



Technology readiness: a precursor for Industry 4.0

DOI nr: <https://doi.org/10.35683/jcm19095.59>

C MARNEWICK

University of Johannesburg, Applied Information Systems

cmarnewick@uj.ac.za

ORCID NR: <https://orcid.org/0000-0002-2340-8215>

AL MARNEWICK

University of Johannesburg, Postgraduate School of Engineering Management

amarnewick@uj.ac.za

ORCID NR: <https://orcid.org/0000-0002-7458-1296>

ABSTRACT

The fourth industrial revolution (4IR) and its impact on organisations is currently a topic for discussion. There is no consensus on what constitutes the 4IR and whether South African organisations are ready for the envisioned changes brought about by this revolution. Literature suggests that technology will be a driving force of the 4IR. The combination of technologies that enable the new digitalisation used is Industry 4.0. This research aimed to determine the level of usage of Industry 4.0 technology concepts within organisations in order to understand their readiness towards these technology concepts. The results indicate that there is confusion amongst scholars around terminology i.e. Industry 4.0 versus the 4IR. It also indicates that organisations have not implemented the technology concepts associated with the 4IR and that the driving forces for implementing technology concepts is based on operational aspects and not strategic aspects. The results suggest that organisations are so immature in the implementation of these technology concepts that it is impossible to determine their readiness. Firstly, this article clarifies the relationship between the concepts of Industry 4.0 and the 4IR and secondly, whether South African organisations have implemented Industry 4.0 technology concepts. This is important as the one (Industry 4.0) is a precursor for the other (4IR).

Key phrases

4IR; Industry 4.0; readiness and technology

1. INTRODUCTION

“To her unguarded nest the weasel comes sneaking, and so sucks her princely eggs” (Henry V 1.2.170-171). The fourth industrial revolution (4IR) is sneaking upon organisations and just as the weasel sucks the princely eggs empty, organisations will be left behind if they are not ready for the 4IR. This revolution affects all people, organisations, industries and countries. No one is exempted from the impact and effects of the fourth industrial revolution.

The 4IR is a direct result of Industry 4.0 which focuses on the introduction of technologies into industry. The integration of information and industrial technologies is the foundation of Industry 4.0 and ultimately the 4IR (Deloitte 2018; Zhou, Liu & Zhou 2015). Technologies associated with Industry 4.0 include the Internet-of-Things (IoT), Internet-of-Services (IoS), cloud computing and Cyber-based physical systems (CPS) to name but a few (Li 2017; Muhuri, Shukla & Abraham 2019; Zhou *et al.* 2015). There is currently limited empirical evidence about the current state of Industry 4.0 technology awareness, readiness and adoption within the South African context. To be pro-active, organisations should be aware of the underpinning technologies of Industry 4.0 and be ready for the adoption of these technologies.

This article focuses on organisations’ readiness for Industry 4.0 with a specific emphasis on technology readiness. Technology readiness or the digitalisation of the organisation is one of nine dimensions that is a precursor for Industry 4.0 (Schumacher, Erol & Sihn 2016). This article focuses on this dimension i.e. organisations readiness to incorporate technology in their daily operations. There is currently limited research on organisations’ technology readiness for Industry 4.0 especially within a South African context.

Two (2) research questions were derived from the analysis of the literature i.e. (1) how South African organisations are using Industry 4.0 associated technologies and (2) which of the technologies defined under the umbrella of Industry 4.0, is already used by organisations and, if used, to what extent it is used. The article follows a traditional layout with the literature review addressing the concepts of Industry 4.0 and the 4IR as well as a discussion on technology readiness. A section briefly discussing the research methodology followed by the results which are discussed and analysed. The last section concludes the article with a discussion of the results, potential implications and future research.

2. LITERATURE REVIEW

This section focuses on Industry 4.0 as a precursor for the 4IR and the technology readiness of organisations with regards to Industry 4.0.

2.1 Industry 4.0 and the Fourth Industrial revolution

The first industrial revolution happened with the mechanisation of tasks previously performed with manual labour (Drath & Horch 2014). The second industrial revolution was driven by electrification (Schmidt, Möhring, Härting, Reichstein, Neumaier & Jozinović 2015). Both the first two (2) revolutions had a significant impact on productivity (Drath & Horch 2014). The third industrial revolution is a result of digitalisation that enabled the automation of many systems that also positively impacted productivity (Drath & Horch 2014; Pereira & Romero 2017). There is currently a lot written, but not within the South African context, about the fourth industrial revolution which is believed to be underway (Drath & Horch 2014; Hofmann & Rüsçh 2017).

As it is believed that the 4IR is underway, there is still disagreement among scholars with regards to the terms Industry 4.0 and the 4IR. There are some authors who use these terms interchangeably (Kagermann 2015; Pereira & Romero 2017; Zhou *et al.* 2015) but other authors are stating that Industry 4.0 is a precursor for the 4IR (Neugebauer, Hippmann, Leis & Landherr 2016; Schumacher *et al.* 2016). This lack of consistency amongst scholars contributes to the current confusion.

The one theme that emerges from the literature is that Industry 4.0 is the introduction of internet-related technologies into industry (Drath & Horch 2014). These technologies will lead to the enablement of smart manufacturing and many other possible changes not known yet (Drath & Horch 2014; Muhuri *et al.* 2019). Literature suggests that the Industry 4.0 concept is still ill-defined and could mean different things to different organisations (Perales, Valero & García 2018; Pereira & Romero 2017). These technologies are already available in the market and are used by individual consumers and slowly but surely it is introduced by organisations as well (Drath & Horch 2014). The introduction of these technologies into the organisation integrates the digital and physical landscapes (Pereira & Romero 2017).

