INAUGURAL LECTURE
PROFESSOR RUDOLF M OOSTHUIZEN
9 FEBRUARY 2022
17:00

PROGRAMME

WELCOME
Prof SK Ndlovu
Vice Principal: Strategy, Risk and Advisory Services, Unisa

INTRODUCTION
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Executive Dean of the College of Economic and Management Sciences, Unisa

INAUGURAL LECTURE
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RESPONSE
Prof M Coetzee
Department of Industrial and Organisational Psychology, Unisa

CLOSURE
Prof SK Ndlovu
Vice Principal: Strategy, Risk and Advisory Services, Unisa

THE FOURTH INDUSTRIAL REVOLUTION

Smart technology, artificial intelligence, robotics and algorithms (STARA)

Industrial Psychologists in future workplaces

Inaugural lecture of Professor Rudolf M Oosthuizen

Department of Industrial and Organisational Psychology

School of Management Sciences

College of Economic and Management Sciences

University of South Africa (Unisa)

Date: 9 February 2022

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ABSTRACT

Futurists predict that a third of jobs that exist today could be replaced by smart technology, artificial intelligence, robotics and algorithms (STARA). Robots will handle 52% of current work tasks by 2025, almost twice as much as in 2019. Rapid changes in machines and algorithms or computer processes could create 133 million new roles in place of 75 million that will be displaced between 2019 and 2022 (World Economic Forum, 2018). These trends have a major impact on the role of the Industrial Psychologist in workplaces. The objective of the inaugural lecture is to present a critical review of Industrial Psychologists in future workplaces in the context of the Fourth Industrial Revolution (4IR) (Venturini, 2022). A competence model is posed for Industrial Psychologists to perform a strategic intelligence role in organisations in the Fourth Industrial Revolution.

Keywords: Fourth Industrial Revolution, Industrial Psychologist, career, change, technology, disruptive technology, competence, STARA, strategic intelligence

Good afternoon, to the:

Principal and Vice-Chancellor: Prof P LenkaBula

Vice Principal: Strategy, Risk and Advisory Services: Prof SK Ndlovu

Executive Dean of the College of Economic and Management Sciences: Prof MT Mogale

Deputy Executive Dean of the College of Economic and Management Sciences: Prof R Mpofu

Director of the School of Management Sciences: Prof MC Mulaudzi

Chair of Department of Industrial and Organisational Psychology: Dr BPM Maphala

The respondent to my lecture: Prof M Coetzee

My wife, Susan Oosthuizen, my children, Juan and Ruzanne Oosthuizen, my mother, Christa Oosthuizen, my mother-in-law, Rita Brown and family members

Distinguished guests, colleagues, students and friends

1. INTRODUCTION

Thank you for the kind welcome, Prof Ndlovu. I am truly grateful for Unisa's recognition of my scholarship, and my inauguration as a Full Professor. Thank you all for attending this virtual event, an event which signifies my rite of passage as an academic; a profession filled with rituals (Manning, 2000, p. 1). It gives me pleasure to be afforded the opportunity to deliver my inaugural lecture today which is grounded in Industrial and Organisational Psychology. The title for my inaugural lecture is *THE FOURTH INDUSTRIAL REVOLUTION – Smart technology, artificial intelligence, robotics and algorithms (STARA); Industrial Psychologists in future workplaces.* The key role of Industrial Psychologists is to contribute to strategic and operational human resources (personnel) practice and people (individual, group, organisation) behavioural dynamics, assessment and intervention design in organisations. Thus, Industrial Psychologists apply psychology principles in the workplace, develop interventions to ameliorate poor performance, and implement industrial psychology intervention programmes (Graupner, 2021).

In today's high-tech and robotised environment, examples of rapid changes that affect how people function at home as well as in the workplace can be observed. In 2015 Toyota announced a large-

scale billion-dollar project to develop self-driving cars that cannot collide and home robots with higher indoor mobility (Toyota US Newsroom, 2015). The CEO of Ford, Mark Fields, also pronounced that the organisation aims to produce 43 million self-driving cars by 2020 (Cava, 2016). According to James Albaugh, a retired CEO of Boeing Commercial Airlines, the "pilotless airliner is going to come; it's just a question of when" (Gu, Gouliamos, Lobonţ, & Nicoleta-Claudia, 2021; Patterson, 2012). In the academic world, North Carolina State University introduced a high-tech library using a robotic system called bookBot to retrieve books when students make requests. This latest technology condensed library storage space by 88% and distributes books to students within five minutes (NC State University - NCSU Libraries, 2017). By the end of 2017, the estimated number of industrial robots in action around the world was approximately 1,9 million (West, 2015). Nearly 47% of all human jobs (mostly in manufacturing, transportation and logistics, and office and administrative support) in the United States will be replaced by robots, machines, automations or computerisations that can do the work faster, better and with less expense in the long run (Chuang & Graham, 2018; Frey & Osborne, 2017).

1.1 Background

The human workforce is going through a mandated advancement (Jackson, 2014). The collective impact of advanced changes and benefits, and the associated drawbacks, are critical issues that require in-depth dialogues about the workforce. Although the transformation of the workforce may take place over a century, Elliott (2014) suggests that organisations should understand the growing capabilities of technology and its impact on the workforce over the next decade or two (Chuang & Graham, 2018). Stephen Hawking and Bill Gates have warned of mass unemployment due to the rise of smart technology, artificial intelligence (AI), robotics and algorithms, which are termed STARA (Bort, 2014; Lynch, 2015). It is estimated that 33% of occupations that exist today could be diminished by STARA by 2025 (Frey & Osborne, 2013; Thibodeau, 2014) because of advances in robotic dexterity and intelligence, joined with low-cost autonomous units that can possibly outperform people in many work settings and dynamic activities (Frey & Osborne, 2013). Instances of these kinds of innovation incorporate retail self-checkout systems, cell phone applications, robotisation in bookkeeping, the web of things and future advances in driverless vehicles. The cost advantage of these kinds of innovation makes it difficult to think about the prolongation of workers in certain positions. Equally, recent debates encourage the need for teams to work digitally and interdependently on set tasks, and for Industrial Psychologists to cultivate competencies fundamental to STARA, as this may further help reduce staff turnover

intention and catalyse innovation initiatives (Brougham & Haar, 2018; Ogbeibu, Jabbour, Burgess, Gaskin, & Renwick, 2021).

