online Information Resources by Postgraduate Students of Universities", *International Journal of Academic Library and Information Science*, Vol. 12, No. 2, pp. 32-38, 2024.
[80] K.N. Ohei and R. Brink, "Employability Distress: Factors Affecting ICT Graduates' Employability and Work Integration in the Workspace", *Research in World Economy*, Vol. 12, No. 1, pp. 1-23, 2021.
[81] B.E. Okoli and J.U. Okudare "Information and Communication Technology (ICT) Skills as Correlate of Business Education Lecturers' Instructional Effectiveness in Colleges of Education in South-South Geo-Political Zone of Nigeria", *International Journal of Management Technology*, Vol. 11, No. 1, pp. 91-105, 2024.
[82] O.I.O. Olatoye and N. Muchaonyerwa, "ICT Literacy Skills Proficiency and Experience on the use of Electronic Resources Amongst Undergraduate Students in Selected Eastern Cape Universities, South Africa", *Library Management*, Vol. 42, pp. 67-78, 2021.
[83] S. Omar Bouh and H. Unlu, "*The Effect of Information Communication Technologies on Firm's Innovation Performance in Sub-Saharan African Countries*", Emerald Publishing Limited, 2022.
[84] M.A. Osma and D.F. Malanga, "Realities of Microenterprises' ICT use for Business Activities and for Acquiring Online Government Support: A Study in Western Cape Province, South Africa", *The African Journal of Information and Communication*, Vol. 24, pp. 1-23, 2019.
[85] K. Padayachee, "A Snapshot Survey of ICT Integration in South African Schools", *South African Computer Journal*, Vol. 29, No. 2, pp. 1-16, 2017.
[86] M.J. Page, E.A. Brennan, S.E. Chou, R. Glanville, J. Grimshaw, J.M. Hrobjartsson, A. Lalu, M.M. Li, T. Loder, E.W. Mayo-Wilson, E. McDonald, S. McGuinness, L.A. Stewart, L.A. Thomas, J. Tricco, A.C. Welch, V.A. Whiting and P. Moher, "The PRISMA 2020 Statement: an Updated Guideline for Reporting Systematic Reviews", *Systematic Reviews*, Vol. 10, pp. 89-98, 2020.
[87] M. Palczynska and M. Rynko, "ICT Skills Measurement in Social Surveys: Can we Trust Self-Reports?", *Quality and Quantity*, Vol. 55, pp. 917-943, 2021.
[88] R. Pater, H. Cherniaiev and M. Kozak, "A Dream Job? Skill Demand and Skill Mismatch in ICT", *Journal of Education and Work*, Vol. 35, pp. 6-7, 2022.
[89] C.M. Patino and J.C. Ferreira, "Inclusion and Exclusion Criteria in Research Studies: Definitions and Why They Matter", *Jornal Brasileiro de Pneumologia*, Vol. 44, No. 2, pp. 1-8, 2019.
[90] S. Paul, "An Analysis of the Skill Shortage Problems in Indian IT Companies", *Social Science*, Vol. 7, No. 9, pp. 47-58, 2018.
[91] R. Pranckute, "Web of Science (WOS) and Scopus: The Titans of Bibliographic Information in Today's Academic World", *Publications*, Vol. 9, No. 1, pp. 1-12, 2021.
[92] F. Pusterla and U. Renold, "Does ICT Affect the Demand for Vocationally Educated Workers? Swiss", *Journal of Economics and Statistics*, Vol. 158, pp. 1-22, 2022.
[93] K. Ratheeswari, "Information Communication Technology in Education", *Journal of Applied and Advanced Research*, Vol. 3, No. 1, pp. 45-47, 2018.
[94] P. Reddy, K. Chaudhary and S. Hussein, "A Digital Literacy Model to Narrow the Digital Literacy Skills Gap", *Heliyon*, Vol. 9, No. 4, pp. 31-45, 2023.
[95] J.A. Romero and C. Abad, "Cloud-Based Big Data Analytics Integration with ERP Platforms", *Management Decision*, Vol. 60, No. 1, pp. 1-12, 2022.
[96] N. Roztocki, P. Soja and H.R. Weistroffer, "The Role of Information and Communication Technologies in Socioeconomic Development: Towards A Multi-Dimensional Framework", *Information Technology for Development*, Vol. 25, No. 2, pp. 1-17, 2019.
[97] O. Sadiq, D. Hack-Polay, T. Fuller and M. T. Rahman, "Barriers to the Effective Integration of Developed ICT for SMEs in Rural Nigeria", *Businesses*, Vol. 2, No. 4, pp. 501-526, 2022.

[98] O.K. Sebitlo, T. Mbara and R. Luke, "The State of South Africa's Public-Private Partnership Practices in Transport Projects: Problems and Potential", *Journal of Transport and Supply Chain Management*, Vol. 16, No. 3, pp. 1-16, 2022.

[99] M.P. Senyolo, T.B. Long and O. Omta, "Enhancing the Adoption of Climate-Smart Technologies using Public-Private Partnerships: Lessons from the WEMA case in South Africa", *International Food and Agribusiness Management Review*, Vol. 24, No. 5, pp. 1-12, 2021.

[100] A. Sguazzin, "South Africa is Tackling its Second Biggest Growth Problem", Available at https://www.bloomberg.com/news/articles/2023-07-05/south-africa-tackles-biggest-growth-brake-after-energy-skilled-workers-shortage#xj4y7vkg, Accessed in 2023.