With Industry 4.0 also still in development, a single definition is not yet agreed upon (Drath & Horch 2014; Hofmann & Rüsçh 2017). Müller, Buliga & Voigt (2018) summarised various definitions from literature and came to the conclusion that Industry 4.0 focuses on manufacturing and production. In recent literature other authors have started to evolve the definition of Industry 4.0 such as Oztemel and Gursev (2020) "Industry 4.0 is a manufacturing philosophy that includes modern automation systems with a certain level of autonomy, flexible and effective data exchanges encouraging the implementation of next generation production technologies, innovation in design, and more personal and more agile in production as well as customised products."

Although various authors use the terms Industry 4.0 and the 4IR interchangeably, the 4IR relies on Industry 4.0 technologies and the new capabilities it unlocks for both humans and machines. The 4IR explores new ways in which technology becomes embedded within societies and even human bodies (Schwab 2017). The 4IR is characterised by velocity, scope and the impact on systems which distinguishes it from the other three (3) revolutions. The 4IR is evolving at an exponential pace rather than a linear pace. It is also disrupting every organisation in every industry in every country. The breadth and depth of the 4IR's impact, herald the transformation of entire systems of production, management, and governance (Schwab 2017).

Two driving forces for the fourth industrial revolution are suggested by Lasi, Fettke, Kemper, Feld & Hoffmann (2014) i.e. an application pull and a technology push. The application pull focuses on changes due to the changing operating environment. The technology push focuses on the depth and breadth that organisations are using technologies such as smartphones and 3D printers. These two (2) driving forces are realised by Industry 4.0 and would require some changes in the operating environments as illustrated in Table 1.

Table 1: Fourth industrial revolution driving forces

Application pull	Technology push
Short development and innovation periods that enable time to market.	Increased mechanisation and automation through the utilisation of technological aids to support physical work.
Individualisation on demand supporting the trend to customise products to individual demand.	Increase in digitalisation will lead to more data capturing to enable analysis. The increased digitalisation will lead to more technologies to enable simulation, protection.
Flexibility in product development and production.	Miniaturisation of computers and devices.
Decentralisation of decision making to enable faster decisions.	
Resource efficiency to increase economic and ecological efficiency.	

Source: Adapted from Lasi *et al.* (2014)

Organisations that integrate these changes successfully will bring change to the industry landscape. Industry 4.0 is perceived as a “project” that realises the driving forces that leads to the 4IR (Lasi *et al.* 2014). It is also suggested that it is a term for an umbrella of key technology developments which leads to the fourth industrial revolution (Pereira & Romero 2017).

It is evident that Industry 4.0's focus is technology and that its origin emanates from CPS (Zhou *et al.* 2015). Other technology concepts however were incorporated under the Industry 4.0 umbrella as the term evolved. Table 2 presents the most dominant technology concepts that are perceived as contributing to Industry 4.0. This list was compiled by analysing articles focusing on Industry 4.0.

Table 2: Industry 4.0 technology concepts

Technology concepts	Description	References
Concept of "smart"	Smart products will store data as well as interact with the operating environment through its self-awareness ability that will be utilised to communicate autonomously with industrial systems.	(Perales <i>et al.</i> 2018; Pereira & Romero 2017; Schumacher <i>et al.</i> 2016; Zhou <i>et al.</i> 2015)
Open platforms	A software system which is based on open standards that allows for the use of the software to function in other ways than the original programmer intended. It allows organisations to integrate it with their own platforms to add functionality.	(Caruso 2018; Deloitte 2018)
Virtualised	Ability to monitor physical processes i.e. a virtual copy of the physical environment is created and can be used in simulations.	(Castelo-Branco, Cruz-Jesus & Oliveira 2019; Deloitte 2018; Oztemel & Gursev 2020)
Inter-organisational composite applications	Inter-organisational sharing of applications, data and algorithms.	(Deloitte 2018; Marnewick & Marnewick 2019; Schneider 2018)
Software-as-a-Service	Hosting of software and providing access to customers through licencing.	(Deloitte 2018; Hür Bersam & Gül Tekin 2019; Hofmann & Rüsç 2017; Oztemel & Gursev 2020)
Service-Oriented Architecture	Services are provided to other applications over the network.	(Hür Bersam & Gül Tekin 2019; Hofmann & Rüsç 2017)
'Informating' interactions	The interaction between the descriptions and the measurements of activities, events and objects to create information. By doing so, these activities become visible to the organisation.	(Deloitte 2018; Hür Bersam & Gül Tekin 2019; Marnewick & Marnewick 2019; Oztemel & Gursev 2020; Zuboff 1988)
Data, information and knowledge mix	Data collection in big quantities and use in applications to do prediction analysis, pattern monitoring or statistical analysis.	(Deloitte 2018; Muhuri <i>et al.</i> 2019)

Technology concepts	Description	References
Open data	Data freely available to organisations to use for their benefit.	(Deloitte 2018; Hür Bersam & Gül Tekin 2019; Oztemel & Gursev 2020)
Industry standards	A generally accepted standard to facilitate the integration across systems.	(Deloitte 2018; Hür Bersam & Gül Tekin 2019; Oztemel & Gursev 2020)
Information architecture	Structural design of shared information environments.	(Deloitte 2018; Hür Bersam & Gül Tekin 2019)
Networked, dynamic business processes (CPS)	Technologies used to integrate computing and physical processes.	(Kagermann 2015; Perales <i>et al.</i> 2018; Pereira & Romero 2017; Zhou <i>et al.</i> 2015)
Distributed business process management	The management of an environment that provides reliable and timely information about the organisation's supply-chain and supporting rapid decision-making.	(Deloitte 2018; De Sousa Jabbour, Jabbour, Foropon & Godinho Filho 2018; Klen, Rabelo, Spinosa & Ferreira 1999)

Source: Authors' own analysis

Organisations should ready themselves for these technology concepts and once they have readied themselves, then they can adopt these technologies and start reaping the benefits of Industry 4.0.

