



A fourth industrial revolution integrated intelligence taxonomy for top management

DOI: <https://doi.org/10.35683/jcm1018.202>

JACOBUS HENDRIK OOSTHUIZEN*

Stellenbosch Business School, University of Stellenbosch, South Africa

Email: cobus.oosthuizen@icloud.com

ORCID: <https://orcid.org/0000-0001-9989-3686>

*corresponding author

MARIUS UNGERER

Stellenbosch Business School, University of Stellenbosch, South Africa

Email: mariusu@usb.ac.za

ORCID: <https://orcid.org/0000-0002-8578-5374>

JAKO VOLSCHENK

Stellenbosch Business School, University of Stellenbosch, South Africa

Email: jakov@usb.ac.za

ORCID: <https://orcid.org/0000-0003-1423-4417>

ABSTRACT

Background: Socioeconomic transformation driven by technological advancement has become more significant in scale, scope, and complexity, so much so that the term fourth industrial revolution (4IR) has been ascribed to this era. The velocity, breadth and depth, and systems impact of the 4IR is unlike anything humankind has experienced. Thus, how should organisational leaders orientate themselves to navigate through the 4IR, which includes a future characterised by ever-increasing technological advancement?

Purpose of the study: Leadership and management practices are not keeping pace with advancements in theory and application comparable to the 4IR's exponential advancement. Although various studies related to leadership and management in the 4IR have emerged in recent times, a theory and practice gap from a top-management intelligence (cognitive disposition) perspective remains. This paper aims to establish an integrated intelligence taxonomy for top management to navigate the 4IR.

Design/methodology/approach: Drawing on insights of global experts, the Delphi method was applied to develop categories of intelligence that reveal the essence of what is required to address the challenges of the 4IR. Accordingly, three iterative rounds of inquiry were conducted with experts until a consensus was achieved.

Findings: Nine themes emerged from the Delphi study that constitute a 4IR integrated intelligence taxonomy. These were categorised by means of a conceptualised intelligence theme descriptor: complexity intelligence; inquiry intelligence; critical intelligence; futures intelligence; adaptive intelligence; creative intelligence; emotional intelligence; ethical intelligence; and collaborative intelligence.

Managerial implications: This study offers insight to practitioners concerning the context and critical issues associated with the 4IR and the cognitive disposition required from a management and leadership practice



perspective so as to effectively navigate the 4IR. It further contributes to serving as a reference point to measure performance in relation to the nine integrated intelligence typologies. This allows for the identification of competence gaps and need-specific developmental interventions.

Keywords

Cognitive disposition; Fourth industrial revolution; Intelligence; Top management

JEL Classification: M0

1. INTRODUCTION

The socioeconomic transformation driven by technological advancement has been so significant in scale, scope, and complexity that the term fourth industrial revolution (henceforth referred to as 4IR) has been adopted to describe this era that is unlike anything humankind has previously experienced (Schwab, 2016). Leadership and management practice, however, are not keeping pace with advancements in terms of theory and application comparable to the 4IR's exponential advancements (Alvesson & Sandberg, 2013; Cai, 2014; McAfee *et al.*, 2014; Mongeau, 2014). In fact, criticism towards outdated leadership and management theory and practice was highlighted during the 2008 financial crisis, with 'responsible leadership' (Falk & Blaylock, 2012; Pless & Maak, 2011; Storsletten & Jakobsen, 2015; Waldman & Galvin, 2008), and 'crisis leadership' (James & Wooten, 2011; Walker *et al.*, 2016), gaining prominence, among others.

Muff *et al.* (2020) posited that, since the 2008 financial crisis, the call for responsible leaders in and beyond business was amplified as corporate scandals continued unabatedly. Maak *et al.* (2021:67) further argued a case for two major "fault lines of leadership" highlighted by the COVID-19 pandemic: narcissism and ideological rigidity. The COVID-19 pandemic emphasised the role of leadership in times of crisis, with Maak *et al.* (2021) further proffering that many leaders failed to instil hope, but rather engaged in acts of selfish, destructive, and 'toxic leadership' to the detriment of numerous people around the world. The COVID-19 crisis highlighted the intellectual qualities expected from leaders:

systemic thinking and the ability to mirror environmental complexity; reflective and critical thinking, and the ability to update one's views when evidence changes; reasoning and ethical skills, and thus the ability to evaluate and judge one's decisions in the context of the greater good." (Maak *et al.*, 2021:81)

In addition, Kwiotkowska *et al.* (2022) argued that the 4IR has resulted in the emergence of new forms of leadership (e.g., digital leadership, virtual leadership, e-leadership); thus, leaders need to reorient themselves to navigate the changes introduced by Industry 4.0 technology. How then should organisational leaders orientate themselves to navigate the 4IR with a potential future characterised by ever-increasing technological advancement? How should leaders prepare and approach a future where the timelines for the adoption of key disruptive trends are indeterminate, as is the degree of certainty with respect to these advancements? Mongeau (2014) asserted that management practice will progressively need to become more innovative in terms of affirming its value proposition in relation to emerging advanced decision technology systems. Although top managers are far from obsolete, machine learning is progressing at a rapid pace; thus, executives need to become adept in creating innovative new organisational forms required to manage in an age of machine intelligence, accentuating creative abilities, leadership skills, and strategic thinking (McAfee *et al.*, 2014). Chui *et al.* (2015) posited that the organisational and leadership implications are profound and that leaders to front-line managers will need to redefine jobs and processes to ensure organisational longevity. This attests to the inadequacy and outdatedness of the prevalent leadership and management practice 'intelligence configuration', thereby highlighting the need to understand the requisite 'intelligence configuration' needed by top management to effectively navigate 4IR.

Various studies related to leadership and management in the 4IR emerged as the 4IR narrative became popular among management scholars, which, amongst others, are:

- Pollitzer (2019), who conceptualised a framework for connecting drivers of plausible digital futures to sustainable development goals (SDGs);
- Markowitz (2019), who studied the roles of policymakers in harnessing the 4IR in SADC;
- Alade and Windapo (2020a), who studied 4IR leadership effectiveness in construction companies and developed an effective 4IR leadership framework for construction organisations (Alade & Windapo, 2020b);
- Adekanmbi and Ukpere (2022), who evaluated the correlational effects of perceived leadership 4.0, workplace ostracism, innovative work behaviour, and organisational performance in Nigeria; and
- Kwiotkowska *et al.* (2022), who investigated leadership competency shortages and its configurations in relation to low leadership effectiveness of Industry 4.0 in Poland.

Nonetheless, there still remains a theoretical and practice gap from a top-management intelligence (cognitive disposition) perspective. Drawing on the non-unitary theory of

intelligence developed by Sternberg (1985), this paper aims to establish an integrated intelligence taxonomy for top management to navigate the 4IR. Top management refers to the highest level in the managerial hierarchy and the decisive source of authority within the organisation. These individuals are accountable to the owners and responsible for the overall management of the organisation (Darr, 2011; Du Toit *et al.*, 2007; Murugan, 2008), and have a direct influence on the formulation of the organisation's strategy (Nielsen, 2010).

2. LITERATURE REVIEW

With the disruption ushered in by 4IR, humanity is faced with a range of complex and wicked problems that require innovative and adaptive solutions. The reconfiguration of leadership and management practice's cognitive disposition is at the heart of navigating these complexities and associated wicked problems. In the quest for understanding the appropriate cognitive disposition, non-unitary theories of intelligence and other typologies need to be drawn upon, and the literature review that follows will subsequently explore these themes, highlighting key research and findings that have emerged in these areas.

2.1 Background

Machine algorithms have been increasingly applied to intellectual tasks that were once an exclusively human domain, tasks which are *ex post facto* redefined as "not requiring true intelligence" (Armstrong, 2014:10). Both ends of the occupational spectrum will likely be impacted as software automation and machine learning advances (Ford, 2013). Davenport and Ronanki (2018) agreed that job losses are expected as smart machines assume certain tasks traditionally completed by humans; however, they believe this fear is overrated because cognitive systems perform specific tasks, not entire jobs.

Across sectors, leadership and an understanding of the unfolding changes are limited when considering the need to rethink economic, social, and political systems in response to the 4IR (Schwab, 2016). This rapid rate of change has necessitated a re-evaluation of corporate structure and workplace business practices, particularly within the leadership realm. At its core, the 4IR strives to reduce the need for human labour; thus, leaders are grappling with how these changes are impacting business dynamics, strategies, and their own leadership roles. The effects of the 4IR and the importance of the right leadership style during this decisive time cannot be underestimated (Herold, 2016). However, Daud *et al.* (2021) argued that many senior executives are not appropriately prepared to embrace the changes perpetuated by the 4IR. Moreover, Kwiotkowska *et al.* (2022) posited that leaders will have to be more open and daring toward the changes the 4IR present. Schwab (2016) argued that the challenges of the

4IR can only be meaningfully addressed by means of nurturing and applying four different types of intelligence: (1) contextual (how we understand and apply our knowledge); (2) emotional (how we process and integrate our thoughts and feelings and relate to ourselves and to one another); (3) inspired (how we use a sense of individual and shared purpose, trust, and other virtues to effect change and act towards the common good); and (4) physical (how we cultivate and maintain our personal health and well-being and that of those around us to be in a position to apply the energy required for both individual and systems transformation).

