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Article

Assessing the improvement of information communication technology for the construction SMES in the 4IR

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Abstract: Purpose: The fourth industrial revolution (4IR) is assured to transform the construction sector from a project-based industry to a market-based industrialised process. Yet, its slow uptake can be attributed to current emphasis on technological adoption. This study focused on the development of small medium enterprises (SMEs) in the construction industry (CI) of South Africa (SA). The study explicitly focused on the adoption of information communication technology (ICT) in the construction SMEs. In a bit to further advance SMEs, the study observed the practice of communication technology tools. The purpose of this paper is to investigate to what extend ICT is practised in the construction SMEs. **Methodology:** the research design was established on explanatory case study approach in Gauteng province, South Africa – the methodology adopted is quantitative method. The approach was done via the use of survey questionnaires which was distributed virtually by means of emails, LinkedIn and WhatsApp. Participants are questioned regarding their experience of practicing ICT tools within their organizations. **Findings:** The study findings indicated that ICT tools have been in practice to a negligible extend in SA construction SMEs, the empirical results affirm that the number 1 classified communication tool used in SA construction SMEs is face to face meetings, seconded by phone calls. However, the experience is diverse; it shows that ICT tools are being practised in the organizations with 4IR experience unlike the SMEs without experience that portrays the highly practised paper-based system in their organizations. **Originality:** the study recommends that the SMEs review the influence of ICT tools in construction and implement them in their organizations considering their benefits to the industry in this era (4IR). This will help maximise the opportunities brought by ICT and further improve the South Africa construction SMEs in terms of technology adoption.

Keywords: construction; fourth industrial revolution; information communication technology; small medium enterprises

1. Introduction

The term “Industry 4.0” refers to the fourth wave of industrial transformation, which can be distinguished from the first three waves of mechanisation, electrification, and computerisation. Industry 4.0 is driven by data, digital technology, and automation (Dallasega et al., 2018; World Economic Forum, 2018). The fourth revolution is not about inventing new technologies per se, but rather about combining existing technologies, many of which have been around for a long time. Decision-making can be automated, and data can be transformed into opportunities for wealth creation thanks to this technological bricolage that blurs the distinction between the physical and digital (or virtual) worlds more and more. Industry 4.0 has focused on developing new revenue streams, particularly in the wake of major crises like the Global Financial Crisis of 2008 and the Covid-19. Industry 4.0 has created the re-imagining of a brave new mass-personalised and self-configured world believed to become more efficient and flexible in an effort to find new methods to generate value.

The challenge of scaling up 4IR technologies persists despite the promising future of these technologies. Numerous studies have demonstrated how the construction industry trails other industries in adopting 4IR technologies (Hawksworth et al., 2018; Manyika et al., 2017). The issue of resistance to technological change is frequently used to explain the discrepancy between 4IR objectives and realities in the construction sector (Hall et al., 2020). The claim made in this briefing note is that 4IR's ability to bring about significant transformation has so far been constrained by the narrow focus on technology. Simply focusing on technological adoption ignores the social and ethical dimensions necessary to realise the industry 4.0's revolutionary potential. In order to raise more intriguing and significant concerns about Industry 4.0 in the construction sector, the goal of this critique is to draw attention to the social dimensions currently practiced in construction SMEs.

The principal research question to be answered by the paper is to what extend do construction SMEs practice ICT in their workplace. The objectives of the paper are to explore the nature of 4IR in the construction industry, to discover the importance of ICT in the construction SMEs and to what extend are ICT tools adopted by the industry thus far.

2. Literature review

This section of the paper covers the related literature from scholarly articles. It explores the synopsis of the Fourth Industrial Revolution (4IR) in the construction industry (CI), challenges affecting the practise of 4IR technologies in CI and the importance and benefits of practising Information Communication Technology (ICT) tools in the organizations. The sub-sections are outlined as follows:

2.1. 4IR in construction industry

The 4IR refers to the Internet of Things (IoT) and the Internet of Services (IoS) combined with the manufacturing environment, where every modern business in the world connects to and intelligently controls its machinery, manufacturing facilities and warehousing facilities through digital physical frameworks by exchanging data (Gilchrist, 2016). Industry 4.0 allows for a more comprehensive, synchronized, and integrated manufacturing approach. It connects the physical and digital worlds, allowing for better collaboration and communication between departments, vendors, goods, and employees. It allows the corporation's administrators to accurately track and understand each aspect of their activities, as well as to incorporate hard data to improve efficiency, improve processes, and stimulate growth (Epicore, 2018). The transition from the current "respond to occasion" practices to the "predict the occasion" practice is made possible by the integration of BIM into the IT environment (Woodhead et al., 2018). The integration of distributed computing and BIM enables project partners to collaborate continuously from different locations to improve fundamental leadership and ensure project deliverability (Craveiro, 2019). When used in conjunction with BIM, the IoT can increase profitability (Li, 2016), improve the data stream across a project life cycle (Dave et al., 2015), increase energy efficiency (Bottaccioli et al., 2017), and enhance security and welfare (Fang et al., 2016; Oesterreich and Teuteberg, 2016).

With the availability of cutting-edge information and online computing to subsequently assemble and process electronic information into the value chain on discrete assignments, Industry 4.0 has put the construction industry to the test (Alaloul, et al., 2018). As the specialised components of the available advances are still being examined, the development of and methods for dealing with mechanisation in the construction industry are still in their early stages and not fully utilized (Lu et al., 2016). However, some advances have entered the industry, such as distributed computing, flexible figuring, and modularisation (Oesterreich and Teuteberg, 2016). Despite the fact that development has been a level market for the past 50 years, tasks related to development are becoming increasingly complex, necessitating the use of Industry 4.0 as a solution for another course of action (Alaloul, 2018; Bock, 2015). This has occurred since, while being a big supporter of the business and economy of many countries, the construction industry currently has one of the lowest capital speculations, capital power, and research and development (RandD) force compared to other divisions (Hampson et al., 2014). The construction industry's fragmented production network, which includes a few SMEs, restricts the ability to invest resources in innovative developments (Dallasega et al., 2018).

The lack of a dedicated procedure change technique committed execution strategy, and business system configuration has also contributed to the reception's lacklustre performance. There is a need to suggest a few utilisation strategies because Industry 4.0 makes esteem that alter the general business system in the construction industry. Industry 4.0 is necessary, to have the capability to enhance the quality and efficiency of construction and manufacturing. It must have the ability to automate both design and manufacturing processes and the viability of managing a heterogeneous and significant amount of data.

2.2. Challenges affecting the practise of 4IR technologies in construction

The South African construction industry was introduced to a digital construction which will attract valuable investors (Global Africa Network, 2020). BIM, prefabrication, 3D printing, wireless, sensors and automatic and robotic equipment is the way of construction industry today (Van Rensburg, 2020). In addition, the author Van Rensburg (2020) emphasised that the industry could save between 12% and 20% annually on costs. Moreover, the CEO of Construction Computer Software, Andrew Skudder, stated that this technology is increasing productivity and cutting costs (Schwab, 2020). He also indicated that in the coming decade, the sector is expected to embrace digitization fully. Nonetheless, the implementation of 4IR is threatened by absence of funds, size of projects and availability of resources, interest and views of the CI as outlined below.