Fascinatingly, STARA is not being utilised into simply low-paid, low-talented jobs. Hi-tech algorithms are being utilised in research, and information-writing algorithms inside organisations and broad communications are becoming more progressive. Also, the use of robots with high-precision finesse is increasing fundamentally. An investigation of 702 professions itemised the probability of STARA seizing employment. Occupations at risk incorporate, for instance, accountants, commercial pilots, client administration, sales, and office employees (Frey & Osborne, 2013; Bhargava, Bester, & Bolton, 2021). STARA could also substantially affect healthcare (Bloss, 2011; Lorentziadis, 2014), education (for instance through web-based learning), transportation, and farming enterprises. In general, research demonstrated that 47% of occupations are in danger of being eliminated by STARA (Brougham & Haar, 2018).

In the South African context, President Cyril Ramaphosa positioned the Fourth Industrial Revolution (4IR) into his national economic strategy, generating criticism for its neoliberal rhetoric echoing the World Economic Forum (WEF) and concern it would not create jobs. For corporations it means rethinking strategies and auto-cannibalisation of business models. For policy-makers in manufacturing nations it is supposed to raise national competitiveness and bring manufacturing home, potentially blocking developing nations from creating jobs through attracting labour-intensive manufacturing (Hu, 2021). Its effects on work and employment are forecast to be complex, potentially heightening inequality by reducing demand for low levels of skills. South Africa has a significant skills shortage, due to failings in its education system, limiting the supply of managers, researchers and workers needed for 4IR (Venturini, 2022). There are also problems of poor quality infrastructure, reflecting weak governance and state capture. It has a poor record in policy formulation and implementation, especially across departments, with notable delays in cybersecurity and data protection. There is only a small domestic market and, despite aspirations, it is not an easy gateway to the rest of Africa, which has strong demographic growth but limited spending power and poor physical distribution systems. Moreover, South African firms have to compete with a strong Chinese presence (Sutherland, 2020).

2 LITERATURE REVIEW

2.1 Emerging Digital Workspaces of the Fourth Industrial Revolution

The concept of 4IR describes the increasing digitisation of the entire value chain and the resulting interconnection of people, objects and systems through real-time data exchange. It is characterized by the proliferation of increasingly complex technologies that are bringing together the physical, digital, and biological worlds (Spath et al., 2013; Dorst, Hahn, Knafla, Loewen, & Rosen, 2015; Rotatori, Lee, & Sleeva, 2021). As a result of that interconnection, products, machines and processes are equipped with AI and are enabled to adapt to spontaneous changes in the environment independently. Furthermore, smart technology becomes embedded in broader systems, which enhances the creation of flexible, self-controlling production systems. There are various fields of application for smart technology and systems; however, the focus is still on industrial applications (Porter & Heppelmann, 2015; Huber & Kaiser, 2015; Hecklaua, Galeitzkea, Flachsa, & Kohl, 2016).

An essential facet of the 4IR is autonomous production methods powered by robots that can complete tasks intelligently, with the focus on safety, flexibility, versatility and collaboration. Without the need to isolate its working area, its integration into human workspaces becomes more economical and productive, and opens up many possible applications in industries (Cheng, Awan, Ahmad, & Tan, 2021). Robots that are more industrial are evolving with the latest technological innovation to facilitate the 4IR (Roland Berger Strategy Consultants, 2014). In the 4IR, robots and humans will work hand in hand, so to speak, on interlinking tasks and using smart-sensor human-machine interfaces. The use of robots is widening to include various functions, namely production, logistics and office management (to distribute documents), and they can be controlled remotely. If a problem occurs at a production plant, for example, a worker will receive a message on his/her mobile phone, which is linked to a webcam, so he/she can see the problem and give instructions to let the production continue until he/she comes back the next day. Thus, the plant operates 24 hours a day while workers are only there during the day (Bahrin, Othman, Azli, & Talib, 2016).

Thus, the 4IR is based on cyber physical systems, the Internet of Things and the Internet of Services. More companies and nations are joining the movement and are using different approaches to be competitive and to benefit from the productivity and economic gains it provides (Trauth-Goik, 2021). Although the 4IR covers a very wide area of application in the manufacturing industry, the trend is quickly materialising through the emergence of robotic and automation

product innovation that is tailored for the industrial revolution. Hecklaua et al. (2016) state that the 4IR creates many new opportunities for companies, but at the same time, several challenges are arising from the ongoing automation and digitisation.

Financial challenges: Among an ongoing globalisation process, organisations have to cope with reduced time to market, shorter product life cycles, and the need to cut costs in order to stay competitive (Helmrich, 2015). Organisations need to rationalise their innovation processes and transform their business model to a sophisticated level of service orientation (Shahd & Hampe, 2015). In addition, customer expectations have changed towards a higher level of customisation and flexibility. As a result, markets have become increasingly volatile and heterogeneous (Stock-Homburg, 2013). Therefore, the need for collaboration is more pronounced than before. Companies now have to enter strategic alliances with their suppliers or competitors to stay competitive (Hecklaua et al., 2016; Umar, Rizvi, & Naqvi, 2021).

Societal challenges: Strategies are needed to attract young people, while retaining the expertise of older employees. Younger generations express contrary social values, such as the growing importance of a good work-life balance (Stock-Homburg, 2013). In addition, increasing virtual work and flexible work topics require new forms of lifelong learning (Brühl, 2015). Processes are becoming more multifarious, leading to an increase in jobs that require higher qualifications. Therefore, organisations need to qualify their employees for more strategic, coordinating and creative tasks with advanced responsibilities (Hecklaua et al., 2016; Rotatori et al., 2021).