In view of the complexity, multiplicity, and uncertainty of the 4IR, the demand to become more flexible, adaptable, and capable of leading and managing under conditions of severe uncertainty becomes evident. Solutions provided by modernity and the drivers of progress appear, in many instances, to have become problems of post-normal times (Montuori, 2012). Sardar and Sweeney (2016) are of the view that the changes we are facing are not incremental and isolated, but occur simultaneously and are both connected and interconnected. This constitutes a complex system that Probst and Bassi (2014) view as being dominated by dynamics beyond human control, which are the result of multiple interactions between variables. However, these variables do not follow a regular pattern, but their dynamic interplay can lead to unexpected consequences. In terms of leadership and management as two forms of authority rooted in the distinction between uncertainty and certainty, Grint (2008) posited that it can also be related to Rittel and Webber's (1973) typology of 'tame and wicked problems'. Whilst a tame problem may be complicated, it is resolvable through one-sided acts and is likely to have occurred previously. However, a wicked problem is more complex as it cannot be removed from its environment, solved, and returned without affecting the environment (Grint, 2008). It is subsequently argued that the nature of the 4IR presents top management with challenges inherent to complex systems and wicked problems.

2.2 Complexity and the 4IR

Complex systems exhibit nonlinear behaviour (Anderson, 1999), and organisation theory has not yet caught up with the sophisticated tools that have emerged for analysing the behaviour of complex adaptive systems (Anderson, 1999). Complexity theory assumes that a system can be comprised of living parts that are intelligent and capable of adapting to their environment through interactions, communication, and coordinated activities (McGregor, 2012). Complex behaviour subsequently arises from the inter-relationship, interaction, and inter-connectivity of the elements within a system and between a system and its environment (Mitleton-Kelly, 2003). The implication in a connected and interdependent human system is a

decision or action by any individual (group, organisation, institution, or human system) that may affect related individuals and systems (Mittleton-Kelly, 2003).

Because of the velocity, breadth and depth, and systems impact of the 4IR, Schwab (2016) asserted that complex problem-solving, social, and system skills will become increasingly more in demand (Schwab, 2016). Mittleton-Kelly (2003:23) argued as follows:

if organisations are seen as complex evolving systems, co-evolving within a social 'ecosystem', then our thinking about strategy and management changes. With the changed perspective comes a different way of acting and relating which could lead to a different way of working. In turn, the new types of relationship and approaches to work could well provide the conditions for the emergence of new organisational forms.

Operating in an increasingly complex and disruptive environment requires intellectual and social agility, rather than a fixed and narrow focus. In practical terms, this implies that leaders cannot afford to think with a silo mentality. The approach to problems and challenges must be holistic, flexible, and adaptive, while continuously integrating many diverse interests and opinions (Schwab, 2016).

2.3 Wicked problems and 4IR

"Wicked Problems" "are those complex, ever-changing societal and organisational planning problems that you haven't been able to treat with much success, because they are not static. They're messy, devious, and they fight back when you try to deal with them" (Ritchey, 2013:1). In contrast, 'tame problems' only have a limited degree of uncertainty and are, thus, associated with management (Grint, 2010). The concept of wicked problems has its origin with Rittel and Webber (1973), who argued that the types of problems encountered in policy and planning are qualitatively different from those of 'science' and must, therefore, be treated as such (Morrison, 2013). Rittel and Webber (1973:160) are not calling them "wicked" because these properties are themselves ethically deplorable, but they use the term "wicked" as an expression similar to that of "malignant", "vicious", "tricky" or "aggressive." When considering the 4IR's associated complexities, a single scientific solution that adapts, shapes, and harnesses the potential of disruption appears to be impossible for top management. In terms of creating strategy, Camillus (2008) proffered that contemporary strategic-planning processes do not help companies cope with the serious problems they face. According to Camillus (2008:100), numerous strategy issues are not merely tough or persistent – they are "wicked." These types of problems tend to reveal themselves when organisations are faced with constant change or unprecedented challenges (such as those presented by the 4IR). In

fact, Camillus (2008:100) argued, “it’s the social complexity of wicked problems as much as the technical difficulties that make them tough to manage.”

Grint (2010) noted the importance of the collective in addressing wicked problems. Since wicked problems are partly characterised by the absence of an answer on the part of the leader, it benefits the leader to involve the collective to come to terms with the problem. Subsequently, Grint (2010) posited that wicked problems necessitate the transfer of authority from the individual to the collective, as only collective engagement can appropriately address the problem. Due to the degree of uncertainty involved in wicked problems, it is, unavoidably, associated with leadership, which, according to Grint (2010:13), implies that leadership is “not a science but an art – the art of engaging a community in facing up to complex problems.”

2.4 Leadership and management in the 4IR

Leadership and management practices in the 4IR subsequently appear as having to embrace Morin’s (2008:5 notion of “complex thought”, but tend to steer away from the paradigm of simplification driven by “blind intelligence” (domination of principles of disjunction, reduction, and abstraction). Moreover, Gottfredson’s (1997:13) definition of intelligence references “a very general mental capability that, among other things, involves the ability to reason, plan, solve problems, think abstractly, comprehend complex ideas, learn quickly and learn from experience.” This definition provides a sound basis for pursuing reconfiguring leadership and management thinking to reflect a broader and deeper capability for comprehending and navigating the 4IR.

Schwab (2016) listed four intelligence types: contextual (the mind); emotional (the heart); inspired (the soul); and physical (the body), to be nurtured and applied to meaningfully address the challenges of the 4IR. Building on these four intelligence types, Oosthuizen (2017) conceptualised six additional types: entrepreneurial (the disposition); strategic (the orientation); transdisciplinary (the perspective); ecosystem (the coalescence); Socratic (the philosophy); and ethical (the morals). Arguing the case for a more comprehensive intelligence framework, Oosthuizen (2017) stated that the organisational and management practice implications of the 4IR are profound; thus, leaders will need to redefine their management orientation to ensure organisational longevity.

What is implied by ‘intelligence’ in the context of this paper? It is important to note that this study does not intend to explore intelligence from a psychological, biological, or neurological perspective *per se*. Contrariwise, this paper aims to investigate the term intelligence as a broad descriptor for the following: collective thinking (the systematic transformation of mental

representations of knowledge to characterise actual or possible states of the world); reasoning (drawing inferences); judgement (assessment of the value of an option); decision-making (choice among alternatives); and problem-solving (construction of a course of action to achieve a goal) (Holyoak & Morrison, 2005).

Since leadership and management behaviour can be deemed as originating from cognitive processes, the intelligence paradigm is argued as being vital when considering the appropriate mindset to navigate the 4IR. Drawing on the postulate of intelligence as a general mental capability involving the ability to reason, plan, solve problems, think abstractly, comprehend complex ideas, learn quickly, and learn from experience (Gottfredson, 1997), non-unitary theories proved best suited as theoretical grounding for this study due to its acknowledgement of diverse cognitive functioning.

2.5 Non-unitary theories of intelligence

According to Anderson and Reid (2005), Gardner's theory of multiple intelligences accounts for the diverse range of central adult capacities by considering a diverse range of abilities, each regarded as a traditional conception of 'intelligence'. Gardner listed autonomous intelligence as linguistic, musical, logical–mathematical, spatial, bodily–kinaesthetic, personal, naturalist and spiritualist, manifesting itself in culturally relevant 'intelligent' behaviours (Anderson & Reid, 2005). Nevid (2013), however, postulated that although Gardner's theory has popular appeal, it does not account for the interrelationships among the different kinds of intelligence, nor does it make a determination on how many separate intelligences are required to account for the full range of mental abilities.

Sternberg's theory proposed several types of intelligence: analytical intelligence; creative intelligence (which involves insight, synthesis, and the ability to respond to new situations); and practical intelligence (which involves the ability to solve real-life problems). In terms of how it manifests, it is suggested that each kind of intelligence involves a control hierarchy of cognitive components that contribute to our 'mental self-management, which include performance components, knowledge acquisition components and meta-components (Anderson & Reid, 2005). Nevid (2013) posited that Sternberg's triarchic theory is significant as it provides a much-needed focus on how people use their intelligence in everyday life.

Sternberg's (1999) triarchic theory of intelligence (referred to as a theory of 'successful intelligence' to distinguish the theory from theories of strictly academic intelligence) consists of three distinctive domains: (1) practical intelligence; (2) analytical intelligence; and (3) creative intelligence. Practical intelligence is concerned with individuals applying their abilities

to the kinds of problems that confront them in daily life, such as at work or home. Thus, practical intelligence involves applying the components of intelligence to adapt to, shape, and select environments (Sternberg, 2005). In terms of analytical intelligence, Sternberg (2005) explained this as the information processing components of intelligence; as such, they are applied to analyse, evaluate, judge, and contrast. Moreover, these are typically involved when components are applied to relatively familiar kinds of problems where the judgments to be made are of an abstract nature. Creative intelligence, as per Sternberg (2005), has to do with how well an individual copes with relative novelty (i.e., as Sternberg (2003:55) highlights, “the efficiency with which an individual is able to transition between conventional and unconventional ways of thinking.”

2.6 Other intelligence typologies

Noteworthy is that the ‘intelligence’ theme has seen multiple new ‘configurations’ as it relates to various disciplinary orientations. In systematically reviewing qualitative and quantitative empirical work: editorial commentaries and theoretical work; case studies; evaluative, descriptive, sociological, psychological, management, and economics papers, the following ‘intelligence typologies’ were also identified. These ‘intelligence typologies’ include the following: contextual intelligence (Brown *et al.*, 2005; Schwab, 2016); emotional intelligence (Goleman, 2004; Schwab, 2016); inspired intelligence (Schwab, 2016); physical intelligence (Postle, 1989; Schwab, 2016); cultural intelligence (Ang *et al.*, 2006; Livermore & Van Dyne, 2015); social intelligence (Goleman & Boyatzis, 2008); strategic intelligence (Djekic, 2014; Wells, 2012); ethical intelligence (Belohlavek, 2007; Coyne *et al.*, 2013); digital intelligence (Adams, 2004; Waller, 2015); entrepreneurial intelligence (Oosthuizen, 2016); transdisciplinary intelligence (Oosthuizen, 2017); ecosystemic intelligence (Oosthuizen, 2017); and Socratic intelligence (Oosthuizen, 2017).