The analyses of current literature indicate that there is a distinction between Industry 4.0 and the 4IR. The following working definitions can be deduced: Industry 4.0 focuses on technology and technology concepts that drives automation and connectivity resulting in a "smart" environment. 4IR on the other hand, focuses in the impact of Industry 4.0 on societies including organisations and industries. This leads to the first research question of how South African organisations are using Industry 4.0 technology concepts.

The next section focuses on technology readiness as a precursor for the adoption and implementation of Industry 4.0 technology concepts.

2.2 Technology readiness

Various technology readiness models are available from literature that assesses the role of technology in marketing and serving customers (Parasuraman 2000). These technology readiness models are applied to measure an individual's inclination to embrace new technology at work or at home in order to achieve certain goals (Jaafar, Ramayah, Abdul-Aziz & Saad 2007; Parasuraman 2000). One such a readiness model developed by Parasuraman (2000) has been utilised across industries to determine the technology readiness of construction managers, students and many more (Jaafar *et al.* 2007; Lai 2008).

Organisations are only starting to consider the driving forces of Industry 4.0. The current technology readiness models focus on an individual's inclination to embrace new technology and these models were perceived as too complex for the purpose of this research. Research is currently starting to be published around the topic on how to measure the readiness for Industry 4.0 within organisations. Schumacher *et al.* (2016) proposed nine (9) dimensions to measure manufacturing companies' readiness for Industry 4.0. Sony and Naik (2019) suggested six (6) dimensions to be measured when evaluating the readiness for Industry 4.0. Table 3 consolidates the readiness dimensions.

Table 3: Industry 4.0 readiness dimensions

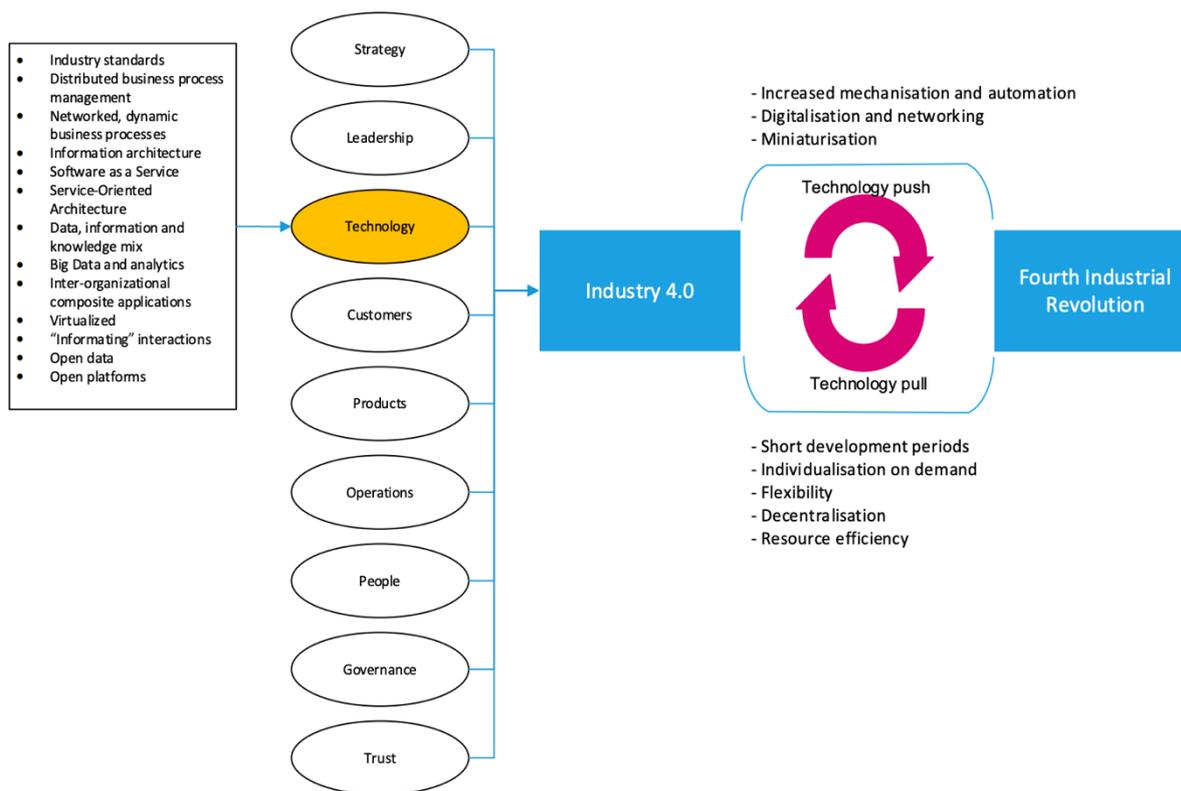
Readiness Dimensions	(Schumacher <i>et al.</i> 2016)	(Sony & Naik 2019)
Strategy	Measures include the availability of an Industry 4.0 roadmap; available resources; Adaption of business models.	Readiness of organisational strategy
Leadership	Measure the willingness of leaders; management competences and methods; the existence of central coordination for Industry 4.0.	Top management involvement and commitment
Customers	Utilisation of customer data; digitalisation of sales/services as well as customer's digital media competence.	Extent of digitalisation of supply chain
Products	Individualisation of products; digitalisation of products; product integration into other systems.	Smart products and services
Operations	Decentralisation of processes; modelling and simulation; interdepartmental collaboration.	
Culture	Knowledge sharing; innovation and cross company collaboration; value of ICT in company.	
People	ICT competences of employees; openness of employees to new technology; autonomy of employees.	Employee adaptability with industry 4.0
Governance	Labour regulations for Industry 4.0 suitability of technological standards; protection of intellectual property.	
Technology	Existence of modern ICT; utilisation of mobile devices; utilisation of machine-to-machine communication.	Level of digitalisation of organisation

Source: Adapted from Schumacher *et al.* 2016 and Sony and Naik 2019

These dimensions highlight the importance of existing technology in organisations. For the purpose of this study, the focus is on the technology dimension. This leads to the second research question: which of the technology concepts defined under the umbrella of Industry 4.0 (Table 2) is already used by organisations and to what extent are they used. Before any readiness for Industry 4.0 can be established, it should be known whether Industry 4.0 technology concepts are actually applied within the technology landscape of the organisation.