Technical challenges: Companies must be able to deal with a large amount of data (big data) efficiently (Huber & Kaiser, 2015). Extensive Information Technology infrastructures, such as communications networks and Internet protocols, need to be built and implemented (Brühl, 2015). Standardised interfaces and open architectures that enable co-operative work on different platforms have to be developed (Shahd & Hampe, 2015). The storage of large amounts of data on external servers raises the additional problem of cybersecurity since data must be protected from unauthorised access. Employees must further acquire the necessary skills to be equipped for the increase in virtual work (Hecklaua et al., 2016; Ross & Maynard, 2021).

Ecological challenges: One main challenge affecting the environment is ongoing climate change (Elheddad, Benjasak, Deljavan, Alharthi, & Almabrok, 2021). Conditions in the biosphere change continuously, which has an impact on all living creatures within the system. In addition, the efficient utilisation of ecological resources is becoming more critical, considering most of them are

scarce. As a result, organisations are recognising their role in driving sustainable solutions (Hecklaua et al., 2016; Spath et al., 2013).

Political and legal challenges: Governments need to support organisations with the development of new technologies as well as the incorporation of those technologies in the current environment. Furthermore, governments need to institute legal parameters for the usage of big data. The most important concern is the protection of privacy because data will be collected on every system while interacting with smart objects (Brühl, 2015). Rising work flexibility further requires the establishment of policies and procedures regarding work times and safety matters to protect employees (Hecklaua et al., 2016).

2.2 Smart technology, artificial intelligence, robotics and algorithms (STARA)

The future of world of work compels Industrial Psychologists to consider the biggest questions of their time: What influence will the continuing march of STARA have on where people work and how people work? Will people need to work at all? What is their place in an automated world? Many analysts focus on smart technology and the impact that automation is predicted to have on careers and the workplace. The real story is far more complicated – it is less about technological innovation and more about the manner in which humans decide to use that technology (Luz Tortorella, Cauchick-Miguel, Li, Staines, & McFarlane, 2021). The shape that the workforce of the future takes will be the result of complex, changing and competing forces. Some of these forces are evident, but the speed at which it will unfold is hard to predict. Policies and laws, the governments that impose them and broad trends in consumer, citizen and employee sentiment will all influence the transition toward an automated workplace. The outcome of this battle will determine the future of careers in 2030 (Kojm, 2012). When so many complex forces are at play, linear predictions are too simplistic. Organisations, governments, Industrial Psychologists and individuals need to be prepared for a number of possible, even seemingly unlikely, outcomes (Stubbings, 2018).

2.2.1 Smart technology

Durães, Carneiro, Bajo and Novais (2018) state that the rapid progress of wireless communication and sensing smart technologies has enabled the development of smart learning environments that can detect the environmental context and quantify the attention of an employee in his/her workplace. In the field of computer science, a smart environment is a digitally augmented physical world where sensor-enabled and networked devices work continuously and collaboratively to make the lives of citizens more comfortable (Chang, & Chen, 2021). Significant developments in smart devices, wireless mobile communications, sensor networks, pervasive computing, machine learning, robotics, middleware and agent technologies, and human-computer interfaces have made the aspiration of smart environments a reality. The concept “smart” denotes the ability to autonomously acquire and apply knowledge, and the concept “environment” denotes employee’s surroundings (Cook & Das, 2005).

Alongside this technological evolution, job offers have changed, bringing along many significant and wide-ranging changes. Some of the most tarnished changes are the emergence of indicators such as responsiveness to rapid changes, which, in extreme cases, can compromise the life and well-being of employees. In moderate circumstances, it will impair concentration, general cognitive skills and productivity. Several of these careers are the so-called desk jobs, in which people frequently work for more than eight hours (Durães et al., 2018; Liao & Drury, 2000).

2.2.2 Artificial intelligence (AI)

The potential for digital platforms and AI to underpin and develop the world of work is unbounded (Haefner, Wincent, Parida, & Gassmann, 2021). This platform stratum creates a digital value chain, commoditisation, and automation of the back office, but it comes with warnings. While it can create a thriving trading sphere, it can sprout to take over the entire financial system, and with platform, pervasiveness comes vulnerability to cyberattacks or wide-scale manipulation (United Nations Department of Economic and Social Affairs, 2010). Closely linked to digital platforms are data. How governments, organisations and individuals decide to share and use it, is key to our worlds – even the most human-centric. AI in the form of digital assistants or “chatbots” and machine learning (ML), which is a branch of AI and computer science focuses on the use of data and algorithms to imitate the way humans learn, gradually improving its accuracy. It could understand, learn, and then act based on that information.

It is useful to think of three levels of AI. Assisted intelligence, which is widely available today, improves what people and organisations are already doing. An example is the Global Positioning System navigation programme that offers directions to drivers and adjusts to road conditions. Augmented intelligence, which is emerging today, helps individuals and organisations to do things they would otherwise not be able to do (Haefner, Wincent, Parida, & Gassmann, 2021). For example, shuttle services would not be able to exist without the combination of programmes that organise the service. Autonomous intelligence, which is being developed for the future, establishes machines that act on their own. For example, self-driving vehicles, when they come into widespread use. Some visionaries believe AI could create a world where human abilities are amplified as machines help mankind process, analyse and evaluate the abundance of data that creates today's world, allowing humans to spend more time engaged in high-level thinking, creativity and decision-making (Stubbings, 2017; 2018).

AI and ML are two major drivers of the advancement of big data and technology. Part of the challenge in understanding, evaluating and leveraging these technologies is that it is inherently multidisciplinary. Indeed, nearly any AI- or ML-related start-up with a nexus to human resource will have teams that are dominated by engineers, computer scientists, developers, data scientists and other tech-/math-savvy specialists (Raisch & Krakowski, 2021). The market for AI/ML applications in industrial psychology has continued to grow. Therefore, the focus continues to be on the technology, a trend that is not expected to abate anytime soon. Moreover, in such a technology-dominated environment, it is easy for a field such as Industrial Psychology to get lost in the shuffle and to lose sight of the critical role Industrial Psychologists can play (Putka & Dorsey, 2018).