Absence of Funds: The government is keen to support the civil construction to move to 4IR operations, however, is faced with challenges to move to e-government such as; lack of adequate skills to develop e-government services and developing policies for cheap access of developing mobile broadband infrastructure (Moloi et al., 2018). Aghimien et al. (2019) revealed that the ultimate challenges for implementing these technologies are, high cost to obtain innovation and training.

The Size of the Projects and Availability of Resources: Most enterprises do not practice these technologies because they are involved in small and medium projects with less capability and profitability. Because of this, the organisations become uncertain of the decision to adapt these technologies due to cost implications and maintenance (Van Rensburg, 2020). According to Aghimien et al. (2019) the industry lacks growth for dynamic capabilities for detecting extensive grip of technologies. Studies shows that lack of education, unaligned of labour supply and demand are the challenges in the industry. The decision of going digital will cause job losses which are the major concern for companies, while another impediment is the lack of digital skills and requirements for developing these tools (Yeni-letsoko and Pillay, 2019). Similarly, Gaspar et al. (2019) emphasized that the adoption of 4IR is stalled by challenges such as fear of job loss. While Kariem (2020) disclosed that poor technical capacity with no policy and regulation is the barrier to the adoption of these technologies.

Construction industry Level of Interest and Views: The construction industry does not show any interest in implementing 4IR technologies because the industry refuses to practically implement ideas to develop strategies to implement the technologies but rather conclude that the technologies are too expensive (Mahachi, 2020). Additionally, Japheth and Kiprotich (2014) disclosed that the professionals are afraid to change the traditional way and adopt the new technologies and most importantly employ digital trainings. Furthermore, the industry shows no interest, while there are no specialized professionals, technical skills and the client is not insisting the implementation of the processes. Bayode et al. (2019) emphasised that the construction industry faces insufficient electricity, unavailability of financial resources, no access the wireless broadband powered network and no skills to operate the technologies. Moreover, the construction firms decided to stick to the proven method of performing works avoiding using the new technologies because is perceived as taking risks (Akinboade and Mkowena, 2012).

2.3. The importance of ICT tools in construction

The construction industry is extremely large, complex and multifaceted; it accommodates processes for building new structures and engineering projects (Behm, 2008; Caglar et al., 2005). Because of the complexity of the construction sector, which is made up of different construction agents such as contractors, architects, engineers, etc., a collective communication structure housing these various construction agents is required to complete a successful project (Becerik, 2004; Murtala et al., 2013; Popoola et al., 2017). As a result, the construction industry is forced to manage associations, putting further pressure on it to save costs and increase efficiency.

The use of ICT can improve the capability of construction development. ICT solutions linked to telefax machines are widely used in business communications these days for the sharing of data such as drawings, images, schedules, papers, and other essential information (Amusan and Ayo, 2017). Modelling and visualisation are two examples of cutting-edge ICT applications. However, developments in ICT have created new potential for improving communication, cooperation, and information management in the construction business (Stewart, technologies). Many other countries have effectively employed project webs, teleconferencing, electronic document management systems, mobile computing, and integrated software such as enterprise resource planning (ERP) (Vadhavkar and Pena-Mora, 2000). Although the use of these ICTs could enhance data and communication in the construction industry by reducing the use of paper documents and drawings, enhancing record organisation and filing, and enabling quicker, less expensive, and more accurate communication streams, the widespread adoption has not yet fully taken hold in this industry (Hassan and McCaffer, 2002). Despite this, ICT has been hailed as a vital resource for the construction sector, and contract employees and other industry experts should embrace its use in the sector as well as in their various construction enterprises and organisations (Woksepp and Olofsson, 2006).

According to summary findings from studies like Hassanain (2000), Mohammad et al. (2017) and Peansupap (2004), time restraints, complexity, and operational disintegration have compelled many organizations, both large and small, to integrate ICT into their business procedures. Since the construction industry of today and tomorrow depends on the use of sustainable systems made possible by ICT, it is obvious that the deployment of these ICT technologies is intended to facilitate information sharing among people and organizations (Gopalakrishnan and Brindha, 2017).

Woksepp and Olofsson (2006) illustrated that it is impossible to emphasize the importance of ICT application. They pointed out that a wide range of activity areas may anticipate ICT-based expected benefits and impacts, including: Construction stages (planning, design, procurement, and site operations); in Digital sites, such as the adoption of ICT and automation in site operations. Project management, legal, and contractual difficulties are also included in corporate procedures. ICT is also utilized in the building and construction sector’s life cycle performance, monitoring, and performance measurements, as well as in operations involving the supply chain, costing, and accounting, and rapid, inexpensive, and efficient construction. **Table 1** below shows the existing theories of improvement within the construction sector.

2.4. Existing theories of development in construction industry

Table 1. Theories of development in construction industry

Author	Methodology approach	Sector	Enterprise size	Country
Qalati et al. (2021)	Quantitative	Manufacturing, IT, construction, logistics and restaurant	SME	Pakistan
Oesterreich and Teuteberg (2016)	Quantitative and qualitative	Construction	Large enterprise	Germany

Dallasega (2018)	Systematic literature review	Construction	SMEs and large enterprise	United Kingdom
Maduku et al. (2016)	Systematic review	Manufacturing, tourism, wholesale and retail	SMEs	South Africa
Legg et al. (2015)		Health	SMEs	Denmark and New Zealand
Park and Kim (2013)	Systematic literature review	Construction	Business size not specified	Korea
Porwal and Hewage (2013)		Construction	All size	Canada
Han and Lee (2013)	Qualitative?	Construction	Large	USA
Chen and Luo (2014)	Case study	Construction	Large	China
Li et al. (2019)	SLR and quantitative	Construction	Large	UK
Hong et al. (2017)	Case study	Construction	Large	China
Cerovsek	Literature and software review	AEC/O	Large	Slovenia
Alias et al. (2014)		AEC	Large	Malaysia
Viswanathan (2021)	Literature survey	All sectors	SMEs	South Africa
Haupt et al. (2019)	Quantitative and qualitative	Construction	SMEs	South Africa
Adu-Amankwa et al. (2019)	Quantitative	Engineering	SMEs	UK
Martı´nez-Roma´n a (2011)	N/A	All sectors	SMEs	Spain
Akadiri et al. (2012)	N/A	Construction	SMEs and large	UK
Dlungwana	N/A	Construction	SMEs	South Africa
Hosseini et al. (2016)	Quantitative	Construction	SMEs	Australia
Davis et al. (2016)	Qualitative	Construction	SMEs	Australia
Giudice et al. (2021)	Quantitative	Manufacturing	SMEs	Italy
Zhang et al. (2015)	N/A Ontology-based semantic modelling	AEC	All sizes	USA/ China
Coleman et al. (2016)	N/A	All business sectors	SMEs	Europe
Alqam and Saqib (2020)	Qualitative /explanatory research design	All sectors	SMEs	Oman
Hwang and Kim (2021)	Quantitative	Manufacturing	SMEs	Korea
Gregurec et al. (2021)	Qualitative	Service sector	SMEs	N/A
Serumaga-Zake and Van der Poll (2021)	Qualitative	Manufacturing	SMEs	South Africa
Rozmi and Hadi (2019)		All	SMEs	Malaysia

Maduku et al. (2016) and Qalati et al. (2021) investigated the influence of technology-organizational-environmental (TOE) factors on the use of social media (SM) by SMEs in developing nations. The study identified parameters influencing social media adoption and SMEs performance. Although the study did not look at all of the technical aspects of ICT that affect SMEs, it did find a direct beneficial correlation between technology (namely social media) and SMEs' performance.