Figure 1 provides a high-level overview of how organisations can ready themselves for Industry 4.0 and become a role-player within the 4IR. The six (6) dimensions of Sony and Naik (2019) need to be addressed before organisations can be ready for Industry 4.0. These dimensions are integrated and cannot be addressed in isolation. The focus of this article is to determine which of the technology concepts under the Industry 4.0 umbrella is already within the landscape of the organisations. In order to determine the existence of technologies in the landscape the level of digitisation was reviewed. The digitalisation dimension consists of various technologies, the level of availability would provide an indication, to an extent, how geared the organisation is towards digitalisation. Technology usage will push the increase of mechanisations and automation, digitalisation and networking as well as miniaturisation within an organisation. The technology push creates an application pull where organisations are applying the pulled technology resulting in shorter development periods, individualisation on demand, flexibility, decentralisation and resource efficiency. The changes within the organisation brought about by Industry 4.0, are then constituted as the 4IR. These changes impact the skills employees' require, the way project teams are managed and the introduction of new management styles (Marnewick & Marnewick 2019).

Figure 1: Industry 4.0 to 4IR Roadmap



Source: Authors own construction

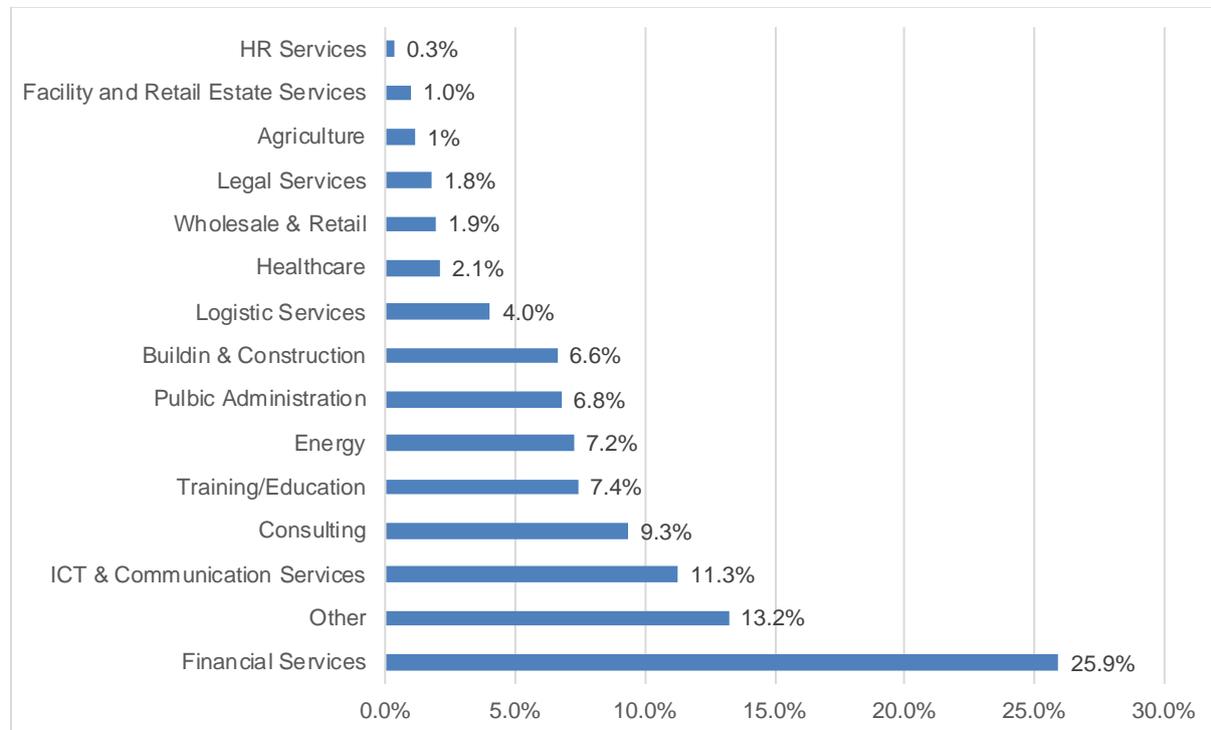
The answering of the research questions requires a sound research methodology. The next section discusses the research methodology for this study.

3. RESEARCH METHODOLOGY

A quantitative approach was adopted to determine the readiness level of South African organisations with regards to Industry 4.0 technologies and the impact of this readiness. The adoption of a quantitative approach allowed the researchers to quantify the problem through the generation of numerical data that quantify the opinions and behaviours. In this instance, the adoption of Industry 4.0 technology concepts is quantified. For the reason that it is difficult to engage with organisations as a whole, the survey was done at an individual level. Individual project managers were the units of analysis. New technology initiatives are generally rolled out by means of projects and managed by project managers. It is for this reason that project managers were targeted. Individuals were targeted using snowball sampling as a non-probability sampling technique. The aim of the non-probability sampling approach was to get a representative sample. A total of 621 valid responses were received, representing projects across 15 industries as per Figure 2. The purpose of the results in

Figure 2 is (1) to understand the survey sample and their organisations, (2) to show that they are representative, and (3) to give context to the results.