3. METHODOLOGY AND FINDINGS

The Delphi method was applied to develop categories of intelligence to reveal the essence of what is required to meaningfully address the challenges of the 4IR. Dalkey *et al.* (1969:v) conceived of the Delphi technique as “a method of eliciting and refining group judgements”, which Grime and Wright (2016:11) referred to as “facilitating structured group communication in order to gather a consensus of expert opinions in the face of complex problems, expensive endeavours, and uncertain outcomes.”

Chen *et al.* (2014) argued that the Delphi method is superior to traditional surveys or literature reviews for classifying items into categories through content analysis, because it involves

rigorous queries from experts and stakeholders. A Delphi study attempts to obtain consensus from a group of experts by employing repeated responses on questionnaires and controlled feedback (Nevo & Chan, 2007). A key advantage of this approach is that it avoids direct confrontation among experts (Chen *et al.*, 2014). Characterised by anonymity (expert participants are approached individually), iteration (several rounds) and feedback (results are clustered and sent back to all participants) (Woudenberg, 1991), the Delphi method is a systematic and interactive research technique for procuring the judgment of a panel of independent experts relevant to a specific topic (Hallowell & Gambatese, 2010).

In terms of whom is deemed an 'expert', Gläser and Laudel (2009) described experts as individuals who possess special knowledge of a social phenomenon in which the interviewer is interested. Pfadenhauer (2009) further elaborated that an expert typically knows the knowledge stock that is 'characteristic' of or 'relevant' to a certain field and is responsible for solving related issues. For the purposes of this study, the Delphi panel criteria comprised local and international individuals that have demonstrated thought leadership related to the 4IR and its permutations as it is associated with leadership, management, strategy, the world of work, and society through publications and seminal works, expert panel participation, and keynote addresses, which are integral to their day-to-day careers.

In terms of process, Anheier and Katz (2009) posited that the Delphi method typically involves five steps: (1) selection of Delphi participants; (2) decision on the form of communication; (3) development of a questionnaire or interview; (4) analysis of initial returns; and (5) second (and subsequently third, and so on) Delphi round and analysis. Drawing on Gordon (2009), the following high-level process was followed for the Delphi study:

- Experts on leadership and the 4IR were identified and asked to participate in the inquiry. The key to a successful Delphi study lies in the selection of participants (Gordon, 2009; Okoli & Pawlowski, 2004). At this initial contact, the nominated persons were informed about the Delphi study and invited to participate while being assured of anonymity.
- In the first-round questionnaire, participants were asked to provide their judgements on what leaders require to lead in the 4IR. The content analysis identified a range of themes regarding skills, competencies, capabilities, disposition, orientation, mind-set, and the like that emerged.
- In the second-round questionnaire, the themes that emerged were presented to the group along with the request to rate the themes in terms of their importance for the "2030-and-beyond" leader on a scale of 1 (Not essential) to 10 (Absolutely essential). Descriptive

statistical analysis was applied, and a consensus was reached on six of the fifteen themes that emerged.

- In the third round (final) questionnaire, participants were presented with the second-round results and requested to reassess their opinion based on the themes in which a consensus was not reached. Descriptive statistical analysis was again applied, and a consensus was reached on three more of the fifteen emerged themes, which totalled a consensus on nine themes.

Essentially, the administration procedure, therefore, involved three general steps: (1) brainstorming for important factors; (2) narrowing down the original list to the most important ones; and (3) ranking the list of important factors (Okoli & Pawlowski, 2004). The detailed process follows next.

3.1 Data collection

Securing respondents proved to be challenging amidst second and third follow-ups. Seventy-eight individuals were initially approached (Australia = 1; Canada = 2; China = 1; Germany = 1; Hong Kong = 1; India = 1; Korea = 1; Mexico = 1; Netherlands = 2; New Zealand = 1; South Africa = 28; Singapore = 1; Slovak Republic = 1; Spain = 2; Sweden = 1; Switzerland = 3; UAE = 1; UK = 7; USA = 22).

As far as Delphi panel sizes are concerned, literature on the optimum size of Delphi groups varies considerably (Aichholzer, 2009; Sandrey & Bulger, 2008), and there is no set standard, nor has it ever been established what constitutes a large or small panel (Avella, 2016). Keeney *et al.* (2011) and Giannarou and Zervas (2014) also indicated that there are no strict rules regarding panel size and the response rate, but that it is rather related to the purpose of the investigation.

Ziglio (1996) asserted that the criterion for deciding on the sample size of a Delphi panel is not (and cannot be) a statistical one and further stated that useful results can be obtained from small-sized, homogeneous groups of 10-15 experts. However, Day and Bobeva (2005), referring to Dalkey *et al.* (1969), posited that seven is a suitable minimum panel size. Okoli and Pawlowski (2004), on the other hand, suggested the size of a Delphi panel should be between 10 and 18 participants. Sandrey and Bulger (2008) also argued that a panel should include at least 10 members and conveyed that little improvement in results can be expected when a panel increases beyond 25-30 members. Furthermore, Franc (2016) recommended 8-12 members for a Delphi panel and emphasised that diminishing returns occur if more members are added.

For the purposes of this study, a 12-member panel was established as the objective. Potential experts were shortlisted from a pool of people, both internationally and locally, who were deemed to meet the criteria.

Emails explaining the purpose of the study, along with informed consent and a link to the online questionnaire, were sent to the 78 shortlisted individuals. The self-administered questionnaire was designed using Google Forms, which enabled capturing the data in a spreadsheet output form, indicating the timestamp (when the questionnaire was done), unique participant identification number, consent indicator, and responses to the questionnaire. Of the 78 individuals approached and invitations extended, only 15 experts volunteered to participate. Table 1 below reflects the cryptic biographies of the 15 participants.

Table 1: Delphi experts' cryptic biographies

#	Expert Cryptic Bio
1	Renowned author and speaker on technology trends Researches Internet access, mobile trends, e-commerce, social media, cloud computing and trends shaping business and consumer use of technology.
2	Practising neurosurgeon and a pioneer in the application of psychoneuro-immunology. Studies include human consciousness and its enhancement based on the integration of the neurosciences with PNI, designed to enhance wellness, performance and leadership in personal, clinical and corporate environments.
3	Up to 2017 GM for Product & Digital at large mobile network Now Associate Professor Business transformation, knowledge management and behavioural change management Business performance improvement and operating model optimisation to deliver consistent, customer relevance across all digital touch points (PhD Information Systems)
4	Head of Digital for Wealth at large financial institution Specialises in developing organisational strategies that connect digital capabilities with products and services and optimise customer experience to increase revenue through digital instruments (PhD)
5	Theoretical Physicist, Head of Innovation at a large ERP firm and Astronaut Candidate for Mars One - Human Settlement on Mars (PhD Quantum Biology)
6	MD of various entrepreneurial ventures, published author, expert and consultant in futures studies and scenario planning (PhD, DBA)
7	Director on numerous boards and highly experienced in the leadership development industry Executive Development, Management Practice, and Organisational Development (MA)
8	Director at large consulting firm: Skilled in large-scale Business Transformation, Organisational Design, Human Capital Management, Performance Improvement, Culture Change and Leadership and Executive Team Development
9	Professor of Computing Sciences 600+ citations Business Intelligence, User Experience, Big Data, Project Management (PhD, DBA)

10	Professor, Top Research Scientist and Scientific Project Manager at the Centre for Innovation in Design and Technology at a University in Mexico, as well as National Academia Representative and Coach for the Regional Secretariat of Intelligent Manufacturing Systems in Mexico (PhD Information & Communication Tech)
11	UNESCO Chair in Futures Studies; Professor, Graduate Institute of Futures Studies, Tamkang University; Associate, Melbourne Business School, University of Melbourne; Adjunct Professor, Faculty of Arts and Social Sciences, University of the Sunshine Coast; Co-Director of Metafuture.org (PhD)
12	Editor-in-Chief, Strategy+Business; Managing Director PwC Global; Writer; Editorial Director of Fifth Discipline Fieldbook Project; Research member of Society of Organizational Learning (MA)
13	Business owner and healthcare entrepreneur. Founder of a healthcare company with more than 10 000 employees; featured in the book "Reinventing Organizations" and among the most cited and cherished examples of Teal organisations and practices (MBA)
14	Managing Director Engaging Futures Futurist Futures Strategy Stakeholder Engagement Keynote Presenter (PhD)
15	Executive Director for Public Relations and Legal in the South Pacific. Specialise amongst others in stress management and spiritual intelligence (SI). Assists companies to take work health and safety from compliance to best practice with regard to personal development, stress management and work-life strategies.

Source: Authors' own compilation

Round 1

Following the invitation to participate, panel members were presented with an initiating questionnaire, along with a science fiction angle utilised to create a future-oriented focus. The brief was as follows:

"A group of world-renowned neuro- and techno-scientists have created a mechanism (hardware) and process to re-program the human brain. They are now approaching experts to develop various programs (software) for a variety of human jobs requiring re-programming to deal with the unprecedented technological advancements driven by 4IR and shaping a disruptive future.

You have been specially selected to contribute to the development of a software program called "The 2030-and-Beyond Intelligent Leader" for specific application on top management of organisations to enable them to effectively navigate 4IR.

Drawing on the postulate of intelligence as general mental capability involving the ability to reason, plan, solve problems, think abstractly, comprehend complex ideas, learn quickly and learn from experience, you are required to approach this future-fit state of top managers holistically, considerate of skills, competencies, capabilities, disposition, orientation, mind-set and the like... [Pause and reflect]"

After the brief, participants were presented with the assignment, emphasising a 'clean slate':

"With 2030 and beyond in mind, in the space provided below, list the collection of skills, competencies, capabilities, disposition, orientation, mind-set and the like you believe should be "programmed" into top-management practitioners of the future. Along with each listing, also provide an explanation / description so that the programmers of "The 2030-and-Beyond Intelligent Leader" program will understand what is implied.