2.2.3 Robotics

Up to the present time, most robots have been "slaves" to their human operatives, but they are gaining much greater power and autonomy. The increasing use of robots has sparked the question how robots can be integrated successfully into human-robot teams. Richards (2017a) indicates that teams can share goals through delegation between humans and robots, or "agent" members. There is a great deal of paranoia surrounding the increasing power and capacity of robots (Righetti & Smart, 2021). Media scare reports insinuate robots will soon take great swathes of today's careers, especially in industries that already use advanced automation. Undoubtedly, there is some justification for the anxiety. In 2014 robot sales across the world increased by 29%

to 229,261 units in comparison to the previous year. In most cases, robots allow humans to be withdrawn from monotonous, challenging or dangerous tasks (Richards, 2017a).

Advanced robotics is taking expansion to the next level and will pose more questions about robot-human integration. New designs of robots are skilful in becoming agent-based models (ABMs) that can be connected not only to other robots, but also to a wider network composed of both humans and machines. This is already becoming conventional. Human-robot teams are used in advanced space systems, as well as in day-to-day activities. A robot tour guide may accompany visitors to museums, and some hospitals are already using robot helpers. In a short time, the ABMs will be helping people in their homes, especially frail or ageing people. Robots will increasingly be part of human-agent teams in advanced industrial plants (Tresa, Francina, Jerlin Oviya, & Lavanya, 2021).

The nature of trust is additionally pivotal if groups are to perform well. To date, most robots have been acquainted as slaves with human workers. They have given unsurprising sources of information, which has made it easy to understand their intentions. It is not that hard to incorporate those robots. Notwithstanding, when the operators have more self-governance, a human-robot relationship will require a more noteworthy level of adaptability to consider the assignment of power. A formal system of control could help the communications of people and robots to function well (Bhargava, Bester, & Bolton, 2021). The human operators could see the robot components in two distinctive ways. The main alternative would be a bottom-up methodology, which means the ABMs would keep on being basic machine-slaves that satisfy human objectives. The second alternative would be a top-down methodology, which means the ABMs would be viewed as equivalent individuals from the group. A top-down methodology would enable the elements of the group to shape similarly as in customary human groups, with characterised jobs and standards of conduct (Richards, 2017b).

At the point when robots become increasingly self-ruling, there might be a requirement for monitoring robots. Human supervisors could be trained with monitoring their development. Security systems, on the one hand, may utilise robots to perform repetitive tasks, however, a human would screen their performance to ensure quality was not compromised. On the other hand, an ABM may perform complex activities, yet only perform the last activity if approved by a human. Nevertheless, if security was not a factor, a robot could be permitted more important tasks. Richards (2017b) further indicates the developed phase of ABM self-rule where they become managers of human groups. He demonstrates this would raise various issues. Above all else, numerous workers may prefer a fellow human manager. Richards (2017b) additionally

contends that if a robot turned into a manager, people would normally scrutinise the idea of the tasks to be performed. Just other robot individuals from the group would not suggest discussions except if they were intended to do as such (Alcover, Guglielmi, Depolo, & Mazzetti, 2021).

In reviewing the achievement of robot-human groups, it is not adequate for Industrial Psychologist to only analyse the quantitative viewpoints. Any analyses need to consider the prolonged impact that robots in a group may have on human relationships. What will be the effect on trust in the organisation overall? It might be that profitability rises at first, yet the group's relationships change with the perception that errors become progressively normal. After some time, a part of the investigations that emerge from human-robot collaborations may turn out to be less fundamental. As AI propels, robots may come to be viewed as social specialists. A group may turn into a self-contained unit with a mutual "limited wisdom" (Richards, 2017b).

2.2.4 Algorithms

The rise of the Internet created a hope among economists and policy makers that it would lower labour market search costs and lead to better market outcomes. In many online product markets, the designing platform now goes beyond simply providing information but rather makes explicit, algorithmically generated recommendations about whom to trade with or what to buy (Horton, 2017; Resnick & Varian, 1997; Adomavicius & Tuzhilin, 2005; Varian, 2010). Algorithmic systems can attempt to infer preferences, determine the possible choice set, and then solve the would-be buyer’s forced optimization problem. At their best, algorithmic systems can incorporate information not available to any individual party. Furthermore, these recommendations have zero marginal cost, and recommendation quality potentially improves with scale.

To date, algorithmic recommendations have been rare in labour markets, but as more aspects of the labour market become computer-mediated, recommendations will become increasingly feasible. However, it is not clear that labour market recommendations can meaningfully improve upon what employers can do for themselves. Industrial Psychologists could assist with choosing who is appropriate for a particular job opening by evaluating indescribable qualities that are difficult to capture in a statistical model. Or perhaps assembling a pool of reasonable applicants is simply not that costly to employers. Beyond the perspective of the individual employer, a concern with recommendations is that, by design, they encourage an employer to consider some workers but not others. If crowd-out effects are strong – which has been the case in some job search assistance programmes in conventional labour markets (Crépon, Duflo, Gurgand,

Rathelot, & Zamora, 2013). Recommendation interventions are less attractive from a social welfare perspective (Moser, Den Hond, & Lindebaum, 2021).

Horton (2017) concluded that algorithmic recommendations are both acted upon by employers and also effective at raising hiring, at least for some kinds of job openings where more applicants of high quality are valued. While the algorithm is a “black box,” it delivers recommendations observationally identical to the kinds of workers employers recruit in the absence of these recommendations, at least within the limits of available measurements and statistical power. As such, it makes sense to think of algorithmic recommendations as substituting for costly employer effort. There is a superficial symmetry between job openings and workers; job openings can be readily created and destroyed by employers at will, and while workers do enter and exit the labour market, it seems likely that the employer decision to create and fill an opening is more elastic with respect to assistance than the labour force participation of an individual worker. Turning to the conventional market analog, for-profit recruiting firms offer their services primarily to companies rather than individuals. As more of the labour market becomes computer-mediated, the possibilities for platform-based interventions grow in scope and power. Platforms invariably collect enormous amounts of data on market behaviours and outcomes; they also have nearly full control over what information market participants can see, and when. This possibility could have enormous equity and efficiency consequences for labour markets (Tsamados et al., 2021).