[101] V. Siddoo, J. Sawattawee, W. Janchai and O. Thinnukool, "An Exploratory Study of Digital Workforce Competency in Thailand", *Heliyon*, Vol. 5, No. 5, pp. 1-14, 2019.

[102] P.M. Sreejith and S. Sreejith, "Exploring the Role of Cultural Capital, ICT Skills and Entrepreneurial Self-Efficacy in Shaping Entrepreneurial Intention among Women", *The Journal of Telecommunications and the Digital Economy*, Vol. 11, No. 2, pp. 1-12, 2023.

[103] Statistics South Africa, "Quarterly Labour Force Survey 2019: Quarter 1 Statistics South Africa, Pretoria", Available at: https://www.statssa.gov.za/publications/P0211/P02111stQuarter2019.pdf, Accessed in 2019.

[104] Statistics South Africa, "Quarterly Labour Force Survey 2021: Quarter 2 Statistics South Africa, Pretoria", Available at: https://www.statssa.gov.za/publications/P0211/P02112ndQuarter2021.pdf, Accessed in 2021.

[105] J. Stofkova, A. Stofkova, K.R. Malega, P. Krejnus, M. Binasova and V. Daneshjo, "Digital Skills as a Significant Factor of Human Resources Development", *Sustainability*, Vol. 14, pp. 1-20, 2022.

[106] P.H.S. Suoto and R.L.D.S. Morais, "Tabnlet Use in Young Children is Associated with Advanced Fine Motor Skills", *Journal of Motors and Behaviour*, Vol. 52, pp. 196-203, 2020.

[107] A. Ternikov, "Soft and Hard Skills Identification: Insights from IT Job Advertisements in the CIS Region", *Peer Journal of Computer Science*, Vol. 8, No. 2, pp. 1-10, 2020.

[108] D. Thapa and Y. Karki, "Exploring the Link between Digitalisation and Sustainable Development: Research Agendas", *Proceedings of International Conference on e-Business, e-Services and e-Society*, 2021.

[109] C.A. Tiba, "The Ability of Newly Qualified Teachers to Integrate Technology into their Pedagogical Practice", Master Thesis, Department of Management Studies, Cape Peninsula University of Technology, pp. 1-78, 2018.

[110] F. Tilya, "*Information and Communication Technology and Educational Policies in the Sub-Saharan African Region*", International Handbook of Information Technology in Primary and Secondary Education, pp. 1145-1159, 2018.

[111] S. Timotheou, Y. Sobrino, S.V. Giannoutsou, N. Cachia, R. Mones and A.M. Ioannou, "Impacts of Digital Technologies on Education and Factors Influencing Schools' Digital Capacity and Transformation: A Literature Review", *Educational Information Technology*, Vol. 28, No. 6, pp. 6695-6726, 2023.

[112] L. Turulja, D.S. Vuges and M.P. Bach, "Big Data and Labour Markets: A Review of Research Topics", *Procedia Computer Science*, Vol. 217, pp. 526-535, 2023.

[113] H. Twinomurinzi and N. Msweli, "Digital Natives Still Need Intentional Digital Skills in the 41R: Comparing the General and ICT Self-Efficacy of South African Youth", *Development*, Vol. 12, pp. 15-20, 2019.

[114] O. Umugiraneza, S. Bansila and D. North, "Exploring Teachers' Use of Technology in Teaching and Learning Mathematics in KwaZulu-Natal Schools", *Pythagoras*, Vol. 39, No. 1, pp. 1-13, 2018.

[115] A. Verma, S. Dandgawhal and A.K. Giri, "Impact of ICT Diffusion and Financial Development on Economic Growth in Developing Countries", *Journal of Economics, Finance and Administrative Science*, Vol. 34, No. 4, pp. 1-15, 2023.

[116] J. Vreuls, M. Koeslag-Kreunen, M. Van Der Klink, L. Nieuwenhuis and H. Boshuizen, "Responsive Curriculum Development for Professional Education: Different Teams, Different Tales", *The Curriculum Journal*, Vol. 33, No. 4, pp. 636-659, 2022.

[117] V. Walker, G. Bowkett and I. Duchaine, "Sectoral Perspectives: Preparing Information and Communication Technology Talent for the Future", *Canadian Public Policy*, Vol. 44, No. 1, pp. 817-892, 2018.

[118] A.M. Weber and S. Greiff, "ICT Skills in the Deployment of 21st Century Skills: A Cognitive Developmental Perspectives through Childhood", *Applied Science*, Vol. 13, No. 7, 2023.

[119] R. Williams, H.W. Park and C. Breazeal, "PopBots: Designing an Artificial Intelligence Curriculum for Early Childhood Education", *AAAI*, Vol. 33, pp. 9729-9736, 2019.

[120] J. Woetzel, J. Seong, N. Eung, N. Ngai, J. Chen, L.K. Tang and B. Wang, "Reskilling China: Transforming the World's Largest Workforce into Lifelong Learners", Available at: https://www.mckinsey.com/featured-insights/china/reskilling-china-transforming-the-worlds-largest-workforce-into-lifelong-learners, 2021.

[121] World Economic Forum, "The Future of Jobs Report 2020", Available at: https://www3.weforum.org/docs/WEF_Future_of_Jobs_2020.pdf, Accessed in 2020.

[122] Z.Y. Zhu, H.M. Xie and L. Chen, "ICT Industry Innovation: Knowledge Structure and Research Agenda", *Technological Forecasting and Social Change*, Vol. 189, pp. 1-27, 2023.