Example: Emotional intelligence – how we process and integrate our thoughts and feelings and relate to ourselves and to one another."

At the end of the questionnaire, participants were then given the option to share any other insights, views, or opinions they considered significant to the study under the heading, 'General'.

Thematic analysis was adopted to analyse the responses of Round 1 in pursuit of generating themes and taxonomy. Braun and Clarke (2006:79) described a thematic analysis as "a method for identifying, analysing, and reporting patterns (themes) within data" that, at a minimum, organises and describes data in rich detail. Referring to Ayres *et al.* (2003), Vaismoradi *et al.* (2016) posited that 'theme' is used as an attribute, descriptor, element, and concept (i.e., an implied topic that organises a collection of repeating ideas). Bradley *et al.* (2007) perceived themes as general propositions that emerge from diverse and detail-rich data and provide recurring and unifying concepts regarding the subject of inquiry. Taxonomy, on the other hand, is "a system for classifying multifaceted, complex phenomena according to common conceptual domains and dimensions" (Bradley *et al.*, 2007:1765). The details of each theme were refined through continuous analysis, after which names and descriptions for each theme were generated. Analysis of the extracts was related back to the research question and literature, and from Round 1, 15 themes emerged: (1) Complex Problem Solving / Decision-making / Judgement; (2) Communication / Negotiation / Collaboration; (3) Emotional Intelligence; (4) Creativity / Innovation; (5) Critical Thinking; (6) Cognitive Agility; (7) Human, Artificial Intelligent Agent & Data Interface; (8) Continuous Learning; (9) Cultural Intelligence; (10) Ethics; (11) Strategic Foresight / Strategic Orientation / Futures; (12) Adaptability; (13) Integrated Intelligence; (14) Spirituality; and (15) Neohumanism.

Round 2

For Round 2, respondents were provided with the 15 themes that emerged from Round 1 and asked to rate the importance of each on a scale of 1 (not essential) to 10 (absolutely essential). Each theme included a description for respondents to interpret the theme appropriately, and

in preparation for determining consensus, descriptive statistics were calculated with the results presented below in Table 2.

Table 2: Descriptive statistics of Round 2 responses

	N	Median	Q1	Q3	IQR	Mode	Mean	% 8-10	SD	CV
Complex Problem Solving / Decision-making / Judgement	13	9	8	10	2,00	10	8,923	91,6	1,038	0,116
Communication / Negotiation / Collaboration	13	8	8	9	1,00	8	8,462	75	1,127	0,133
Emotional Intelligence	13	8	8	10	2,00	8	8,462	83	1,330	0,157
Creativity / Innovation	13	8	8	10	2,00	10	8,231	75	1,833	0,223
Critical Thinking	13	9	8	10	2,00	10	8,615	75	1,758	0,204
Cognitive Agility	13	9	7	9	2,00	9	7,846	83	2,075	0,265
Directing Human and Artificial Intelligent Agent Symbiosis	13	8	6	9	3,00	8	7,231	50	2,279	0,315
Continuous Learning	13	9	8	9	1,00	9	8,692	91,6	0,751	0,086
Cultural Intelligence	13	7	7	9	2,00	7	7,692	50	1,797	0,234
Ethics	13	9	8	10	2,00	10	8,385	83	1,850	0,221
Strategic Foresight / Strategic Orientation / Futures	13	9	8	9	1,00	9	8,385	83	1,325	0,158
Adaptability	13	9	8	9	1,00	9	8,615	83	1,193	0,138
Integrated Intelligence	13	9	8	9	1,00	9	8,154	83	1,676	0,206
Spirituality	13	8	5	10	5,00	10	7,462	58	2,470	0,331
Neohumanism	13	7	4	9	5,00	9	6,462	50	3,230	0,500

Source: Authors' own compilation

The median (centre value) is a measure to determine the average or the middle value of a set of data which has been arranged (Wisniewski, 1997). Moore *et al.* (2011), however, argued that measuring the centre alone can be misleading since two themes with the same median rating can actually be very different in theory and in practice. Hence, measuring the spread by means of percentiles is particularly appropriate. According to Moore *et al.* (2011), the most frequently used percentiles, other than the median, are quartiles. The first quartile represents the 25th percentile, while the third quartile is the 75th percentile (i.e., the first and third quartiles show the spread of the middle half of the data). In calculating the quartiles, Waters (2011)

stated that data are arranged in ascending value/size. Subsequently, the first quartile, Q1, represents the value a quarter of the way through the data, with 25 per cent of the values smaller and 75 per cent larger (value number $(n + 1) / 4$). Furthermore, the third quartile, Q3, represents the value three-quarters of the way through the data, with 75 per cent of the values smaller and 25 per cent larger $(3(n + 1) / 4)$.

The quartiles are then used to define a more narrow range (Q3 – Q1) that contains 50 per cent of the values, namely, the interquartile range (IQR). According to Wisniewski (1997), *ceteris paribus*, which is a lower value for the IQR, produces less variability in the central part of the data set. Thus, the lower the IQR, the closer Q1 and Q3 are to each other. Mode is simply the value that occurs most frequently (Waters, 2011) and relies more on observation than calculation (i.e., identifying the most frequent value).

An explanation of a distribution mostly includes a measure of its centre, which is commonly the mathematical average or mean (Moore *et al.*, 2011). The mean of a set of values is derived by adding all the values together to arrive at the sum and dividing the sum by the number of values (Waters, 2011), or, in a more compact notation $\bar{x} = \frac{1}{n} \sum x_i$. The column “% 8-10” simply refers to the frequency of responses between the values eight and ten expressed as a percentage. Furthermore, standard deviation measures the distribution by means of calculating how far the observations are from their mean (Moore *et al.*, 2011), which is the most common measure of distribution (Tiemann, 2010; Waters, 2011). The standard deviation (s) is the square root of the variance (s^2): $s = \sqrt{\frac{1}{n-1} \sum (x_i - \bar{x})^2}$.

The last column in the table reflects the coefficient of variation (CV), which is helpful to assess comparative relative variability rather than the absolute variability (Wisniewski, 1997). CV is defined as the ratio of standard deviation over the mean (Waters, 2011) or $CV = \frac{s}{\bar{x}}$.

In our study, ‘Continuous Learning’, for example, had a standard deviation of 8,6 per cent of the mean value. The relatively low coefficient of variation suggests more consistency between the responses as comparable to ‘Neohumanism’ with a standard deviation of 50 per cent to the mean value.

Finally, the reliability of the 10-point semantic differential scale was measured using Cronbach’s Alpha to assess internal consistency. The greater the Cronbach alpha coefficient, the more reliable the scale. George and Mallery (2003:231 provided the following rules of thumb: “ $\alpha > .9$ – Excellent, $\alpha > .8$ – Good, $\alpha > .7$ – Acceptable, $\alpha > .6$ – Questionable, $\alpha > .5$ – Poor, and $\alpha < .5$ – Unacceptable.” All 13 participants’ responses were used to determine the

reliability of the scale (Table 3). The results indicate that all 15 themes measured have an acceptable reliability with Cronbach Alpha values above the customary cut-off value of 0.70 as suggested for internal consistency (Nunnally & Bernstein, 1994).

Table 3: Reliability of measuring scale

Items	Cronbach Alpha
All items	0.8442
Complex Problem Solving / Decision-making / Judgement	0.8371
Communication / Negotiation / Collaboration	0.8311
Emotional Intelligence	0.8541
Creativity / Innovation	0.8383
Critical Thinking	0.8369
Cognitive Agility	0.8371
Directing Human and Artificial Intelligent Agent Symbiosis	0.8321
Continuous Learning	0.8496
Cultural Intelligence	0.8316
Ethics	0.8224
Strategic Foresight / Strategic Orientation / Futures	0.8276
Adaptability	0.8326
Integrated Intelligence	0.8396
Spirituality	0.8268
Neohumanism	0.8181

Source: Authors' own compilation

Measuring consensus

According to Keeney *et al.* (2011), there is no general agreement on what an appropriate level of consensus for a Delphi should be, or how this level of consensus should be determined. It is also noteworthy that consensus does not mean a 100 per cent agreement, as it is unlikely for a diverse group of people with different viewpoints to reach unanimity (Avella, 2016). Citing Vernon (2009), Avella (2016) added that consensus in Delphi typically ranges from a 55 to 100 per cent agreement, with 70 per cent considered the standard.

Giannarou and Zervas (2014) stated that there are studies that measure consensus through frequency distributions and others using the standard deviation or the interquartile range.

Citing Binning *et al.* (1972), Gupta and Waymire (2008), Kittell-Limerich (2005), and Saunders *et al.* (2009), Giannarou and Zervas (2014) further posited that each analysis should also contain the calculation of the mean and median, since these are utilised to describe the middle and most distinctive response, depicting the central tendency. It is also used to describe the coefficient of variation, signifying the observations' homogeneity, and the mode, representing the most frequently occurred value. Hsu and Sandford (2007) concurred that the primary statistics applied in Delphi studies are measures of central tendency (means, median, and mode) and levels of dispersion (standard deviation and inter-quartile range) to present information concerning the collective judgments of respondents.