Figure 2: Respondent presentation per industry



Source: Calculated from survey results

The first section of the survey covered demographic data about the respondents: role in the organisation, industry sector and the domain in which the respondent's role belong. The second section of the questionnaire focused on the technology readiness and consisted of six (6) questions. Questions one (1) to three (3) focused on the ranking on Industry 4.0 technologies, challenges and influences. Questions four (4) to six (6) required the respondents to rate the degree they believe their organisation is prepared for Industry 4.0 technologies, the benefit of these technologies to the organisation and the extent to which these technologies were implemented. These six (6) questions resulted in 46 items.

There are two (2) criteria that data must meet for credible results to be produced: data must be both valid and reliable (Field 2018). A further distinction can be made between internal validity and external validity (generalisability). There are several ways of assessing internal validity. Logical validity is based on subjective judgment that the measurement items relate to the stated research questions. This was addressed through the design of the questionnaire. Content validity relates to the domains being measured, and whether the scale items measure those domains (Pallant 2010). For this research, all Industry 4.0

technologies were drawn from literature and are believed to be valid. The technology concepts identified in Table 2 were used as the basis for the design of these questions. Using Holt, Armenakis, Feild & Harris (2007) as well as van Dierendonck and Nuijten (2011) as the basis of the questionnaire, speaks to the construct validity of the questionnaire. From an external validity point of view, the data is believed to be generalisable within South Africa. The findings however might not be generalisable outside of organisations not involved in technology implementations.

There are a number of criteria for data reliability. The data must be consistent, with the same method being used to gather it, and must exhibit independence among the respondents. It must be stable, meaning that gathering more data would produce similar results, and reproducible, meaning that if the research were repeated, it would also produce similar results. A commonly accepted way of measuring reliability is by using Cronbach's Alpha test, where an alpha of 0.7 or above is considered satisfactory (Pett, Lackey & Sullivan 2003). An overall alpha value of 0.871 (46 items) resulted from the analysis and indicates that there was sufficient internal consistency.

Another requirement for many types of statistical data analysis is that the data for each rating item are normally distributed. Normality is measured by skewness and kurtosis, which are calculated for each of the rated items. The parameters skewness / standard error of skewness, and kurtosis / standard error of kurtosis are used. Ratios above 2.58 indicate that the data may not be normal (Rose, Spinks & Canhoto 2015). Based on this ratio, and inspection, ratings for the items are normally distributed. Having done reasonable checks on the data, the conclusion is that the data can be used for analysis.

4. DATA ANALYSIS

The results in Table 4 indicate the organisations' focus areas for technology initiatives. These results are compared with an international study's results (Deloitte 2018). This comparison is done to benchmark the South African organisations' focus areas against international organisations. The results indicate that the focus areas are more focused in the operational business areas. Technology initiatives are currently the focus in operations/processes business area (78.9%) and the product development business area (51.5%). This is in line with the origins of Industry 4.0 that is based on cyber-physical systems (Neugebauer *et al.* 2016). Organisations are currently only focusing on areas where they can make quick wins. Areas with little focus are logistics (16.4%) and talent management (23.3%). With regards to the results from logistics, this is in contrast with the

predictions of Frey and Osborne (2017) stating that there is a high probability that transportation will be computerised.

Table 4: Focus of technology initiatives

Business Area	South Africa	International (Deloitte 2018)	Difference (Percentage)
Operations/processes	78.9%	73%	5.9%
Product development	51.5%	48%	3.5%
Marketing/sales/customer support	48%	56%	-8%
Supply chain/sourcing	40.1%	20%	20.1%
Manufacturing/production	28.5%	30%	-1.5%
Talent management	23.3%	40%	-16.7%
Shipping/logistics	16.4%	6%	10.4%
Average	40.95%	39%	

Source: Calculated from survey results

The results from the South African study are to an extent different from that of the international study. The top focus in both studies is within operations/processes (78.9% versus 73%). Two (2) areas that are quite different are the supply chain/sourcing and shipping/logistics. More South African organisations are focusing on the introduction of technologies into these areas than international organisations.

The low levels of focus (Table 4) can be contributed to the challenges that organisations are facing. Respondents were asked to list the top three (3) challenges that they are facing. These results are displayed in Table 5. Technology per se, appears twice in the top three (3) spots i.e. the lack of technology know-how (44%) and the lack of adequate technologies (41%). These two (2) challenges are a direct response to challenge number one (1) stating that there is no internal alignment about the strategies pertaining to the 4IR, which needs to be followed. If there is no strategy, then it is close to impossible to determine the adequate technologies.