Oesterreich and Teuteberg (2016) investigated the use of Industry 4.0-related technologies in the construction industry, highlighting the political, economic, social, technological, environmental, and legal ramifications of their implementation. Nonetheless, the research addressed essential aspects of the subject, specifically financial, societal, and technological. Dallasega (2018) investigated the impact of Industry 4.0 on the construction supply chain (CSC) and developed a framework to help construction companies improve supply chain closeness. The study was solely concerned with improving closeness in the CSC and did not address all areas of the construction process that require improvement in this period.

Maduku et al. (2016) developed a multi-perspective framework that incorporates components from the technological, organizational, and environmental settings of small and medium-sized firms. The study did not address 4IR technology, communication tools, or ethical drives, which are critical components of SMEs' development through 4IR. However, it revealed the need of implementing mobile marketing for small and medium-sized enterprises, which is a critical component of SME improvement.

Zhou et al. (2015) created an integrated improvement framework centered on safety competency, accident statistics, design for safety, and safety culture. Not only did these authors reveal characteristics related to safety management methods, but they also underlined the importance of new technology applications as an intermediate solution to preventing workers from injuring themselves in a hazardous setting. Park and Kim (2013) also focused on supporting safety management practices by integrating BIM with current technologies in order to improve field safety risk identification, worker risk recognition capacity, and real-time communication between construction managers and workers Chen and Luo's (2014) model also recognize the value of construction software in terms of construction quality control and effective information usage.

Porwal and Hewage (2013) integrated Building Information Modeling (BIM) to enhance the value proposition of construction products. Han and Lee (2013) introduced a framework leveraging video-based motion capture technology to establish a reliable and automated method for monitoring worker activities, particularly focusing on detecting unsafe behaviors. Viswanathan and Telukdarie (2021) undertook research aimed at fostering the growth of Small and Medium Enterprises (SMEs) through digitalization and feasible business assistance, with a particular emphasis on the sustainability aspect. While these researchers explored into the fundamental sub-components of construction software essential for SME enhancement, they did not comprehensively address all aspects determining the success of the software for SMEs development initiative.

Zhu et al. (2019) offer an updated hybrid ensemble machine learning strategy called RS-MultiBoosting, which combines two traditional ensemble Machine Learning approaches, random subspace (RS) and MultiBoosting, to increase the accuracy of forecasting SMEs' credit risk. Juárez (2016) investigated the potential of knowledge management to drive small and medium-sized organization innovation and business performance. The authors discovered these frameworks/models in an attempt to promote SMEs in CI, and their area of focus was BIM, knowledge management (KM), innovation, performance, information and communication technology (ICT) which is essential to this study.

According to Davis et al. (2016), innovation is critical for productivity development and advancement in several areas of the economy, including the construction industry. The writers solely examined the theoretical and practical elements of innovation in SMEs. The study did not cover the 4IR technologies, communication tools, construction software, and ethical drivers that the inquiry suggests may have an impact on the development of SMEs in the construction division. Giudice et al. (2021) did not construct a model/framework, but rather focused on the effects of digital innovation and industry 4.0 in manufacturing SMEs, as well as the benefits of combining the two breakthroughs.

Moeuf et al. (2018) explored new changes to SMEs’ production planning and control functions in the era of Industry 4.0 but did not address features of SEM development in the era of 4IR. Alqam and Saqib (2020) investigated the notion of the Fourth Industrial Revolution and its influence on SMEs, with a primary focus on cyber-physical systems and IoT. There were no frameworks or models built. Hwang and Kim (2022) investigated how implementing key technologies of the Fourth Industrial Revolution (4IR) affects small and medium enterprises (SMEs) but didn’t create a model. Gregurec et al. (2021) explored the effective technologies employed by SMEs during the COVID-19 pandemic to adapt to changes, focusing on how these technologies could shape sustainable business models for smaller firms instead of devising a framework.

Serumaga-Zake and Van der Poll (2021) developed a conceptual framework for integrating 4IR technologies and opportunities into SMEs, albeit without validation, and with a focus outside the construction sector. Adegbite and Govender (2021) investigated the anticipated roles of SMEs and their evolving roles in the 4IR for sectoral growth and transforming the informal sector in Africa. They also suggested a framework to aid SMEs in their 4IR endeavours. Wiesner et al. (2018) and Jones et al. (2018) created particular maturity and preparedness models.

Matt et al. (2016) provides a very early first attempt at a methodical approach to how SMEs might implement Industry 4.0. In 2018, they transformed the technique into a five-step methodology for SMEs (Matt et al., 2018). Similarly, other academics are working on the development of Industry 4.0 tool kits and roadmaps to make it easier to implement Industry 4.0 in SMEs (Mittal et al., 2018). Moica et al. (2018) address the need for Industry 4.0-compliant workplace management as well as modified Manufacturing Execution Systems (MES) for SMEs. Even though aspects of 4IR development were discussed by the previous studies, they were mostly focused on large scale enterprises. They failed to identify the critics pertaining to the development of construction SMEs through the usage of ICT.

3. Methods

The study employed a quantitative method to identify SMEs development pointers in the fourth industrial revolution (4IR) through ICT. This strategy was achieved by creating a survey questionnaire and distributing it to construction professionals in Gauteng, South Africa. The chosen participants were architects, quantity surveyors, safety officers, construction managers, engineers etc. who work in the small and medium-sized enterprises.

The SMEs ICT development in construction is shaped by various factors, both independent and dependent. Independent variables include 4IR technologies, challenges faced by construction SMEs in the 4IR era, and communication methods. The dependent variable is the inclination towards promoting SMEs within the context of the fourth industrial revolution. A causal connection between independent and dependent variables was established through methodologies such as case studies, correlation analysis, Kaiser-Meyer-Olkin (KMO) tests, and Bartlett's test of sphericity. The findings of the research are presented through statistical analyses, literature reviews, tables, figures, and graphs. It's important to note that the research was confined to SMEs operating within the Gauteng province and specifically within the built environment sector of South Africa.

3.1. Participants

The participants of the research were 28 civil engineers, 25 construction managers, 24 electrical engineers, 23 quantity surveyors, 17 architects, 16 for "other" (these are participants whose profession was not listed in the questionnaire but still fall within construction industry), 12 health and safety officers, 10 site engineers, 8 foreman and 6 project managers as illustrated in **Figure 1**. The total of participants who answered this question is 169 as compared to 192 respondents who answered the rest of the questions. The reason is that some participants skipped this question (missing data).