There are also some comparable studies where the scope of a Delphi study was to assess and demonstrate the importance of variables. For example, Giannarou and Zervas (2014) referred to a study by Hayne and Pollard (2000), where the importance of 23 issues in information systems (IS) management was evaluated. Moreover, in another study conducted by Nakatsu and Iacovou (2009), they assessed the importance of 25 risk factors of outsourced software development from a client perspective in domestic and offshore settings. To illustrate applicability, Giannarou and Zervas (2014) provided a case that used a Likert scale of 0-10 (respectively for non- and high-importance) (Asonitis & Kostagiolas, 2010; Ishikawa *et al.*, 1993; Mullen, 2003; Nerantzidis, 2013), and the opinion of 12 experts. Similarly, this study made use of three combinatory measures to determine consensus:

- (i) 51 per cent and more responded to the category 'absolutely essential', which translates into values between 8 and 10 on the 10-point Likert scale (Hackett *et al.*, 2006);
- (ii) an interquartile range below 2.5 (Kittell-Limerick, 2005); and
- (iii) a standard deviation below 1.5 (Christie & Barela, 2005).

Based on the assessment of Round 2, a consensus on the importance of themes was achieved on six of the fifteen themes, as depicted in Table 4 below.

Table 4: Round 2 themes achieving consensus

	N	Median	Q1	Q3	IQR	Mode	Mean	% 8-10	SD	CV
Complex Problem Solving / Decision-making / Judgement	13	9	8	10	2,00	10	8,923	91,6	1,038	0,116
Communication / Negotiation / Collaboration	13	8	8	9	1,00	8	8,462	75	1,127	0,133
Emotional Intelligence	13	8	8	10	2,00	8	8,462	83	1,330	0,157
Continuous Learning	13	9	8	9	1,00	9	8,692	91,6	0,751	0,086
Strategic Foresight / Strategic Orientation / Futures	13	9	8	9	1,00	9	8,385	83	1,325	0,158
Adaptability	13	9	8	9	1,00	9	8,615	83	1,193	0,138

Source: Authors' own compilation

Round 3

For Round 3, respondents were informed that six of the fifteen themes that emerged from Round 1 achieved consensus, and an explanation was offered on how it was achieved (i.e., the statistical measures used). Respondents were also provided with a list of the nine themes where consensus was not reached. A table containing the descriptive statistics was also provided to give participants a sense of the group's responses to assist in their personal reflection on the nine themes. During Round 3, 12 responses were received, achieving the objective of 12 participants. From the data received, a consensus was achieved on three of the nine themes. A detailed explanation of the procedure is discussed.

For Round 3, respondents were provided with the results of Round 2, highlighting the six themes on which consensus was reached: (1) Complex Problem Solving / Decision-making / Judgement; (2) Communication / Negotiation / Collaboration; (3) Emotional Intelligence; (4) Continuous Learning; (5) Strategic Foresight / Strategic Orientation / Futures; and (6) Adaptability. Respondents were then requested to re-evaluate their individual ratings on the remaining nine themes: (1) Creativity / Innovation; (2) Critical Thinking; (3) Cognitive Agility; (4) Human + Intelligent Agent + Data Interface Management; (5) Cultural Intelligence; (6) Ethics; (7) Integrated Intelligence; (8) Spirituality; and (9) Neohumanism.

In determining consensus, descriptive statistics were again calculated and, from Round 3's assessment, a consensus on the importance of themes was achieved on three of the nine themes, as depicted in Table 5.

Table 5: Round 3 themes achieving consensus

	N	Median	Q1	Q3	IQR	Mode	Mean	% 8-10	SD	CV
Creativity / Innovation	12	9	8	9,25	1,25	9	8,667	75	1,073	0,124
Critical Thinking	12	9,5	8,75	10	1,25	10	9,250	75	0,866	0,094
Ethics	12	10	8,75	10	1,25	10	9,167	83	1,267	0,138

Source: Authors' own compilation

The results of Round 3 were incorporated with the other themes on which consensus was reached, resulting in nine themes as the final list. Table 6 contains the final list of themes on which consensus was reached.

Table 6: Final list of themes achieving consensus

	N	Median	Q1	Q3	IQR	Mode	Mean	% 8-10	SD	CV
Complex Problem Solving / Decision-making / Judgement	13	9	8	10	2,00	10	8,923	91,6	1,038	0,116
Communication / Negotiation / Collaboration	13	8	8	9	1,00	8	8,462	75	1,127	0,133
Emotional Intelligence	13	8	8	10	2,00	8	8,462	83	1,330	0,157
Continuous Learning	13	9	8	9	1,00	9	8,692	91,6	0,751	0,086
Strategic Foresight / Strategic Orientation / Futures	13	9	8	9	1,00	9	8,385	83	1,325	0,158
Adaptability	13	9	8	9	1,00	9	8,615	83	1,193	0,138
Creativity / Innovation	12	9	8	9,25	1,25	9	8,667	75	1,073	0,124
Critical Thinking	12	9,5	8,75	10	1,25	10	9,250	75	0,866	0,094
Ethics	12	10	8,75	10	1,25	10	9,167	83	1,267	0,138

Source: Authors' own compilation

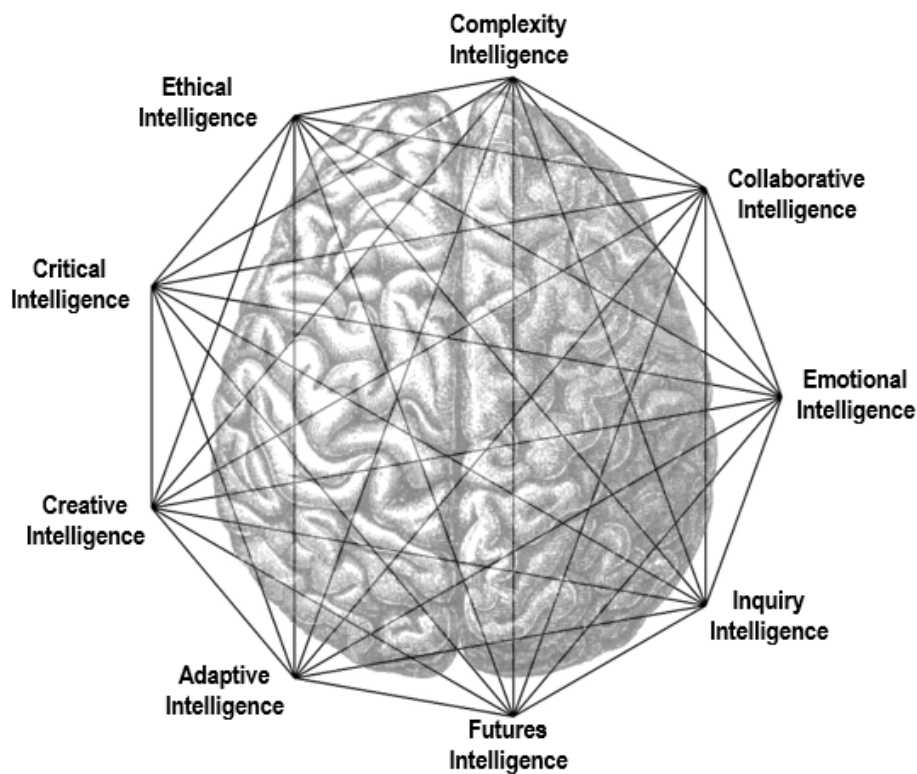
4. DISCUSSION

The nine themes that emerged from the Delphi study subsequently constitute the 4IR-integrated intelligence taxonomy the study set out to determine. These were categorised by means of a conceptualised intelligence theme descriptor:

1. Complexity Intelligence (Complex Problem Solving / Decision-making / Judgement)
2. Collaborative Intelligence (Communication / Negotiation / Collaboration)
3. Emotional Intelligence
4. Inquiry Intelligence (Continuous Learning)
5. Futures Intelligence (Strategic Foresight / Strategic Orientation / Futures)
6. Adaptive Intelligence (Adaptability)
7. Creative Intelligence (Creativity / Innovation)
8. Critical Intelligence (Critical Thinking)
9. Ethical Intelligence (Ethics)

Graphically the integrated taxonomy is illustrated in an enneagon, as depicted in Figure 1 below.

Figure 1: 4IR Integrated Intelligence Taxonomy



Source: Authors' own compilation

A discussion of each descriptor ensues as informed by the literature. Apart from the initial literature review, it was deemed necessary to further consult literature that specifically emphasised the nine themes that emerged from the Delphi study. In so doing, each theme has been comprehensively described, cognisant of seminal works, further theoretical developments, and how it ultimately relates to the 4IR, which is the focus of this study.

4.1 Complexity intelligence

Problem-solving refers to the process whereby a gap between a current situation and a desired state is perceived, after which a person aims to resolve this gap and navigate a path to a desired state obscured by known or unknown barriers (Funke, 2012; Huit, 1992). Dörner and Funke (2017:6) further deduced complex problem-solving as “a collection of self-regulated psychological processes and activities necessary in dynamic environments to achieve ill-defined goals that cannot be reached by routine actions.” Talanker (2016), however, proffered that problem-solving and decision-making are simply diverse aspects of the same multi-stage goal-oriented cognitive process.

Complexity is interpreted by Morin (2008) as a fabric of heterogeneous elements that are inseparably associated (i.e., the fabric of events, actions, interactions, retroactions, determinations, and ‘chance’ that constitutes our phenomenal world). In examining judgement, Shotter and Tsoukas (2014) highlighted the importance of emotions, moral agency, language use, and, especially, the selective and integrative nature of perceptual processes. In critiquing currently dominant approaches to judgment, they argued a compelling case for a concept of judgment known as “phronesis” (practical wisdom, an intellectual virtue that implies ethics) based on Aristotle's thinking. This involves deliberation grounded in values, concerned with practical judgement and informed by reflection, and is pragmatic, variable, context-dependent, and oriented toward action (Shotter & Tsoukas, 2014). In earlier work on the concept, Flyvbjerg (2006) stated that phronesis concerns values and goes beyond analytical, scientific knowledge (episteme) and technical knowledge or know-how (techne), and it involves judgements and decisions made in the manner of a skilful social actor. Phronetic leaders, Shotter and Tsoukas (2014:225) posited...

are people who have developed a refined capacity to come to an intuitive grasp of the most salient features of an ambiguous situation and, in their search for a way out of their difficulties, to craft a particular path of response in moving through them, while driven by the pursuit of the common good.