3 METHOD

3.1 Study Design

The critical review of the research literature entailed a broad systematic review of contemporary research on the themes of the 4IR – STARA. This approach allowed the author to evaluate documented research on Industrial Psychologists in future workplaces.

3.2 Study Eligibility Criteria

The boundary of the systematic review was defined to include only documented contemporary research in the field of industrial psychology published from 2015 to 2022. A search was done by means of an on-line information technology service, including search engines such as EBSCOhost/Academic Search Premier, and Google Scholar academic databases. The terms 4IR – STARA and Industrial Psychology were used in the search. The full texts of publications were downloaded from the databases in order to ascertain which articles to include or exclude from the systematic review. The inclusion criteria for articles reviewed for the purpose of this lecture were studies exploring Industrial Psychologists in future workplaces. The research articles were treated as the sources of data.

3.3 Data Analysis

A qualitative approach was followed in exploring the 4IR-STARA, and Industrial Psychologists in future workplaces. In the first stage, the author read the studies carefully to form a comprehension of the phenomenon 4IR-STARA under exploration. In the second stage, the author synthesised a portrait of the phenomenon 4IR-STARA that accounts for relations and linkages within its aspects. Stage 3 consisted theorising about how and why these 4IR-STARA relations appear as they do, and Stage 4 consisted of re-contextualising the new knowledge about the 4IR-STARA phenomena and relations back into the context of how other authors have articulated the evolving knowledge. Forty-eight studies were identified in a systematic search for relevant research published between January 2015 and January 2022 in the following electronic databases: EBSCOhost/Academic Search Premier and Google Scholar Academic database. Publications were evaluated for quality, and eight studies were identified as the primary sources for exploration.

3.4 Strategies Used to Ensure Data Quality

Systematic, rigorous, and auditable analytical processes are among the most significant factors distinguishing good from poor quality research. The researcher therefore articulated the findings in such a manner that the logical processes by which they were developed are accessible to a critical reader, the relation between the actual data and the conclusions about data are explicit, and the claims made in relation to the data set are rendered credible. Considerations were also

made in terms of potential publication bias (i.e. the assumption that not all research on the topic may have been published), trustworthiness or credibility, true value and quality, appropriateness, and reflection on the research endeavour in its entirety, as well as best practice. Value and quality were assured by reviewing each article in terms of scientific and methodological rigour in exploring the 4IR-STARA, and Industrial Psychologists in future workplaces. All data were retained for possible future scrutiny.

4 DISCUSSION AND PRACTICAL IMPLICATIONS

4.1 Industrial psychology and the maturation of artificial intelligence and machine learning technology

Organisations are managing a wave of new human resource-interrelated information and technologies. Information is accruing faster, it is getting advanced and it is received in a multitude of forms (for example, big data). Technology is emerging that deduces to make use of such information, but it is sprouting at a pace faster than organisations can assimilate, and faster than science can meticulously assess. Organisational leaders have been racing to determine how to exploit this brand-new wealth of information and technology, but in a milieu where advances are occurring so quickly, it is easy to feel engulfed. To appreciate the value of Industrial Psychology, it is important for managers to look beyond the publicity surrounding AI/ML human resource technology and to consider tough downstream questions. Industrial Psychology can be of value in not only assisting managers to separate the wheat from the chaff when it comes to assessing existing AI/ML technology for human resources, but also in creating stout AI/ML human resource technology for their organisation in the first place. Five questions are posed and answered to illustrate the value of Industrial Psychology in the assessment and creation of AI/ML technologies (Putka & Dorsey, 2018).

How does AI/ML technology ensure data integrity it ingests to inform predictions or forecasts? Ensuring data integrity has to be the responsibility of a person or a team and not a machine. Industrial Psychology offers a profundity and research experience that eclipses many other fields in respect of objectively assessing the value of “people data” and the extrapolations made with that information. What verification can the developers of AI/ML technology provide of the value of the output it produces? “Evidence” must withstand judgement in the light of professional principles

and standards that have existed for decades. These principles and standards draw profoundly on research and practice in the discipline of Industrial Psychology and related scientific fields that relate to the assessment, prediction and explanation of people's psychological characteristics, behaviour and feelings.

What verification can the developers of an application provide that it will have a demonstrable positive impact on an organisation? Implementing this technology will decrease turnover among new employees by 20% and save organisations money. Assertions regarding what any given portion of AI/ML can accomplish vary in terms of the quality of the proof upon which they are grounded. Assessing the quality of findings and data created to assess the effectiveness of AI/ML-related human resource technology is something that Industrial Psychologists are qualified to do. What possibility is there for the application of the technology to have unfavourable consequences? If an AI/ML human resource application lives up to its publicity (for example if adoption leads to a significant decrease in turnover, an increase in speed to hire, a more engaged workforce or increased competence), it may come at a concealed cost. Organisations are unwilling to acknowledge for example, a reduction in workforce diversity, a defilement of employment law or a breach on employee confidentiality. In the employment sphere, Industrial Psychologists are well accustomed to the trade-offs and results related with various types of assessment and decision-making approaches. These unplanned consequences can be very hard to ascertain without going beyond the technology and getting into the essence of why the technology "works" and having subject knowledge with the content concerned.