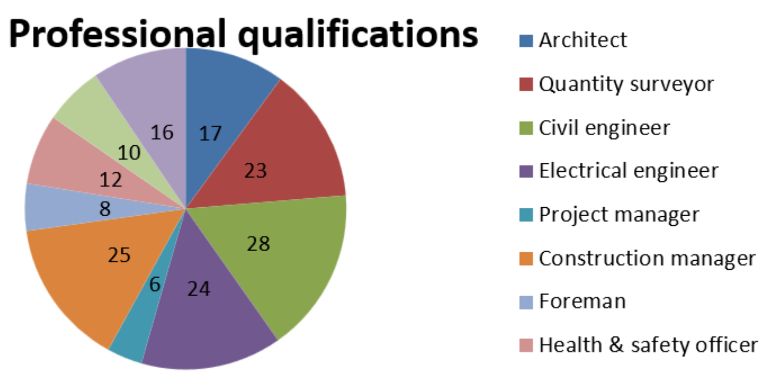

Figure 1. Professional qualifications of respondents.

The participant's experience in the construction industry (CI) is shown in **Figure 2**. It shows 74 participants with 6–10 years' experience in the CI, 59 participants with 0–5 years' experience, 39 with 11–15 years' experience, 14 with 16–20 years' experience and 6 participants with more than 20 years of experience.

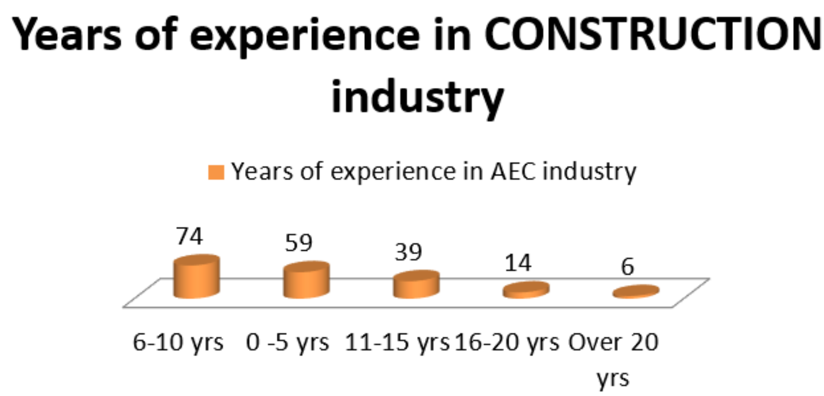

Figure 2. Number of years of experience in the CI.

The research participants were asked how many years of experience they have with the practice of 4IR applications within their organizations. **Figure 3** below shows 98 were respondents with no experience of 4IR, 52 participants had 2 years and less experience, 14 participants had 3–4 years of experience, 3 participants had 5–6 years' of experience and 2 participants had 9–10 years of experience.

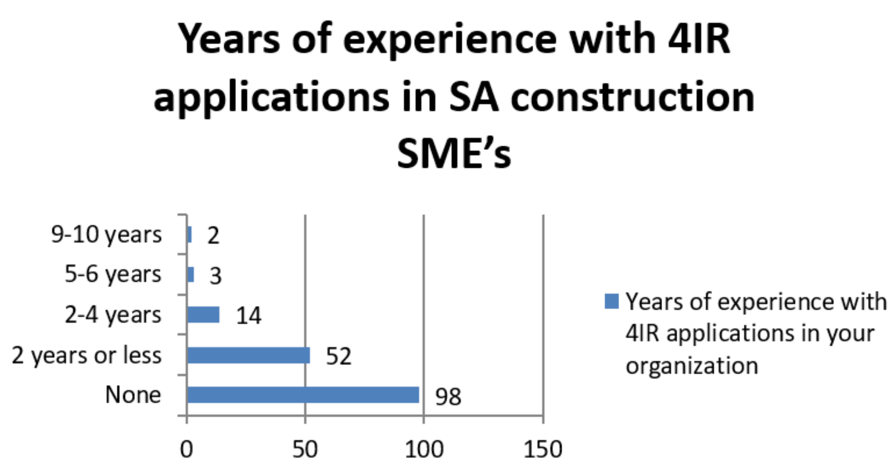

Figure 3. Years of experience with 4IR applications.

3.2. Data collection

The quantitative approach was used to gather the data. Respondents were sent a survey questionnaire via email and other social media platforms, using Google Forms. Because it guarantees that the right person intended to respond, the electronic method ensured that the questionnaires were distributed quickly. The answers were entered into Excel as raw data, and software (SPSS v26) was used to analyse the results.

Literature review: The examination of documents was the first type of data gathered. The literature on industry 4.0 for the advancement of construction SMEs was examined for this investigation. A wide range of sources, including books, theses, dissertations, and articles from scholarly and academic journals, were used. Information was sourced using search engines like Google Scholar, which was connected to university libraries

(University of Johannesburg and Central University of Technology), as well as Science Direct, Scopus, Emerald, SAGE, Springer, Academia, etc. The construction industry, industry 4.0, industry SMEs development, industry theses and dissertations, and industry reports were located by using keywords such as these. Torraco (2016) claims that this helps the researcher evaluate and synthesize representative literature on the topic in an integrated way so that new theoretical models and perspectives on the topic are generated.

Questionnaire survey: Data were gathered using multiple-choice questions and a Likert scale. Electronic data collecting over the web was implemented. Web-based electronic data gathering is a widely used data collection technology for conducting quantitative surveys, according to Creswell (2012). This tool's ability to collect data quickly and easily is one of its benefits. An instrument for collecting data was created: a survey questionnaire. It was designed to take into account the study's goal and address the research questions. Callerly (2005) emphasized that questionnaires are primarily research instruments of data collection within the quantitative method; they are also regarded as cost effective and time saving of all the data gathering instrument in the research. Questionnaires are effective means of gathering data, even though they are predicated on assumptions and believes that will cooperate and be eager to answer the research questions.

Valid cases: The researcher discovered from the online questionnaire, as shown in **Table 2** below, that some of the 201 participants did not complete all of the questions. Among the individuals ($n = 201$) who initiated the online survey, 178 finished it. The study only included respondents ($n = 169$) who completed every item in a given part of the questionnaire. According to Creswell (2012), one way to handle missing data is to exclude participants whose scores are missing from the data analysis and only include those for whom complete data are available. As a result, the study included valid cases from the online survey ($n = 169$).

Table 2. Valid cases

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	169	84.1	94.9	94.9
	No	9	4.5	5.1	100.0
	Total	178	88.6	100.0	
Missing	System	23	11.4		
Total		201	100.0		

Source: Author.

3.3. Procedure

The research was conducted using primary data and secondary data. The primary data was conducted using related literature that was gathered from the research gate, google scholar, google and web of science search engines. Articles, research papers, journals, eBooks and conference papers of related literature were downloaded using the key words. Secondary data was conducted by sending out questionnaires to participants, collecting raw data that was later analysed.