According to Nonaka and Toyama (2007:378), phronesis is the syntheses of “knowing why” as in scientific theory, with “knowing how” as in practical skill, and “knowing what” as a goal to be achieved. Identifying complex problems and reviewing related information to develop and evaluate options and implement solutions are essential in the 4IR (WEF, 2018). Moreover, Schwab (2016) emphasised complexity in relation to the 4IR as well as the subsequent need for complex problem-solving to increase.

4.2 Collaborative intelligence

In times of crisis (similarly in the 4IR), leaders should relate to the skills of negotiating as a “strategic calculus” through open communication and a formal process of searching for the best solution to mitigate the effects of the crisis and to acquire an effective solution (Puscas, 2010). Appley and Winder (1977:281) considered collaboration as a...

relational system in which (1) individuals in a group share mutual aspirations and a common conceptual framework; (2) the interactions among individuals are characterised by “justice as fairness”; and (3) these aspirations and conceptualisations are characterised by each individual's consciousness of his/her motives toward the other...

According to Schwab (2016), it is how we use our sense of individual and shared purpose, trust, and other virtues to effect change and act towards the common good in the 4IR. Collaboration is strongly correlated to trust, communication, commitment, knowledge sharing, information exchange, and acting with a high level of transparency (Schöttle *et al.*, 2014). Furthermore, this drives the process of shared creation (Camarihna-Matos & Afsarmanesh, 2018). Massingham (2019a) proposed that the practical wisdom of professional practice is to execute tasks or resolve problems through collaboration and knowledge sharing.

In the 4IR, a capacity for agility will not only be crucial for setting business priorities and managing physical assets, but is also focused on employee motivation and communication. Collaboration is, therefore, essential to generate positive, common, and hope-filled narratives, enabling individuals and groups to participate in, and benefit from, the ongoing transformations (Schwab, 2016). Additionally, Manda and Dhaou (2019) concluded that the integration and interoperability of cyber-physical systems are critical for enhancing communication and collaboration between man and machine. Moreover, collaboration is crucial during transformation and change, especially between the various actors in the 4IR to ensure a broad participation in this new era, which will not only disrupt business but also government and society (Manda & Dhaou, 2019). The complexity of the transformation that is unfolding

demands new forms of multi-stakeholder collaborations, implying that engaging partners outside the organisation and challenging traditional boundaries are no longer adequate for longevity in the 4IR (WEF, 2018).

4.3 Emotional intelligence

Salovey and Mayer (1990:189) defined emotional intelligence as “the subset of social intelligence that involves the ability to monitor one’s own and other’s feelings and emotions, to discriminate among them and to use this information to guide one’s thinking and actions.” Goleman (2004) highlighted five components of emotional intelligence: (1) self-awareness; (2) self-regulation; (3) motivation; (4) empathy; and (5) social skills. Lazovic (2012) perceived it as developing positive relations and achieving emotional commitment from followers, which strengthens organisational culture, improves resilience, and increases flexibility. ‘Central’, Lazovic (2012) argued, is the adaptation of creating conscious and intelligent actions regarding one’s own emotional responses as well as managing other people’s reactions to a situation. It enables managers to enhance their collective intelligence, thereby yielding higher levels of productivity. Moreover, managers with high social intelligence, as referenced by Beheshtifar and Roasaei (2012), appear to be adept in effective cooperation, problem-solving, and increasing creativity.

From a practical wisdom perspective, Lindebaum *et al.* (2018) referred to emotional equanimity and emotional stability, whilst Massingham (2019b) elaborated on emotional control and emotional regulation. Additionally, Likierman (2020) denoted recognising one’s own emotions and biases and removing them from the equation. Thus, understanding centres more on emotional experiences than on cognitive and intellectual structures alone (Bachmann *et al.*, 2018). The 4IR also involves the emotional strength to exercise the will to accomplish goals in the face of opposition, predicated on the ability to recognise and regulate emotions in oneself and others (Sosik & Zhu, 2020), and to process and integrate our thoughts and feelings relevant to ourselves and others (Schwab, 2016). For business leaders and policymakers, emotional intelligence is the vital underpinning for skills critical to succeed in the 4IR paradigm (Schwab, 2016).

4.4 Inquiry intelligence

Lifelong (continuous) learning, Fischer (2000) argued, is essential for inventing the future of societies and has a bearing on dimensions of learning: (1) self-directed learning; (2) learning on demand; (3) collaborative learning; and (4) organisational learning. Continuous learning, however, does not refer to only formal, informal and non-formal learning; it also includes the

skills, knowledge, attitudes, and behaviours one acquires during day-to-day experiences (Dunn, 2003). The following aspects all underline the relevance of lifelong learning: exponential growth; the changing nature of information in the digital age; the difficulty of foreseeing the skill sets required for knowledge-based economies; demographic shifts and increased mobility; and the growing concern for unsustainable patterns of consumption and production (UIL, 2010). Dağgöl (2017) added that problem-solving skills and lifelong learning are related to each other, and coping competence completes the process of lifelong learning. Commitment to lifelong learning in a transformational and deep way relates to practical wisdom (Ames & Serafim, 2019; Hays, 2013), involving, among others, learning to “consider what is appropriate to the occasion” and acting accordingly and learning from real-life challenges (Carter *et al.*, 2017). Continuous learning, in this regard, is also about relearning (Massingham, 2019b) and turning knowledge into understanding (Likierman, 2020).

Hence, more than anything, the 4IR places a premium on self-directed learning and thinking (Penprase, 2018). To remain relevant as well as improve employability, a commitment to continuous learning is essential. Accordingly, continuous learning has become not only a key enabler for social inclusiveness and equality, but also a prerequisite for innovation and sustainable growth (WEF, 2018).

4.5 Futures intelligence

Carleton *et al.* (2013) proffered that foresight is the ability to plan by means of a view of the future, essentially, the practice of looking forward based on a combination of mindset and methodology. It, however, acknowledges that the future is ambiguous in aiming to prepare decision-makers for how the future may unfold. Hence, foresight, as posited by Conway (2015), is the capacity to think systematically about the future to enhance decision-making today. Conway (2015) further elaborated that foresight is a cognitive capacity, which permeates existing processes with a future perspective to a degree that is not formalistically akin to conventional strategic planning. In a volatile, uncertain, and complex world (characteristic of the 4IR), emergent strategic planning processes are increasingly useful, thereby emphasising foresight as an important skill to master (Tully, 2016). Of further significance is the ability to consider what may happen (Possible Futures), what could happen (Plausible Futures), what will likely happen (Probable Futures), and what we want to happen (Preferred Futures) (Hancock & Bezold, 1994).

The world has become increasingly diverse, as is the case with the 4IR and other happenings across the planet; these changes impact the way people live, work, travel and communicate;

thus, foresight and futures are necessary to “help us recover our agency” (Inayatullah, 2008:20). Pragmatically speaking, Inayatullah (2008) proposed to map the past, present and future, so as to anticipate future problems and their consequences. Moreover, we should be acutely aware of the grand patterns of change to extend the analysis to include worldviews, myths, and metaphors. Moreover, we should learn to create alternative futures, choose a preferred future, and also perform “backcasting” to realise the preferred future (Inayatullah, 2008). As the realities of the 4IR unfold, Schwab (2016) emphasised the need for strategic dialogue to be far more constructive than is presently the case, and it should be infused with the foresight to maximise room for innovation to emerge (Schwab, 2016). In the practical wisdom literature, Cowan (2017) also highlighted foresight and futures, and Bachmann *et al.* (2018) regarded practical wisdom as a form of foresight.

4.6 Adaptive intelligence

Adaptability (also referred to as cognitive agility) is “the ability to deal adaptively with unanticipated situations” (Fletcher & Wind, 2014: 36) or an “effective change in response to an altered situation” (Mueller-Hanson *et al.*, 2005:2). It is important to note that adaptability is not the change itself, nor merely a latent human quality, but rather a meta-skill that draws on the combination of both cognitive and relational skills as well as pattern recognition, adjusting solutions, and implementing plans of action (Burns & Freeman, 2008). Learning to adapt within the dynamic flow of real-time tasks in the 4IR is important, as external influences continue to transform apparent static situations into complex environments (Good & Yeganeh, 2012). Therefore, it also pertains to anticipating change rather than merely reacting to change (Nelson *et al.*, 2010).

Practical wisdom also enables a leader to adapt his/her personality to the perpetual principles of existence, namely, the ability to adapt it to a new context (Bachmann *et al.*, 2018). Thus, practical and wise leaders should be proficient at adaptation (Massingham, 2019b; Sternberg, 2005). The 4IR demands adaptability (Penprase, 2018); thus, the leader’s adaptability to the changes in the internal and external environment, along with the leader’s adaptability to the strategic orientation in determining the organisation’s behaviour, is key (Temelkova, 2018). Adaptability shapes familiarity with change-related situations and improves the ease with which change is performed in similar situations in the future. Adaptable leaders have a high tolerance for uncertainty and are able to cope with new and challenging situations spawned by the 4IR (Ingusci *et al.*, 2019).