Why does the technology work? Employment decision-making does not transpire in a void. It transpires in an increasingly multifaceted regulatory environment (for example, employment and data privacy laws), which becomes even more multiplex when working across territories. The discipline of Industrial Psychology has been absorbed in these matters since legal requirements underlying workforce decisions have existed. This is a fundamental issue for the Industrial Psychology field. Comprehending why the technology creates the resolutions it does is critical to assessing its defensibility from a governing viewpoint. AI/ML technology does not just have possible legal inferences for organisations. Matters of intrinsic trust are a main factor of technology implementation that is often disregarded. Contemplate an employee who obtains career-altering recommendations for instruction or a career pathway from a machine, or a reputable manager tasked with affecting promotion decisions who obtains supplemented machine guidance. Managers and employees must have access to the "why" behind the recommendations offered. Fortunately, the area of "explainable AI" is a lively research area, but such lines of

investigation can only gain from subject matter knowledge and the use of proven theory. In terms of Industrial Psychologists' education in assessment and original theories, they are well trained to assist and explain what is transpiring "beneath the surface".

The last question can be asked: Are Industrial Psychologists propelling AI/ML technology change, attempting to be "fast followers", or are they merely standing on the sidelines, hoping to change the discussion down the road? Certainly, some Industrial Psychologists are part of technology start-ups and are conducting thought-provoking research using AI/ML and designing great applications of the technologies, but Putka and Dorsey (2018) point to a more prominent role. In this role, Industrial Psychologists not only help to shape the great guarantee of AI/ML technology implementation, but also serve the greater purpose integral to the mission of the Industrial Psychology field, which is to improve human well-being and to safeguard long-term organisational performance and flourishing.

4.5 STARA competence model for Industrial Psychologists in the Fourth Industrial Revolution

STARA creates many new opportunities for organisations, but at the same time, several challenges are arising from the ongoing automation and digitisation. A STARA competence model for Industrial Psychologists in the 4IR is proposed. The competencies are clustered into four main categories of competencies.

4.5.1 Specialised competencies

- *STARA knowledge*: Owing to the cumulative task accountability of Industrial Psychologists, STARA knowledge is becoming increasingly significant.
- *Strategic business*: All-inclusive specialised competencies are required to change from operational to more strategic business functions. Industrial Psychologists have to be able to accelerate business results. To add value, Industrial Psychologists must generate competitive market insights, have personal capital, have the skills to influence the business, and get the most important things done. Additionally, to drive agility throughout the organisation (Ulrich, 2021).

- *Advances Human Capability*: Industrial Psychologists have to successfully advance human capability in the organisation. It includes a focus on working with line managers to elevate and develop talent and delivering human resources solutions that improve both individual talent (human) and organisation performance (capability). It also includes a specific focus on championing diversity, equity, and inclusion in the workplace to improve overall organisational performance (Ulrich, 2021).
- *Process comprehension*: Advanced process intricacy demands that Industrial Psychologists have a wider and deeper process comprehension.
- *Media abilities*: Accumulative virtual work requires Industrial Psychologists to be able to use smart technology and media.
- *Programming abilities*: The intensification of algorithms and digitised processes initiates an advanced demand for Industrial Psychologists with programming abilities.
- *Understanding Information Technology security*: Virtual functions on servers or platforms compels Industrial Psychologists to be aware of cybersecurity (Hecklaua et al., 2016).

4.5.2 Methodological competencies

- *Simplifies Complexity*: Industrial Psychologists have to think critically and objectively about the challenges their organisation faces in the 4IR. It reflects the ability to separate signals from noise, think independently, and discover opportunities even during times of uncertainty or crisis (Ulrich, 2021).
- *Mobilizes Information*: Industrial Psychologists have to be able to access, analyse, and act on the information by using 4IR technology to solve problems and influence decisions. It reflects comfort with data-based decision-making, curiosity about advancing digital technologies, and understanding of social issues that will impact the organisation. Industrial Psychologists have to be able to utilise reliable sources for continuous learning in fluctuating environments of AI (Ulrich, 2021).
    - *Creativity*: The need for more smart technology and innovative products, as well as for internal enhancements, calls for creativity of Industrial Psychologists.
- *Innovative thinking*: Industrial Psychologists could become more accountable for strategic functions, thus to act as an innovator.

- *Problem solving*: Industrial Psychologists have to identify sources of mistakes and be able to improve processes and procedures.
- *Conflict solving*: An advanced service emphasis increases customer associations, thus conflicts need to be resolved by Industrial Psychologists.
- *Decision-making*: Since Industrial Psychologists will have higher process accountability, they will have to make their own decisions.
- *Diagnostic abilities*: Constructing and scrutinizing significant amounts of information and multifaceted processes become compulsory for Industrial Psychologists.
- *Proficiency assimilation*: Multifarious quandaries needs to be elucidated more proficiently by Industrial Psychologists, for example examining increasing quantities of algorithmic data (Hecklaua et al., 2016).

4.5.3 Societal competencies

- *Intercultural abilities*: These abilities involve Industrial Psychologists understanding of different cultures, especially different work practices, when working nationally and internationally (Ulrich, 2021).
- *Fosters Collaboration*: This competency captures the extent to which Industrial Psychologists successfully foster collaboration of working together. It includes consideration of how open and self-aware they are, how effectively they inspire trust and respect, and how effectively they build relationships that bring people together (Ulrich, 2021).
- *Language abilities*: These skills involve Industrial Psychologists being able to understand and converse with international associates and customers.
- *Communication abilities*: Service inclination demands good listening and presentation abilities, whereas increasing virtual work requires sufficient virtual communication abilities by Industrial Psychologists.
- *Networking abilities*: Working in a highly globalised and interconnected value chain requires knowledge networks by Industrial Psychologists.

- *Teamwork abilities*: Increasing teamwork and collective work on platforms demand the ability of Industrial Psychologists to respect team rules.
- *Compromising and cooperative abilities*: Units alongside a value chain that are developed into equal partners; Industrial Psychologists have to create win-win situations, particularly in organisations with increasing project work.
- *Knowledge transfer abilities*: Industrial Psychologist could assist organisations to retain knowledge; given the current demographic transformation, explicit knowledge and tacit knowledge need to be exchanged.
- *Leadership abilities*: More responsible functions and flattened hierarchies result in every Industrial Psychologist becoming a leader (Hecklaua et al., 2016).