Probability sampling was used in this study as an appropriate sampling method in lieu of a basic random sample. The technical and management teams involved in building made up the study's population. This approach was picked because it guarantees that the results from the sample should be close to what would have been achieved if the complete population had been measured and gives each unit in the population an equal chance of being selected. Participants were surveyed using a comprehensive set of questions.

Pre-testing was used to ascertain the research's validity, and a questionnaire was used as a measuring tool to ascertain the research's reliability. The consistency of the data collected was examined in this study to assess the factors' reliability; this is represented by the Cronbach's Alpha coefficient. Toke et al. (2012) stated that the Cronbach's Alpha coefficient is used in situations when the coefficient value falls between 0.00 and 1.00, with 1.00 denoting a higher level of internal consistency. If a coefficient value more than 0.6 is obtained, the measuring procedure (MSA) is considered reliable.

3.4. Statistical analysis

The data was collected from 192 construction professionals. The questionnaire was created using google forms and a link was distributed virtual using emails, LinkedIn, and WhatsApp. It consisted of the invitation letter addressed to participants, section A and section B. Section A of the questionnaire entailed biographical data of the participants such as; professional qualifications, years of experience in the CI and number of years of experience with 4IR in their organization. Section B comprises of a five point Likert scale questions whereby 1 = very small extend, 2 = small extend, 3 = medium extend, 4 = high extend and 5 = very high extend of the adoption of ICT tools in the construction SMEs. Feedback was received and raw data was captured in excel spreadsheets and send to the statistician, the SPSS version 26 software was used for statistical results. The data was analysed using frequency and descriptives, explanatory factor analysis (EFA), validity and reliability test and the test for normality and comparison.

4. Empirical results

This section covers the results of the research as well as discussion of the empirical data. As outlined in the review of literature, the adoption of ICT in the organizations is vital and of good value. Therefore, to get an industry perspective on the context of ICT tools practised in the SMEs, a survey questionnaire is adopted to ascertain actual usage of these technologies. Empirical results below give a clear symposium of the feedback from the questionnaire.

Factor analysis for communication tools

The appropriateness of the data for Factor Analysis was examined. The inspection of the correlation matrix showed the availability of coefficients above 0.3, as presented in the table below the aim of **Table 3** was to check if the variables were correlating. The coefficients were found to be above the recommended 0.3 meaning that there's a relation of the variables.

Table 3. Correlation matrix for construction communication tools (CT).

Correlation Matrix																				
		B8.1	B8.2	B8.3	B8.4	B8.5	B8.6	B8.7	B8.8	B8.9	B8.10	B8.11	B8.12	B8.13	B8.14	B8.15	B8.16	B8.17	B8.18	B8.19
	B8.1	1.000	0.457	0.375	0.430	0.231	0.267	0.166	0.513	0.478	0.365	0.299	0.353	0.384	0.404	0.325	0.355	0.309	0.397	0.363
	B8.2	0.457	1.000	0.329	0.443	0.236	0.368	0.168	0.205	0.215	0.249	0.287	0.458	0.275	0.347	0.249	0.318	0.201	0.343	0.386
	B8.3	0.375	0.329	1.000	0.045	0.605	0.459	0.501	0.309	0.337	0.225	0.150	0.185	0.376	0.395	0.324	0.270	0.271	0.323	0.388
	B8.4	0.430	0.443	0.045	1.000	0.077	0.157	0.024	0.242	0.276	0.268	0.434	0.580	0.067	0.083	0.122	0.211	0.065	0.110	0.027
	B8.5	0.231	0.236	0.605	0.077	1.000	0.688	0.731	0.422	0.431	0.256	0.144	0.019	0.372	0.363	0.238	0.250	0.398	0.303	0.347
	B8.6	0.267	0.368	0.459	0.157	0.688	1.000	0.533	0.377	0.322	0.367	0.184	0.086	0.256	0.317	0.208	0.291	0.326	0.388	0.414
	B8.7	0.166	0.168	0.501	0.024	0.731	0.533	1.000	0.398	0.332	0.186	0.146	0.042	0.228	0.345	0.152	0.303	0.280	0.197	0.204
	B8.8	0.513	0.205	0.309	0.242	0.422	0.377	0.398	1.000	0.811	0.418	0.257	0.182	0.446	0.386	0.365	0.349	0.397	0.434	0.289
	B8.9	0.478	0.215	0.337	0.276	0.431	0.322	0.332	0.811	1.000	0.422	0.216	0.178	0.506	0.343	0.353	0.381	0.372	0.448	0.275
Correlation	B8.10	0.365	0.249	0.225	0.268	0.256	0.367	0.186	0.418	0.422	1.000	0.447	0.176	0.412	0.365	0.606	0.624	0.528	0.647	0.534
	B8.11	0.299	0.287	0.150	0.434	0.144	0.184	0.146	0.257	0.216	0.447	1.000	0.508	0.165	0.266	0.425	0.286	0.312	0.338	0.236
	B8.12	0.353	0.458	0.185	0.580	0.019	0.086	0.042	0.182	0.178	0.176	0.508	1.000	0.087	0.156	0.299	0.209	0.112	0.136	0.104
	B8.13	0.384	0.275	0.376	0.067	0.372	0.256	0.228	0.446	0.506	0.412	0.165	0.087	1.000	0.663	0.450	0.406	0.446	0.539	0.422
	B8.14	0.404	0.347	0.395	0.083	0.363	0.317	0.345	0.386	0.343	0.365	0.266	0.156	0.663	1.000	0.460	0.401	0.401	0.453	0.499
	B8.15	0.325	0.249	0.324	0.122	0.238	0.208	0.152	0.365	0.353	0.606	0.425	0.299	0.450	0.460	1.000	0.554	0.447	0.628	0.517
	B8.16	0.355	0.318	0.270	0.211	0.250	0.291	0.303	0.349	0.381	0.624	0.286	0.209	0.406	0.401	0.554	1.000	0.573	0.630	0.433
	B8.17	0.309	0.201	0.271	0.065	0.398	0.326	0.280	0.397	0.372	0.528	0.312	0.112	0.446	0.401	0.447	0.573	1.000	0.648	0.547
	B8.18	0.397	0.343	0.323	0.110	0.303	0.388	0.197	0.434	0.448	0.647	0.338	0.136	0.539	0.453	0.628	0.630	0.648	1.000	0.688
	B8.19	0.363	0.386	0.388	0.027	0.347	0.414	0.204	0.289	0.275	0.534	0.236	0.104	0.422	0.499	0.517	0.433	0.547	0.688	1.000

The KMO measure of sample adequacy reached a value of 0.846 in **Table 4** below, which is greater than the minimum recommended value of 0.6, indicating sufficient items for each factor (George and William, 1989). The Bartlett's test of sphericity tests whether a matrix is significantly different from an identity matrix, thus, it tests the presence of correlations amid variables, providing the statistical probability that the correlation matrix has significant correlations among at least some of the variables Bartlett (1951). This means that the Bartlett test of sphericity should be significant with a p-value less than 0.5per cent. **Table 4** shows that the obtained value was 0.00 which meets the required value of $p < 0.001$.