4.7 Creative intelligence

Creativity is the result of a process that realises ...

a novel work that is accepted as tenable or useful or satisfying by a group at some point in time. By 'novel' I mean that the creative product did not exist previously in precisely the same form. It arises from a reintegration of already existing materials or knowledge, but when it is completed, it contains elements that are new. The extent to which a work is novel depends on the extent to which it deviates from the traditional or status quo." (Stein, 1953: 311)

De Sousa *et al.* (2012) made a distinction between the two constructs, namely, creativity and innovation, emphasising cognitive and emotional processes when speaking of creativity and power and communication when it comes to innovation. Nonaka and Zhu (2012) stated that wisdom-based organisational strategies foster innovation and effectiveness by introducing a moral foundation.

Drawing on a social view of creativity and innovation, Perry-Smith and Mannucci (2017) articulated four distinct phases of an idea journey:

- Idea generation (Generating different creative ideas and selecting the most promising one. Cognitive flexibility is the key requirement for this phase.).
- Idea elaboration (Systematically evaluating the novel idea's potential and further clarifying and developing it. Support is the key requirement for this phase).
- Idea championing (Promotion of the novel idea, aimed at approval and, consequently, the resources to implement it. Influence and legitimacy are the key requirements for this phase).
- Idea implementation (Converting the idea into a tangible outcome that can subsequently be diffused and adopted. A shared vision and understanding are the key requirements for this phase).

Referring to Sternberg and Lubart's (1991, 1995) investment theory of creativity, Sternberg (2005) asserted that creativity requires a confluence of six distinct yet interrelated sources: intellectual abilities (non-conventional thinking, analytic skills, practical-contextual skill); knowledge (knowing enough about a field to move it forward); thinking styles (preferred way of using one's skills); personality (willingness to overcome obstacles, take sensible risks, tolerate ambiguity, and self-efficacy); motivation (intrinsic and task-focused); and environment (supportive and rewarding). Sternberg (2018) further proffered that creativity is not merely an

ability, but partly an attitude toward life; it always takes place within a system and can provide part of the answer to creating a better world.

Taylor (2017:131) evaluated multiple definitions of innovation from literature and developed a composite definition, namely that innovation is “the creative process whereby new or improved ideas are successfully developed and applied to produce outcomes that are practical and of value.” Creativity and innovation are essential in the 4IR (Massingham, 2019b), albeit it is important to note that innovative leaders must be able to balance creativity and discipline (Ding *et al.*, 2019) to ensure creativity is managed in a responsible manner that produces outcomes that are practical and of value. Creativity, originality, and initiative to drive innovation in the 4IR require alternative thinking to develop new ideas for and answers to the opportunities and challenges associated with the 4IR (WEF, 2018). As such, the rapid pace of technology and business model innovation requires a culture of experimentation that tolerates failure and links innovation to a new purpose (WEF, 2018).

4.8 Critical intelligence

Critical thinking is “thinking about your thinking, while you are thinking, in order to make your thinking better” (Paul, 1993:91). Prominent features of critical thinking are as follows: (1) reflective (It is metacognitive – it involves thinking about your thinking.); (2) involves standards (Accuracy, relevance, and depth are examples of standards or criteria.); (3) authentic (thinking about real problems); and (4) being reasonable. There are three parts to critical thinking: asking questions, attempting to answer those questions by reasoning them out, and believing the results of such reasoning (Paul, 1993).

Leadership in the 4IR should be goal-directed while knowing what is required next in a sequence of events that leads to the achievement of the objectives, which is the desired outcome of a leader’s critical thought process. Thus, “critical thinking” is knowing what to do next or simply taking a “common sense” approach (McVey, 1995:89). Sanders and Moulenbelt's (2011) chronological mapping of the more influential definitions of critical thinking posits that the seminal work of Dewey (1910:6) defined reflective thought as: "active, persistent, and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it, and the further conclusions to which it tends, constitutes."

Critical thinking is, therefore, careful and pragmatic goal-oriented thinking (Hitchcock, 2018). It includes the component skills of analysing arguments, making inferences by using inductive or deductive reasoning, judging or evaluating, and making decisions or solving problems (Lai *et al.*, 2011). Leadership praxis is a form of leadership practice that is ethically informed,

committed, and guided by the critical reflection of fundamental practice traditions and one's own practice (Higgs, 2012). Critical thinking relates to practical wisdom, as the realisation of the multi-layered facets of a particular situation's complex realities requiring deliberation, the passing of judgment, balancing of tensions, and critical reflection directed towards practice (Bachmann *et al.*, 2018). Critical thinking in the context of the 4IR is, thus, related to using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems (WEF, 2018). Hence, leadership in the 4IR demands critical reflection on assumptions relevant to technology's impact on jobs, the future skills required, what workforce agility entails, and effective approaches to continuous, sustainable learning (WEF, 2018).

4.9 Ethical intelligence

Ethical leadership is "the demonstration of normatively appropriate conduct through personal actions and interpersonal relationships, and the promotion of such conduct to followers through two-way communication, reinforcement, and decision making" (Brown *et al.*, 2005:120). Ethical leaders are honest, caring, and principled individuals who render fair and balanced decisions (Brown & Treviño, 2006). They tend to pragmatically evaluate the long-term consequences, drawbacks, and benefits of the decisions they make. They are generally humble, have concern for the greater good, strive for fairness, assume responsibility, and show respect for others (Mihelič *et al.*, 2010).

Ethical leadership creates a principled and ethical climate in the workplace predicated on social learning principles (modelling the way (Kouzes & Posner, 2009)) and intervening processes (shared aspirations (Kouzes & Posner, 2009)) (Shin, 2012). In the 4IR, management and leadership practitioners need to be ethically reflexive (i.e., informed by but not dependent on formal ethical principles and practising awareness and insight) and always responsive to problematic situations (Carter *et al.*, 2017). Another noteworthy aspect of leadership is that virtue ethicists perceive practical wisdom as essential for becoming a virtuous leader, since it is aligned with right thinking, right desire, and right action, which create harmony correlated to reason, emotions, and behaviour (Hartman, 2013; Sison & Ferrero 2015). Bachmann *et al.* (2018) also posited that a wise leader should be capable of integrating ethical considerations with instrumental concerns and wisdom, thereby prompting ethical action that is characterised by a sense of community and the greater good instead of self-interest (Massingham, 2019b).

Therefore, in the 4IR, it is not enough that leaders are cognitively disposed to demonstrate ethical behaviours, but they should be attentive to moral issues based on cognitive reflectiveness concerning morality and moral issues (Babalola *et al.*, 2019). With the unfolding of the 4IR, leaders must become alert to current or potential moral issues, especially those where adequate morality guidelines have yet to be established. Thus, leaders must establish the organisation's moral identity to develop a new ethical norm based on a vision of how and why the norm contributes to a better society within the 4IR. Moreover, they should commit to adhering to the organisation's moral precepts and generate support for this new norm (Kaptein, 2019). Also, ethical responsibility and accountability are at the heart of leadership in the 4IR, since a response to disruptive change must ensure a human-centred approach to the challenges of the 4IR (WEF, 2018).

5. MANAGEMENT IMPLICATIONS

It is essential for top-management practitioners to acknowledge the importance of the requisite cognitive disposition in themselves and their followers to effectively navigate the 4IR. They must ensure that they and their followers are equipped to meet the challenges of the 4IR and be capable of managing in an environment marked by constant disruptive change. Thus, top management must create an environment underpinned by a strong organisational vision and mission aimed at promoting the 4IR-mindset development. Accordingly, their managerial attributes and learning should be related to the following: Complexity Intelligence; Inquiry Intelligence; Critical Intelligence; Futures Intelligence; Adaptive Intelligence; Creative Intelligence; Emotional Intelligence; Ethical Intelligence; and Collaborative Intelligence. If employees are not philosophically and technically on board, even a cutting-edge learning-focused plan will not help. If top management has priorities focused only on revenue and the bottom line, the resources for promoting the 4IR-mindset developmental interventions will not be made available.

It is evident that in most organisations, traditional leadership mindsets, styles, and ways of working are not adequate to cope with the challenges of the 4IR operating environment; hence, a new approach to leadership development is necessary. The 4IR calls for a 'new breed' of leaders able to thrive in a rapidly changing environment, implying that leaders now require a broader skill set, with adaptability and the ability to embrace, understand and respond to complexity being essential. Management theories related to informed practice, up to now, are no longer practical in this era of uncertainty and unpredictability. Therefore, this study attempts to contribute to the gap in relation to the cognitive disposition required to effectively navigate the 4IR. In addressing the need for a new breed of leaders who are able

to thrive in a rapidly changing environment, the 4IR Integrated Intelligence Taxonomy can serve as a blueprint from a deficit identification and developmental intervention perspective. Moreover, this type of intervention can serve as a reference point with which to measure performance in relation to the nine integrated intelligence typologies. This allows for the identification of competence gaps and need-specific developmental interventions.