4.5.4 Personal competencies

- *Flexibility*: Escalating virtual work makes Industrial Psychologists time and place independent; work-task rotation further necessitates Industrial Psychologists to be flexible with their job responsibilities.
- *Uncertainty tolerance*: This involves enduring change for Industrial Psychologists, especially work-related change due to work-task rotation or reconfigurations.
- *Continuous learning*: Frequent work-related transformation makes it compulsory for Industrial Psychologists to be willing to continue to learn.
- *Ability to work under pressure*: Industrial Psychologists involved in innovation processes must be able to cope with increased pressure, due to shorter product life cycles and reduced marketing time.
- *Sustainable mindset*: As representatives of their organisations, Industrial Psychologists need to support sustainability initiatives (Norouzi, 2022).
- *Compliance*: This involves stricter rules regarding Information Technology security, working with machines or working hours for Industrial Psychologists (Hecklaua et al., 2016).

- *Resilience*: This involves the capacity of the Industrial Psychologists to cope in spite of the 4IR-STARA, or barriers, or limited resources. Resilient Industrial Psychologists are willing, and able, to overcome fears of the 4IR-STARA by tapping into their emotional strength.

4.6 The strategic intelligence role of Industrial Psychologists in the Fourth Industrial Revolution

Given the proposed competency model, Industrial Psychologists have to perform a strategic intelligence role in organisations in terms of the top ten 4IR workplace trends identified in 2021 (Stark, 2021).

4.6.1 4IR Trend #10: Virtual Learning

Virtual learning, the use of 4IR technology to deliver instruction and facilitate more effective learning, is the tenth most impactful trend identified in 2021. Although the use of 4IR technology to enable digital aspects of learning and gamification has been evolving for decades along with more robust technology and algorithms; the global pandemic, which kept many at home and out of traditional classrooms, accelerated increased usage and adoption across workplaces and educational institutions around the globe (Mulyadi, Huda, & Gusmian, 2022). Industrial Psychologists who focus on learning design, learning delivery, and measurement of outcomes have been instrumental in building and implementing platforms and tools such as learning experience platforms to expand upon more traditional learning management systems, updating design of learning programmes to be mobile/remote first, integrating behavioural economics into approaches to facilitate actions, and measuring the impact of how learning is retained and applied differently because of new delivery approaches (Boyle, 2021).

4.6.2 4IR Trend #9: Building Cultures of Agility and Adaptability

With so much 4IR disruption in different ways across different industries and geographies, many businesses have had to pivot their business strategies and adjust approaches to getting work done accordingly. With some organisations implementing reductions in their workforce and others rapidly expanding, the extent of change experienced in a short time was immense. Some companies found it easier to navigate the change than others, and many who wouldn't describe

their organisation cultures as agile and adaptive have started to embrace building this capability going forward. Industrial Psychologists support organisations to respond by applying diagnostic tools, developing playbooks, and designing other interventions to aid organisations to adopt new values, shift mindsets, and grow their capabilities. Industrial Psychologists responsible for strategic human resources practices such as workforce planning, talent analytics, and other talent management and development practices are also guiding their organisations to increase their agility and adaptability by leveraging data to inform decision making and updating existing practices (DeMeuse, 2021).

4.6.3 4IR Trend #8: The Changing Nature of Work

Many recent developments of this trend are being driven by the growing adoption of artificial intelligence, increased digitization, more automation, and approaches to who (employees, contractors, consultants etc.) does the work and how, often based on an evolution of new skills required. Although artificial intelligence is influencing most technical domains, on its own it lacks any theoretical understanding of humans and how they work. Industrial Psychologists have a unique role to play integrating psychological research on job performance and individual well-being with cutting edge artificial intelligence techniques. The opportunity is to strengthen the humanistic component of work by assisting to leverage artificial intelligence in ways that support individuals rather than solely focusing on organisational efficiencies. It is up to Industrial Psychologists to guide and steer artificial intelligence so that it makes the workplace a better place for humans (Sydell, 2021).

4.6.4 4IR Trend #7: Work-Life Integration

Work-life integration re-emerged as a key trend, in large part due to the shifts which took place in response to the COVID-19 pandemic. Work and other aspects of life converged in new ways when large numbers of workers shifted to work from home. New adaptations are required for handling schooling for children; managing personal and family member illness; and other aspects including community, well-being, health, and other lifestyle components. Industrial Psychologists could guide organisations to understand the challenges employees face and update workforce practices that increase engagement, retention, productivity, adoption of healthy behaviours (for

example introducing stress management tools), training, flexibility, and other key interventions (McDermott, 2021).

4.6.5 4IR Trend #6: Team Effectiveness Across Virtual and Distributed Environments

Team effectiveness across virtual and distributed environments re-emerged as a top trend in 2021, as many workers stopped working in their offices. With significant developments in collaborative 4IR technology over recent years, some organisations have grown accustomed to working effectively without being physically co-located, but others are grappling with challenges to productivity as leaders, managers, and team members who relied on physical proximity are being required to adapt new ways of working. Industrial Psychologists could strategically influence organisations to adapt to this trend through providing models and skill building to help prioritize goals, align resources, facilitate effective communication, conflict management, and other productive and effective behaviours that build and sustain team performance (Curphy, 2021)

4.6.6 4IR Trend #5: Social Justice

Elements of social justice, the process of ensuring equal rights and access to opportunities, regardless of individual factors have been integrated into many corporate social responsibility (CSR) programmes and organisational practices for decades. For example, when George Floyd was killed by a white police officer in Minneapolis last year in the United States of America, it seemed to be the tipping point for many organisations to integrate these programmes further into the fabric of their businesses. Industrial Psychologists often support organisations to address these issues by providing advice and a facilitated approach to identifying meaningful goals in the context of each organisation's ecosystem and developing related road maps (incorporating leadership commitments, employee and community involvement strategies, skill building, measurement tools etc.) to address these complex issues (Beri, 2021).