Table 4. KMO and Bartlett's test for CC.

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.846
Bartlett's Test of Sphericity	Approx. Chi-Square	2094.113
	df	171
	Sig.	0.000

In **Table 5** the Anti-image correlation was checked, the diagonal coefficient values (top left to down right) are the Measures of Sampling Adequacy (MSA), which were all observed to be between 0.7 and 1.0, this is indicative of a strong positive relationship between variables.

Table 5. Anti-image correlation for CT.

Anti-image Matrices																			
Anti-image Correlation																			
	B8.1	B8.2	B8.3	B8.4	B8.5	B8.6	B8.7	B8.8	B8.9	B8.10	B8.11	B8.12	B8.13	B8.14	B8.15	B8.16	B8.17	B8.18	B8.19
B8.1	0.909[a]	−0.153	−0.243	−0.248	0.086	0.030	0.086	−0.245	−0.027	0.001	0.010	−0.010	−0.016	−0.110	0.054	−0.037	−0.024	−0.011	−0.087
B8.2	−0.153	0.869[a]	−0.064	−0.227	0.014	−0.187	0.022	0.072	0.038	0.121	0.023	−0.238	−0.061	−0.081	0.080	−0.110	0.107	−0.085	−0.193
B8.3	−0.243	−0.064	0.885[a]	0.188	−0.298	−0.020	−0.129	0.115	−0.060	0.046	0.034	−0.166	−0.066	−0.007	−0.093	−0.006	0.112	−0.007	−0.093
B8.4	−0.248	−0.227	0.188	0.719[a]	−0.148	−0.011	0.117	0.032	−0.118	−0.189	−0.185	−0.378	0.056	0.035	0.166	−0.089	0.108	0.049	0.133
B8.5	0.086	0.014	−0.298	−0.148	0.758[a]	−0.462	−0.517	0.090	−0.185	0.092	0.004	0.167	−0.161	0.079	−0.142	0.184	−0.273	0.135	−0.054
B8.6	0.030	−0.187	−0.020	−0.011	−0.462	0.847[a]	−0.029	−0.142	0.127	−0.201	0.027	−0.006	0.130	−0.034	0.176	0.003	0.119	−0.165	−0.077
B8.7	0.086	0.022	−0.129	0.117	−0.517	−0.029	0.773[a]	−0.214	0.084	0.031	−0.093	−0.038	0.162	−0.190	0.147	−0.294	0.083	0.044	0.082
B8.8	−0.245	0.072	0.115	0.032	0.090	−0.142	−0.214	0.812[a]	−0.681	−0.032	−0.009	−0.017	0.034	−0.081	−0.096	0.139	−0.110	−0.020	0.063
B8.9	−0.027	0.038	−0.060	−0.118	−0.185	0.127	0.084	−0.681	0.817[a]	−0.059	0.061	−0.017	−0.209	0.117	0.052	−0.090	0.083	−0.099	0.043
B8.10	0.001	0.121	0.046	−0.189	0.092	−0.201	0.031	−0.032	−0.059	0.890[a]	−0.242	0.176	−0.080	0.088	−0.241	−0.285	−0.051	−0.061	−0.193
B8.11	0.010	0.023	0.034	−0.185	0.004	0.027	−0.093	−0.009	0.061	−0.242	0.838[a]	−0.304	0.114	−0.123	−0.154	0.177	−0.131	−0.101	0.095

B8.12	−0.010	−0.238	−0.166	−0.378	0.167	−0.006	−0.038	−0.017	−0.017	0.176	−0.304	0.735 [a]	0.016	0.040	−0.240	−0.016	−0.075	0.117	0.013
B8.13	−0.016	−0.061	−0.066	0.056	−0.161	0.130	0.162	0.034	−0.209	−0.080	0.114	0.016	0.852 [a]	−0.524	−0.020	0.024	−0.062	−0.197	0.131
B8.14	−0.110	−0.081	−0.007	0.035	0.079	−0.034	−0.190	−0.081	0.117	0.088	−0.123	0.040	−0.524	0.852 [a]	−0.132	−0.058	0.001	0.128	−0.226
B8.15	0.054	0.080	−0.093	0.166	−0.142	0.176	0.147	−0.096	0.052	−0.241	−0.154	−0.240	−0.020	−0.132	0.877 [a]	−0.204	0.140	−0.218	−0.096
B8.16	−0.037	−0.110	−0.006	−0.089	0.184	0.003	−0.294	0.139	−0.090	−0.285	0.177	−0.016	0.024	−0.058	−0.204	0.858 [a]	−0.293	−0.210	0.152
B8.17	−0.024	0.107	0.112	0.108	−0.273	0.119	0.083	−0.110	0.083	−0.051	−0.131	−0.075	−0.062	0.001	0.140	−0.293	0.883 [a]	−0.244	−0.180
B8.18	−0.011	−0.085	−0.007	0.049	0.135	−0.165	0.044	−0.020	−0.099	−0.061	−0.101	0.117	−0.197	0.128	−0.218	−0.210	−0.244	0.900 [a]	−0.349
B8.19	−0.087	−0.193	−0.093	0.133	−0.054	−0.077	0.082	0.063	0.043	−0.193	0.095	0.013	0.131	−0.226	−0.096	0.152	−0.180	−0.349	0.882 [a]

Note: a. Measures of Sampling Adequacy (MSA).

To check for common variance shared by factors with given variables, communalities were extracted using the Principal Axis Factoring method. The recommended value for better measurement of factor analysis communalities extraction is 0.3 or greater. **Table 6** shows the communalities obtained are between 0.429–0.893 showing at least 30% common variance of the variables.

Table 6. Communalities for CT.

Communalities		
	Initial	Extraction
B8.1	0.504	0.509
B8.2	0.482	0.518
B8.3	0.514	0.502
B8.4	0.551	0.658
B8.5	0.759	0.893
B8.6	0.594	0.558
B8.7	0.634	0.606
B8.8	0.723	0.784
B8.9	0.720	0.820
B8.10	0.634	0.692
B8.11	0.462	0.429
B8.12	0.534	0.597
B8.13	0.602	0.621
B8.14	0.577	0.567
B8.15	0.594	0.550
B8.16	0.600	0.533

B8.17	0.565	0.535
B8.18	0.721	0.765
B8.19	0.617	0.601

Note: Extraction Method: Principal Axis Factoring.

The total variance explained in **Table 7** indicates a number of factors extracted, this table looks at the initial eigenvalue and only values above 1.00 in the total column. Resulting in five (5) factors extracted (which means that all communication tools are grouped into 5 factors) with Eigenvalue above 1.00 extracted using Principal Axis Factoring method. This factor explains 71.298 percent of the variance before rotation and 61.787 cumulative percentages after rotation.

Table 7. total variance for CT explained.