Table 5: Common challenges

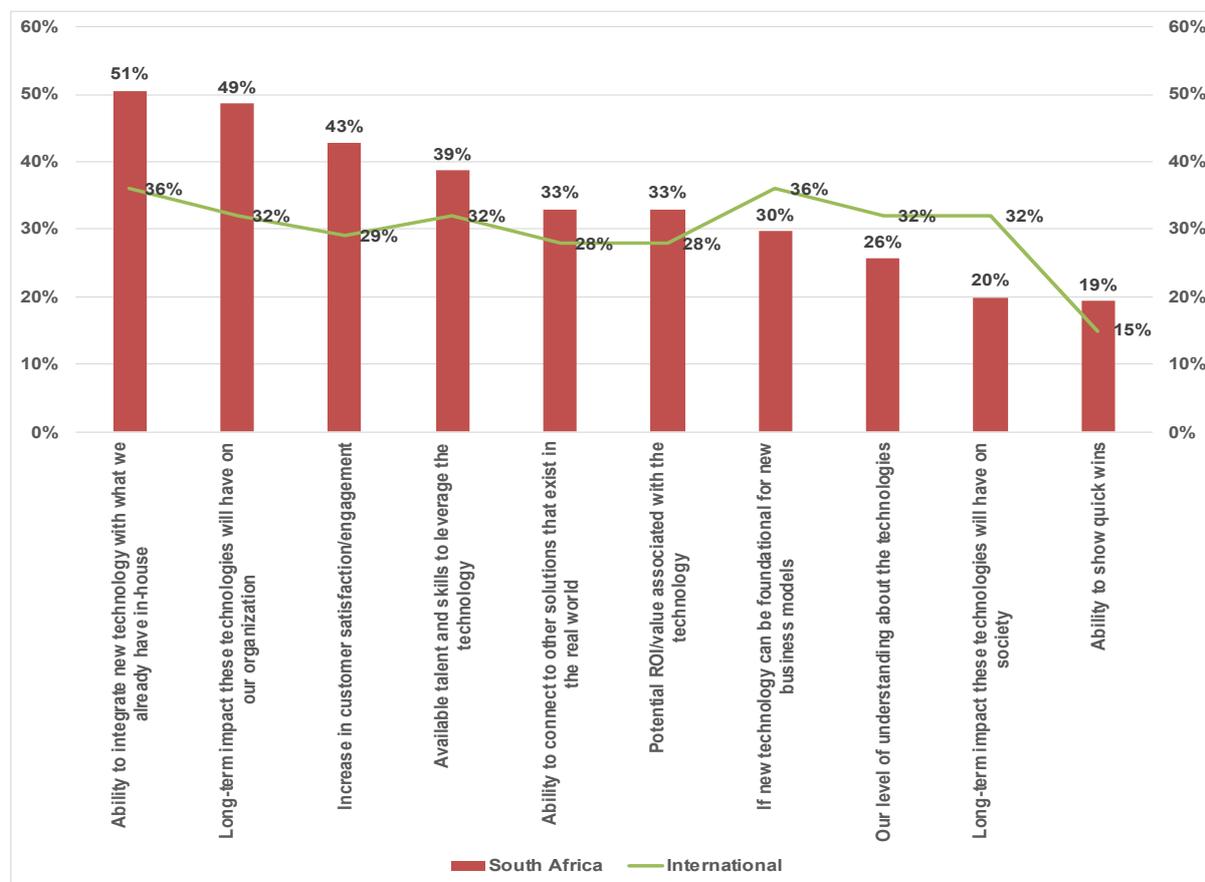
Common Challenges	South Africa	International (Deloitte 2018)	Difference (Percentage)
Lack of internal alignment about which strategies to follow	48%	43%	5%
Lack of technology know-how	44%	29%	15%
Lack of adequate technologies	41%	36%	5%
Budgetary issues	40%	29%	11%
Lack of vision by the leaders	35%	29%	6%
Lack of collaboration with external partners	32%	38%	-6%
Short-termism	31%	37%	-6%
Lack of rank-and-file adoption	9%	32%	-23%
Average	35%	34.13%	

Source: Calculated from survey results

The challenges faced by South African organisations are similar but also different from international organisations. The reason for these differences is not clear and might be included in future research. Two (2) challenges differ quite substantially i.e. that it is not typical to have challenges adopting these technologies and the lack of rank-and-file adoption. A fifth of the South African respondents believe that that they do not have challenges adopting these technologies versus only three (3) percent from the international study. The South African respondents also do not see the lack of rank-and-file adoption as a problem whereas a third of the international organisations perceive this as a challenge. The results from Table 4 and Table 5 indicate that South Africa is unique and that the adoption and implementation of technologies should be addressed from a South African perspective.

Figure 3 illustrates what influences organisations to invest in advanced technologies. If and when organisations invest in advanced technologies, the decision is most likely to be influenced by the ability to integrate new technologies (51%) with current in-house technologies and the long-term impact these technologies will have on the organisation per se. It can be concluded that organisations will invest in advanced technologies only if it is beneficial to the organisation itself. Organisations are not investing in advanced technologies to set them up for the future.