4.6.7 4IR Trend #4: Inclusive Practices to Get, Keep and Grow Talent

Inclusive practices are implemented in organisations in order to ensure that all people, especially those who hold minority identities across various dimensions (for example race/ethnicity, gender, sexual orientation, gender identity, disability, social class, religion etc.), feel accepted and valued

in the workplace. This topic has important implications for enhancing the extent to which the individual and organisational benefits of workplace diversity are realized. Effective management of diversity, equity, and inclusion means that diverse talent are excited about working at an organisation, are able to put forth their best contributions, and desire to stay. Industrial Psychologists are equipped to support this trend in various ways, such as providing organisations with knowledge of inclusive practices, evaluating current practices to identify areas of improvement, developing training to help implement them, examining the role of implicit and explicit bias in organisational processes, exploring disparities in job attitudes across groups, and designing interventions to address them (Jones, 2021).

4.6.8 4IR Trend #3: Implementing Strategies and Measuring Progress on Diversity, Equity, Inclusion, and Belongingness

Related to the above trend, implementation of new strategies and measurement of impact of various diversity, equity, inclusion, and belongingness programmes emerged as its own trend in 2021. This is in large part due to the continual evolution of talent analytics capabilities. With the capture of accurate and consistent data over time, and the availability to key stakeholders of practical reporting and dashboarding tools, progress on diversity, equity, inclusion, and belongingness initiatives, or lack thereof, is becoming much more visible. Industrial Psychologists can use their expertise in the management of large amounts of information and analysis of data to aid organisations to create reporting that leads to increased awareness and education through descriptive analysis, predictive insights, and prescriptive recommendations (Cooley, 2021).

4.6.9 4IR Trend #2: Employee Health, Well-Being, Wellness, and Safety

This trend remains a top priority for many organisations. Benefits costs continue to rise, and organisations continue to invest in helping employees manage stress to help reduce the physical, mental, and emotional impacts that drive increased costs. Those costs are both direct costs to the balance sheet and indirect costs such as lower engagement, performance, and retention. With COVID-19, a much greater focus on safety emerged for both essential and non-essential workers; and many employees shifted to working from home and experienced greater integration between work and family. Industrial Psychologists support organisations by conducting research to identify root causes of stress and design programmes to decrease risks. In collaboration with other

experts, Industrial Psychologists provide advice on the design of ethical and practical benefits programmes and work practices that contribute to health, well-being, wellness, and safety of employees and members of organisation's expanded workforces (Arvan & Fletcher, 2021).

4.6.10 4IR Trend #1: Remote Work and Flexible Working Arrangements

Working remotely and flexible work arrangements emerged as the top 4IR trend in 2021. Although significant variation exists across industries, occupations, and geographies, the rise of remote work impacted many and has a broad array of implications for both employers and employees. To support organisations in adapting to this 4IR trend, Industrial Psychologists could strategically lead organisations to evolve culture and leadership practices, and update the design of workforce strategies. In some cases, strategies will be less dependent on geography and in others will need to incorporate greater understanding of impacts on different types of workers by rebuilding the offices to only hot desks and communal meeting areas. Industrial psychologists could also guide organisations to develop updated compensation practices, productivity measures, hiring practices, assessments of satisfaction, engagement, and career development (Wuerfel, 2021).

5 CONCLUSION

I view myself as playing a professing role in the education and training of professionally qualified Industrial Psychologists, especially in the 4IR, STARA context. My goal is that qualifying students can competently and ethically contribute to strategic and operational human resources (personnel) practice and people (individual, group, organisation) behavioural dynamics, assessment and intervention design in organisations. Due consideration should be given to the disruptive change of the 4IR, STARA and the evolving needs of a generational and culturally diverse knowledge and information society. In line with the Health Professions Council of South Africa's (HPCSA) scope of practice for Industrial Psychologists, and the HPCSA Minimum Standards for the Training of Industrial Psychology (February, 2019), the curriculum is designed to focus on the development and application of Industrial and Organisational Psychology domain area competencies pertaining to tangible and observable human behaviour-related diagnosis, design, intervention and assessment applied at the individual, group and organisational levels. The teaching outcomes incorporate the planning, development and application of relevant and appropriate universal and Afrocentric paradigms, theories, models, constructs and principles of

psychology to issues related to the world of work in the 4IR in order to understand, modify and enhance individual, group and organisational behaviour well-being and effectiveness (Coetzee & Oosthuizen, 2019).

It is imperative that the training of Industrial Psychologists contributes to the conceptualisation, design and implementation of methods of inquiry, including the application of specialised knowledge, skills and technologies relevant to the Industrial Psychology profession to address complex and challenging human behaviour problems in the 4IR organisational context. The solutions, insights and new knowledge generated by means of advanced scholarship and research may contribute to improved quality of work life, organisational productivity and human development in the South African and African work contexts. The ODeL delivery mode enables the intern to gain practical work experience while pursuing further distance education and training as prospective Industrial psychologist. The practical education and training work are based on experiential learning focused on the application of knowledge and skills in the various internship domain areas for Industrial Psychologists (Coetzee & Oosthuizen, 2019).

In conclusion, this Lecture centrered on various ramifications of the 4IR, STARA, particularly for Industrial Psychologists. Current Industrial Psychologists should contemplate that STARA will change the profession forever. Thus, they should progressively be aware of the ramifications of STARA inside their field and design strategies to cope with these potential changes. As AI and ML become increasingly normal, Industrial Psychologists can lead the way in guaranteeing the utilisation of information and research, assisting with the translation of results and guaranteeing the legitimate solidness of information models and their use. Industrial Psychologists could also assist researchers by understanding their employees' responses to their new AI "colleagues" through theories and by creating interventions to enable employees to adjust to the change. As both of these strategies become increasingly important, it will be a basic premise for organisations to incorporate Industrial Psychologists in their information technology groups to use their skills, guaranteeing optimal results for organisations (SIOP Communications Department, 2019). This new period of the 4IR could be viewed as a period of energy for Industrial Psychologists and could be held onto as an open door for research and self-awareness. The strategic intelligence role of the Industrial Psychologists in empowering organisations through times of disruptive change and development, by offering wellness programmes to assist employees to cope, could not be over emphasized.

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