Total Variance Explained									
Factor	**Initial Eigenvalues**			**Extraction Sums of Squared Loadings**			**Rotation Sums of Squared Loadings**		
	Total	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**
1	7.288	38.360	38.360	6.919	36.418	36.418	3.738	19.674	19.674
2	2.173	11.437	49.798	1.801	9.481	45.898	2.620	13.792	33.466
3	1.801	9.479	59.276	1.441	7.586	53.484	2.192	11.537	45.003
4	1.237	6.509	65.785	0.951	5.005	58.490	1.782	9.378	54.382
5	1.047	5.513	71.298	0.626	3.297	61.787	1.407	7.405	61.787
6	0.817	4.301	75.599						
7	0.621	3.267	78.866						
8	0.604	3.176	82.043						
9	0.528	2.777	84.820						
10	0.478	2.516	87.336						
11	0.433	2.281	89.617						
12	0.353	1.858	91.475						
13	0.321	1.688	93.163						
14	0.296	1.559	94.722						
15	0.265	1.393	96.115						
16	0.248	1.308	97.422						
17	0.200	1.053	98.475						
18	0.162	0.851	99.326						
19	0.128	0.674	100.000						

Note: Extraction Method: Principal Axis Factoring.

Section B: 2nd order factor analysis for CT.

The relevance of the data for Factor Analysis was examined. The inspection of the correlation matrix showed the availability of coefficients above 0.3, as presented in **Table 8**. The aim was to check whether the remaining 9 variables were correlating. The coefficients were found to be above the recommended 0.3.

Table 8. Correlation Matric (2nd order factor analysis).

Correlation Matrix						
		SecB_F1	SecB_F2	SecB_F3	SecB_F4	SecB_F5
Correlation	SecB_F1	1.000	0.435	0.448	0.489	0.598
	SecB_F2	0.435	1.000	0.288	0.463	0.438
	SecB_F3	0.448	0.288	1.000	0.400	0.341
	SecB_F4	0.489	0.463	0.400	1.000	0.485
	SecB_F5	0.598	0.438	0.341	0.485	1.000

KMO measure of sample adequacy reached a value of 0.871, which is greater than the minimum recommended value of 0.6, indicating sufficient items for each factor (George and William, 1989). The Bartlett's test of sphericity tests whether a matrix is significantly different from an identity matrix, thus, it tests the presence of correlations amid variables, providing the statistical probability that the correlation matrix has significant correlations among at least some of the variables Bartlett (1951). This means that the Bartlett test of sphericity should be significant with a p-value less than 0.5per cent. **Table 9** shows that the obtained value was 0.00 which meets the required value of $p < 0.001$.

Table 9. KMO and Bartlett's test (2nd order factor analysis).

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.813
Bartlett's Test of Sphericity	Approx. Chi-Square	268.706
	df	10
	Sig.	0.000

The Anti-image correlation was checked, the diagonal coefficient values (top left to down right) are the Measures of Sampling Adequacy (MSA), which were all observed in **Table 10** below to be between 0.7 and 1.0, which is indicative of a strong positive relationship.

Table 10. Anti-image matrices (2nd order factor analysis).

Anti-image Matrices					
Anti-image Correlation					
	SecB_F1	SecB_F2	SecB_F3	SecB_F4	SecB_F5
SecB_F1	0.779a	−0.149	−0.255	−0.163	−0.408
SecB_F2	−0.149	0.851a	−0.039	−0.256	−0.173
SecB_F3	−0.255	−0.039	0.841a	−0.196	−0.034
SecB_F4	−0.163	−0.256	−0.196	0.831a	−0.204
SecB_F5	−0.408	−0.173	−0.034	−0.204	0.791a

Note: a. Measures of Sampling Adequacy (MSA).

Communalities were extracted using the Principal Axis Factoring method to check for common variance shared by factors with given variables. The recommended value for better measurement of factor analysis communalities is 0.3 or greater while an extraction of 0.2 is regarded okay. In **Table 11** below, all factors except for factor 3 (verbal communication) at an extraction of 0.284; shows a common variable ranged between 0.479–0.596. This shows at least 30% of the common variance.

Table 11. Communalities (2nd order factor analysis).

Communalities		
	Initial	Extraction
SecB_F1: Effective construction communication	0.463	0.596
SecB_F2: Social media	0.295	0.359
SecB_F3: Verbal communication	0.246	0.284
SecB_F4: Informative communication	0.373	0.479
SecB_F5: Video conferencing	0.425	0.523

Note: Extraction Method: Principal Axis Factoring.

In **Table 12** the total variance is explained, showing that after careful analysis, the nine (9) variables are depicting that there are two factors. The extraction of factors was performed using the Principal Axis Factoring method. The initial Eigenvalue cumulative percentage for Factor 1 was 53.826 and for Factor 266.101. The cumulative percentage after the rotation sums of squared loadings was 31.11 and 57.639 for factor 1 and 2 respectively.

Table 12. Total Variance Explained (2nd order factor analysis).

Total Variance Explained						
Factor	**Initial Eigenvalues**			**Extraction Sums of Squared Loadings**		
	Total	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**
1	2.769	55.384	55.384	2.240	44.806	44.806
2	0.731	14.619	70.003			
3	0.605	12.094	82.098			
4	0.510	10.203	92.301			
5	0.385	7.699	100.000			

Note: Extraction Method: Principal Axis Factoring.

Empirical and theoretical reliabilities.

Scale reliability test for Section B–Factor 1.

All items making up factor 1 to 5 were subjected to a reliability test and proved to be internally reliable at a value of F1 0.888, F2 at a value of 0.848, F3 at a value of 0.782, F4 at a value of 0.895 and lastly F5 at a reliable value of 0.797 which are all significantly greater than the minimum requirement of 0.7 for Cronbach's Alpha coefficient, as shown in **Table 13** below.

Table 13. Reliability statistics for Section B–F1.

	Reliability Statistics	
Factor name	**Cronbach's Alpha**	**N of Items**
Effective construction communication	0.888	6
Social media	0.848	4
Verbal communication	0.782	5
Informative communication	0.895	2
Video conferencing	0.797	2

Scale reliability test for Section B–2nd Order Factor 1 and Theoretical:

The nineteen (19) items making up factor 1 in the 2nd order analysis of section B were also subjected to a reliability test and proved to be internally reliable at a value of 0.908, which is significantly greater than the minimum requirement of 0.7 for Cronbach's Alpha coefficient, as shown in **Table 14** below.

Table 14. Reliability statistics for Section B–2nd order factor 1.

	Reliability Statistics	
Factor name	Cronbach's Alpha	N of Items
Communication tools/channel	0.908	19

Results showing descriptive on scales per factor.

This part of the results is the empirical factors; the factors were given new names to make it easier to interpret what the study is measuring. **Table 15** shows the calculation of the frequencies per factor as shown below. The table records the overall mean item score per factor, std. deviation as well as the minimum (the lowest score that a respondent had) value "no extend" and the maximum (highest score someone had) value "very high extend" having used a 5 Likert scale questionnaire.