Figure 3: Investment influences



Source: calculated from survey results

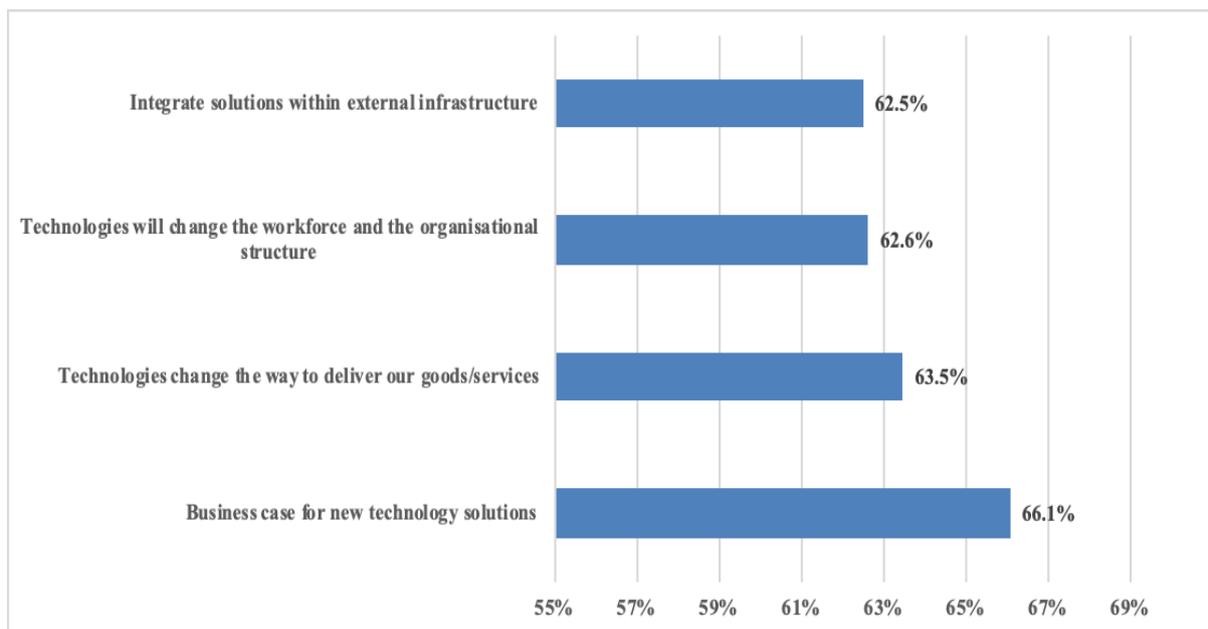
It is evident from the comparison in Figure 3 that the South African investment influences are totally different from the international tendency. Both studies determined that the ability to integrate new technologies with existing technologies is a major influencer. In the case of South Africa, this plays a more important role. The second highest international investment influence is whether new technologies can be the foundation for new business models. In the instance of South Africa, this investment influence is ranked seventh. This again underlines the fact the South African organisations are not using new technologies to set them up for the future.

With regards to question four (4) that focused on the readiness of the organisation, the results indicate that organisations are to some extent prepared to address the issues that are typically associated with Industry 4.0. Cyber-based physical systems is one of the foundations of Industry 4.0 and, through the analysis of the data, 63.2% of the respondents indicated that they are ready to address issues and concerns related to the introduction of smart and autonomous technologies. Industry 4.0 also blurs the lines between industries and

sectors. In this instance, organisations indicated a 59.4% readiness to deal with the blurred lines introduced by Industry 4.0 technology concepts. Organisations are also ready (62.7%) for the emergence of new business or delivery models. Interestingly, no significant correlation could be found between these three constructs.

Although organisations are to some extent ready for smart and autonomous technologies, the results in Figure 4 indicate that these organisations do not necessarily realise the benefits associated with the technologies. Two-thirds of the organisations do have a strong business case for the implementation of new technologies. This can be contributed to the fact that in 63.5% of the cases, they do understand the positive impact these technologies will have on the delivery of their goods and services. Organisations also realise that the introduction of smart and autonomous technologies will have an impact on their workforce and organisational structure (62.6%) and that they need to integrate their solutions with external infrastructures (62.5%).

Figure 4: Benefit of technologies



Source: Calculated from survey results

Table 6 indicates the extent to which organisations have implemented Industry 4.0 technology concepts. Results are presented as an overall average as well as per individual industry. The results indicate that organisations have not fully implemented the technology concepts needed to move them into the fourth industrial revolution. A hundred per cent would indicate full implementation.

Table 6: Technologies implemented

Technology	Percentage	Financial Services	ICT & Communication Services	Consulting	Training	Energy	Public Administration	Building & Construction	Logistic Services
Industry standards	62%	16.7	6.8	5.3	4.2	4.4	3.7	4.4	2.8
Distributed business process management	61%	17.1	7.1	5.9	4.2	4.2	3.8	3.3	2.6
Networked, dynamic business processes	61%	16.7	7.0	5.8	4.3	4.4	3.8	3.3	2.9
Information architecture	59%	15.7	6.4	5.4	4.0	4.8	3.7	3.9	2.7
Software as a Service	59%	15.1	7.2	5.9	4.6	3.8	3.8	3.8	2.9
Service-Oriented Architecture	59%	15.8	6.6	5.6	4.3	4.0	3.9	3.2	2.9
Data, information and knowledge mix	59%	15.7	7.2	5.6	4.1	4.0	4.0	3.3	2.6
Big Data and analytics	58%	16.4	6.7	5.1	4.1	4.0	3.7	3.5	2.8
Inter-organisational composite applications	57%	15.6	6.6	5.4	4.2	3.8	3.8	3.1	2.7
Virtualised	55%	15.2	6.7	5.1	4.5	3.3	3.7	3.1	2.4
"Informating" interactions	55%	14.3	6.7	5.4	4.0	3.3	3.6	3.4	2.4
Open data	54%	14.3	6.1	5.0	4.0	3.5	3.5	3.4	2.4
Open platforms	53%	13.8	6.4	5.0	4.1	3.3.5	3.2	3.0	2.12