The empirical results shows that SecB_F1 effective construction communication is to a moderate extend at the mean score of 3.2882, SecB_F2 social media is a slightly more than a small extend with mean score of 2.3789, SecB_F3 Verbal Communication is to a large extend at mean value of 4.2656, SecB_F4 informative communication mean is 3.4661 which is between large and moderate extend, SecB_F5 Video Conferencing is moderate extend with the mean score of 3.1875.

Table 15. Descriptive on scales per factor.

Factor name	**Mean**	**Std. deviation**	**Min**	**Max**
SecB_F1 Effective Construction Communication	3.2882	0.79647	1.33	5.00
SecB_F2 Social Media	2.3789	0.87951	1.00	5.00
SecB_F3 Verbal Communication	4.2656	0.58217	1.40	5.00
SecB_F4 Informative Communication	3.4661	0.91248	1.00	5.00
SecB_F5 Video Conferencing	3.1875	0.85691	1.00	5.00

Tests for normality and comparisons.

In this section we have done a Kolmogorov-Smirnov test for the test of normality because the group sizes are bigger than fifty (50), we have 98 in the experience group and 71 in the other (no-experience) group. In **Table 16**, we have per group of experience and non-experience's statistic value, df (degree of freedom) in this specific question it is how many people were in each group and sig (significance) that is the p value; was used to determine if the comparisons were normally distributed or not. If the p value is bigger or equal to 0.05 it indicates that it is normally distributed, if it is less than 0.05 it is not normally distributed. Therefore SecB_F1 Effective construction communication for the "no experience" group was normally distributed with the *p*-value of 0.200 while the rest of the variables were not normally distributed.

Table 16. Normality and comparison.

Tests of Normality				
Kolmogorov-Smirnova				
rA5		Statistic	df	Sig.
Effective construction communication	No experience	0.061	98	.200*
	Experience	0.205	71	0.000
Social media	No experience	0.151	98	0.000
	Experience	0.118	71	0.015
Verbal communication	No experience	0.121	98	0.001
	Experience	0.188	71	0.000
Informative communication	No experience	0.189	98	0.000
	Experience	0.236	71	0.000
Video conferencing	No experience	0.215	98	0.000
	Experience	0.240	71	0.000

Parametric test for comparisons.

The parametric test was done to determine if there is a statistically significance difference between the no experience vs experience group in 4IR applications on each of the factor scores, although most of the variables were not normally distributed we used a parametric test to compare the two groups as parametric tests are quite robust against deviations from normality if the group sizes are large enough and similar in size. The group sizes for all factors were large enough as the no experience group was a total of 98 and the experience group 71. effective construction communication (ECC) mean for no experience group was 3.06, for the experience group was 3.54 which suggest that people with no experience adopted less ECC than people with experience; social media (SM) mean for no experience group was 2.23, for the experience group was 2.63; which signifies that the people with experience have adopted to SM more as compared to the people without experience; verbal communication (VC) mean for no experience and experience group was the same at 4.30; which implies that whether one had experience or no experience in 4IR, the VC is the same; informative communication (IC) mean for no experience was 3.31, the experience group was 3.73; it signifies that the IC has been adopted in the experience group far more than in the no experience group ; video conferencing (VCF) mean for no experience was 2.90, for the experience group was 3.54 this shows that the people with experience have adopted to VCF more than the people with no experience.

5. Discussion of results

The study's research question one was whether industry 4.0 may benefit the development of construction SMEs in the fourth industrial revolution through the usage of ICT and construction software. The findings on the adoption of communication channels were that verbal communication is overly utilised seconded by informative communication, effective construction communication and video conferencing which were moderately adopted and social media on the other hand was adopted to a small extent. The findings from the study supports the discovery of studies conducted by (Ojelabi et.al., 2018) that professionals in African countries have a low presence of social media sites. These findings are supported by BDC (2016) that in spite of the potential advantage of the innovative technologies offered by industry 4.0, the construction industry has not been able to totally reap the benefits and compete with the manufacturing sector.

The comparison results showed that 4IR experienced group adopted communication channels to a larger extend than the no experience group. This is supported by studies such of Li et al. (2007), Mak (2011) and Nitithamyong and Skibniewski (2004) who discovered that digitalizing the industry through using various internet-based communication systems will enhance communication among construction professionals, and in return, enhance sustainability of buildings and increase the performance of the construction industry.

The South African construction SMEs will certainly profit from the utilisation of ICT in the 4IR. Related studies of (Gopalakrishnan and Brindha, 2017) attests that the implementation of ICT technologies in construction are aimed at supporting information sharing among individuals and groups. The construction industry of today and of tomorrow demand the use of sustainable systems enabled by information and communication technologies. Also, the literature search was extracted from developed and developing countries. The findings from the literature revealed that the factors that determine the development of construction SMEs are complex with various aspects.

Qalati et al. (2021) indicated that globally large and small medium firms can adopt social media (SM) and other internet-based strategies without requiring additional resources, SM can be employed by small and medium-sized enterprises (SMEs) because of its low cost, technical manageability and ease of use, and its capability to connect with and reach to ample number of consumers. Also, the findings from the review of literature revealed that the development indicators for SMEs in the construction industry could be attributed to the benefit of adopting ICT. These benefits are a better project scheduling, improving productivity, better cost estimation, accelerating the conveyance of documentation and tenderers and increasing the capability of construction development.

The findings in this paper may influence other construction SMEs in Africa and certainly different sectors such as manufacturing businesses. Therefore, to answer the research question, this section proved that the fourth industrial revolution through the adoption of ICT does benefit construction SME's development.

6. Conclusion and recommendations

This paper investigates how the adoption of ICT can improve the construction SMEs in South Africa; while looking at the usage of communication tools in the workplace. The practise of ICT in the industry is of outmost importance for the improvement of SMEs and the industry as a whole, this is previously presented in section 2.3 of the literature review. Based on the empirical data, the paper determined that SMEs in SA have implemented ICT even though a large number of these small enterprises have not yet applied these technologies.

However, in context of this study, verbal communication is adapted to a large extend, video conferencing to a moderate extend while social media is adopted slightly more than a small extend, thus the following recommendations were made in regards to this situation.

6.1. Recommendations

The study recommends that the government, clients and related stakeholders incorporate the use of video conferencing for meetings such as; briefing sessions. This will decrease the costs of transportation used for face to face meetings and also enable more SMEs to partake in project bidding; bridging a gap of attending physical briefing sessions for each tender in different locations. It further recommends that the SMEs should instil the use of ICT tools in their daily workforce to take advantage of the benefits brought by these technologies to further enhance the capability of the industry.

6.2. Limitations

The study only looked at the SMEs in Gauteng province, this is because Gauteng is high populated, and it is South Africa's financial capital and rapidly developing in the business. The broader Gauteng City Region is projected to have contributed around 45% of SA's total economic output in 2013 (StatsSA GDP-R). The participants were strictly construction professionals such as; architects, construction managers, quantity surveyor, engineers etc. this provides a broad representation of different knowledgeable participants offering a wide range of perspectives and experiences of ICT implementation in practice.

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