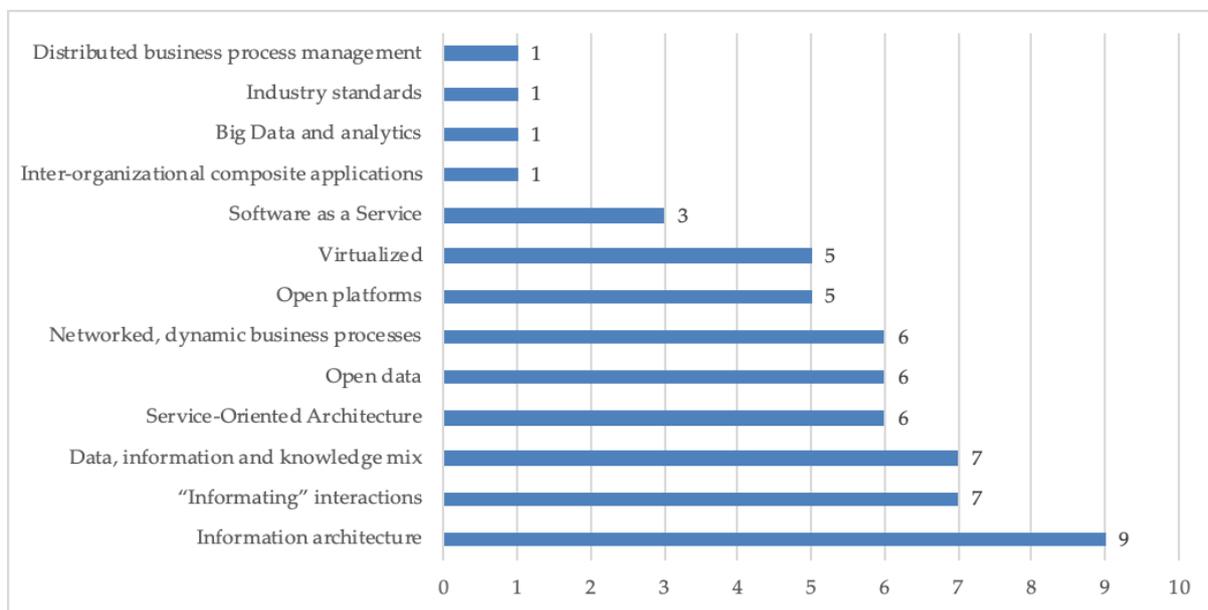
Source: Calculated from survey results

Figure 5 shows the number of times a specific technology concepts correlate with other technology concepts. Intra-technology correlations were determined using Pearson correlations. These correlations are all significant at a level of 0.5 and higher. The top three (3) technology concepts that are correlating the most with the other concepts, are the technology concepts related to information. This can be contributed to the fact that Industry 4.0 is reliant on the transfer of data and information between components, systems and organisations. Intra-technology correlations amongst the implemented technologies indicate

that Information architecture has the most significant correlations with the other technologies. This technology has strong significant correlations with nine (9) other technologies. ‘Informating’ interactions and Data, information and knowledge mix both have seven (7) strong and significant correlations with the other implemented technologies.

The second grouping of technologies is all related to the architecture adopted by the organisations. These technologies form the underlying architecture of Industry 4.0. Three (3) technologies (Service-oriented architecture, Open data and Networked, dynamic business processes) have six (6) strong and significant correlations with the other implemented technologies.

Figure 5: Intra-technology correlations



Source: Calculated from survey results

The high level of significant correlations with the information technologies should not come as a surprise. Information sharing forms the backbone of automation as highlighted by Oztemel and Gursev (2020). It should also be noted that all of the technologies do have a significant correlation with at least one other technology.

5. CONCLUSION

This article focuses on Industry 4.0 and whether South African organisations are ready to implement the technology concepts associated with Industry 4.0. The literature indicates that there is still confusion between the terms Industry 4.0 and the 4IR. The analysis of the literature indicates that there is a distinction between these two (2) terms and that Industry

4.0 is reliant on technologies and that the 4IR is focusing on the impact that these technologies have on an individual, an organisation or a country.

The first research question focuses on how South African organisations are using Industry 4.0 technology concepts. The results indicate the focus is currently on the improvement of operational processes. It can be inferred that this is an inward focus of the organisation to firstly address its internal deficiencies and to optimise its operational processes before it starts focusing on using technologies for automation and data exchange with other organisations. There is currently a low-level focus with regards to using technologies for manufacturing and production. It can be deduced that the South African organisations represented in this research, do not really understand Industry 4.0 and how it can be used to enhance the organisation itself.

The second research question focuses on the extent that organisations are using Industry 4.0 technology concepts. The results indicate that all the technologies are being used but the extent varies. The extent that the technology concepts are used varies within nine (9) percent with the highest implementation at 62% (industry standards) and the lowest implementation at 53% (open platforms). South African organisations still have a long way to go to implement and incorporate Industry 4.0 technology concepts. The direct result of this low level of implementation is that South Africa as a country does have the potential to engage later with the 4IR. Additionally, the challenges faced in terms of technology know-how and technology availability indicates that internally there is work to be done to gear the organisation to take part in the opportunity.

The value of this research is two-fold. Firstly, the research indicates that there is a clear distinction between the terms Industry 4.0 and the 4IR. It is proposed that Industry 4.0 focuses on technology and technology concepts that drives automation and connectivity resulting in a “smart” environment. The 4IR on the other hand, focuses in the impact of Industry 4.0 on societies including organisations and industries. This in itself opens the possibility for a new debate about organisations readiness for Industry 4.0 and the potential impact that organisations do have in moving the society into the 4IR. Secondly, the results show that organisations are not really implementing and using the technologies at hand. This makes it difficult to measure the readiness of organisations to implement Industry 4.0 technology concepts. This can be contributed to the fact that there is still confusion about the various terms and the lack of value that organisations receive from implementing these new technology concepts.

This article opens various avenues for future research. The first aspect is to measure the actual readiness of organisations with regards to Industry 4.0 and readiness models (Parasuraman 2000) can be used in this regard. Another research area should be on the classification of the terms Industry 4.0 and 4IR. There is still a lot of confusion about these terms and this might contribute to organisations' low readiness levels with regards to technologies.

The results in this article ask more questions than what it answers. It is quite easy to determine the technologies implemented and the level of usage but what is not answered is why there is a perceived reluctance amongst South African organisations to ready themselves for Industry 4.0 and the consequences of the 4IR. This can be investigated through in-depth interviews. The impression is created that South African organisations are not really involved in the global debate about Industry 4.0 and the 4IR. There is the possibility that the 4IR, camouflaged as a weasel, will come and suck on organisations' princely eggs ensuring that organisations and ultimately South Africa are laggards when it comes to the 4IR.

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