REFERENCES

- Adams, N.B. 2004. Digital intelligence fostered by technology. *The Journal of Technology Studies*, 30(2):93-97.
- Adekanmbi, F.P. & Ukpere, W.I. 2022. The relational effects of perceived leadership 4.0, workplace ostracism, and innovative work behavior on organizational performance in the fourth industrial revolution (4IR). *EUREKA: Social and Humanities*, (2):3-14.
- Aichholzer, G. 2009. The Delphi Method: eliciting experts' knowledge in technology foresight. In: Bogner, A., Littig, B. & Menz, W. (eds) *Interviewing Experts*. New York, NY: Palgrave Macmillan.
- Alade, K. & Windapo, A.O. 2020. Developing effective 4IR leadership framework for construction organisations. *Engineering, Construction and Architectural Management*, 28(5):1377-1396.
- Alade, K. & Windapo, A. 2019. 4IR leadership effectiveness and practical implications for construction business organisations. 11th Construction Industry Development Board Postgraduate Research Conference, 28-30 July 2019, Springer, pp. 62-70.
- Alvesson, M. & Sandberg, J. 2013. Has management studies lost its way? ideas for more imaginative and innovative research. *Journal of Management Studies*, 50(1):128-152.
- Ames, M.C.F.D.C., & Serafim, M.C. 2019. Teaching-learning practical wisdom (phronesis) in administration: A systematic review. *Revista de Administração Contemporânea*, 23(4):564-586. [<https://doi.org/10.1590/1982-7849rac2019180301>].
- Anderson, M. & Reid, C. 2005. Intelligence, in M. Hewstone & F. Fincham (Eds.) *Introduction to psychology*. Oxford: Blackwell (pp. 268-290).
- Anderson, P. 1999. Complexity Theory and Organization Science. *Organization Science*, 10(3):216-232.
- Ang, S., Van Dyne, L. & Koh, C. 2006. Personality Correlates of the Four-Factor Model of Cultural Intelligence. *Group & Organization Management*, 31(1):100-123.
- Anheier, H. & Katz, H. 2009. Introducing Futures research: forecasting and scenarios, (In Kumar, A., Scholte, J.A., Kaldor, M., Glasius, M., Seckinelgin, H. & Anheier, A., eds. *Global Civil Society 2009: Poverty & Activism*. Sage Publications, London (pp. 238-251).
- Appley, D.G., & Winder, A.E. 1977. An evolving definition of collaboration and some implications for the world of work. *Journal of Applied Behavioral Science*, 13(3):279-291. [<https://doi.org/10.1177/002188637701300304>].
- Armstrong, S. 2014. *Smarter than us: the rise of machine intelligence*. Machine Intelligence Research Institute. Berkley, USA.
- Asonitis, S., & Kostagiolas:A. 2009. An analytic hierarchy approach for intellectual capital: evidence for the Greek central public libraries. *Library Management*, 31(3):145-161.

- Avella, J.R. 2016. Delphi Panels: Research design, procedures, advantages, and challenges. *International Journal of Doctoral Studies*, 11:305-321.
- Ayres, L., Kavanaugh, K., & Knafelz, K.A. 2003. Within-case and across-case approaches to qualitative data analysis. *Qualitative Health Research*, 13(6):871–883.
- Babalola, M.T., Bligh, M.C., Ogunfowora, B., Guo, L., & Garba, O.A. 2019. The mind is willing, but the situation constrains: Why and when leader conscientiousness relates to ethical leadership. *Journal of Business Ethics*, 155(1):75–89. [<https://doi.org/10.1007/s10551-017-3524-4>].
- Bachmann, C., Habisch, A. & Dierksmeier. 2018. Practical wisdom: management's no longer forgotten virtue. *Journal of Business Ethics*, 153:147–165. [<https://doi.org/10.1007/s10551-016-3417-y>].
- Beheshtifar, M. & Roasaei, F. 2012. Role of social intelligence in organizational leadership. *European Journal of Social Sciences*, 28(2):200-206.
- Belohlavek: 2007. The unicist ontology of ethical intelligence. [Internet: http://www.unicist.org/pdf/onto_ethical_intelligence_en.pdf; downloaded on 20 Dec 2016.
- Binning, D., Cochran, S., & Donatelli, B. 1972. Delphi panel to explore post-secondary educational needs in the state of New Hampshire. Manchester, NH: Decision Research.
- Bradley, E.H., Curry, L.A. & Devers, K.J. 2007. Qualitative data analysis for health services research: developing taxonomy, themes, and theory. *Health Services Research*, 42(4):1758-1772.
- Braun, V. & Clarke, V. 2006. Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2):77-101.
- Brown, C.H., Gould, D. & Foster, S. 2005. A framework for developing contextual intelligence (CI). *The Sport Psychologist*, 19(1):51-62.
- Brown, M.E., & Treviño, L.K. 2006. Ethical leadership: a review and future directions. *The Leadership Quarterly*, 17(6):595–616. [<https://doi.org/10.1016/j.leaqua.2006.10.004>].
- Brown, M.E., Treviño, L.K., & Harrison, D.A. 2005. Ethical leadership: a social learning perspective for construct development and testing. *Organizational Behavior and Human Decision Processes*, 97:117–134. [<https://doi.org/10.1016/j.obhdp.2005.03.002>].
- Burns, W.R., Jr., & Freeman, W. 2008. Developing an adaptability training strategy and policy for the DoD. IDA Paper P-4358). Alexandria, VA: Institute for Defense Analyses.
- Cai, H. 2014. Management development: a principles framework and critical skills approach. *Human Systems Management*, 33(4):207–212.
- Camarinha-Matos, L.M., & Afsarmanesh, H. 2018. Roots of collaboration: nature-inspired solutions for collaborative networks. *IEEE Access*, 6:30829-30843. [<https://doi.org/10.1109/ACCESS.2018.2845119>].
- Camillus, J.C. 2008. Strategy as a wicked problem. *Harvard Business Review*, 86(5):98-106.
- Carleton, T., Cockayne, W., & Tahvanainen, A. 2013. Playbook for strategic foresight and innovation. Finland: Tekes.
- Carter, S.M., Mayes, C., Eagle, L., & Dahl, S. 2017. A code of ethics for social marketing? bridging procedural ethics and ethics-in-practice. *Journal of Nonprofit & Public Sector Marketing*, 29(1):20–38. [<https://doi.org/10.1080/10495142.2017.1293384>].
- Chen, A., Lu, Y., Chau:Y.K. & Gupta, S. 2014. Classifying, measuring, and predicting users' overall active behavior on social networking sites. *Journal of Management Information Systems*, 31(3):213–253.

-
- Christie, C.A., & Barela, E. 2005. The Delphi technique as a method for increasing inclusion in the evaluation process. *The Canadian Journal of Program Evaluation*, 20(1):105–122.
- Chui, M., Manyika, J. & Miremadi, M. 2015. Four fundamentals of workplace automation. *McKinsey Quarterly*, Nov 2015.
- Conway, M. 2015. Foresight infused strategy development. In R. Talwar (Ed.), *The future of business: critical insights on a rapidly changing world by 60 futurists*. London: Fast Future Publishing.
- Cowan, M.A. 2017. Inclusiveness, foresight, and decisiveness: the practical wisdom of barrier-crossing leaders. *New England Journal of Public Policy*, 29(1):14.
- Coyne, J., Bell, & Merrington, S. 2013. Exploring ethics in intelligence and the role of leadership. *International Journal of Business and Commerce*, 2(10):27-37.
- Dağgöl, G.D. 2017. Lifelong Learning: not a 21st Century, but an omnitemporal skill. *Journal of Humanities Sciences Research*, 4(12):1254-1267. [<https://doi.org/10.26450/jshsr.207>].
- Dalkey, N. C., Brown, B. B., & Cochran, S. 1969. The Delphi method: an experimental study of group opinion. Santa Monica, CA: Rand Corporation. [Internet: https://www.rand.org/content/dam/rand/pubs/research_memoranda/2005/RM5888.pdf; downloaded on 2 Feb 2019].
- Darr, K. 2011. Introduction to management and leadership concepts, principles, and practices. In Burke, R.E. & Friedman, L.H. (Eds.), *Essentials of Management and Leadership in Public Health* (pp. 7–24). Sudbury, MA: Jones & Bartlett Learning.
- Daud, S., Wan Hanafi, W.N., & Mohamed Othman, N. 2021. Determinant factors for fourth industrial revolution (4ir) leadership attributes: an empirical study from Malaysia. *The Journal of Asian Finance, Economics and Business*, 8(9):301–311.
- Davenport, T.H. & Ronanki, R. 2018. artificial intelligence for the real world. *Harvard Business Review*, 96(1):108-116.
- Day, J. & Bobeva, M. 2005. A generic toolkit for the successful management of delphi studies. *The Electronic Journal of Business Research Methodology*, 3(2):103-116.
- Dewey, J. 1910. *How we think*. Chicago: DC Heath & Co Publishers.
- De Sousa, F., Pellisier, R., & Monteiro, I.P. 2012. Creativity, innovation and collaborative organizations. *The International Journal of Organizational Innovation*, 5(1):1–39.
- Ding, W., Choi, E., & Aoyama, A. 2019. Relational study of wise (phronetic) leadership, knowledge management capability, and innovation performance. *Asia Pacific Management Review*, 24:310–317. [<https://doi.org/10.1016/j.apmr.2018.10.005>].
- Djelic, M. 2014. A brief overview of strategic intelligence. Australian Science. [Internet: <http://www.australianscience.com.au/research-2/brief-overview-strategic-intelligence/>; downloaded on 27 December 2016.
- Dörner, D., & Funke, J. 2017. Complex problem solving: what it is and what it is not. *Frontiers in Psychology*, 8: 1153. [<https://doi.org/10.3389/fpsyg.2017.01153>].
- Dunn, E. 2003. Life through learning; learning through life: the lifelong learning strategy for Scotland. The Scottish Government. [Internet: <http://www.scotland.gov.uk/Resource/Doc/47032/0028820.pdf>; downloaded on 23 May 2019].

- Du Toit, G.S., Erasmus, B.J. & Strydom, J.W. 2007. Introduction to business management. 7 ed. Oxford University Press.
- Falk, C.F. & Blaylock, B.K. 2012. The H factor: a behavioral explanation of leadership failures in the 2007-2009 Financial System Meltdown. *Journal of Leadership, Accountability and Ethics*, 9(2):68-82.
- Fletcher, J.D., & Wind, A.P. 2014. The evolving definition of cognitive readiness for military operations. In H.F. O'Neil, R.S, Perez, & Baker, E.L. (Eds.), *Teaching and Measuring Cognitive Readiness* (pp. 25–52). New York, NY: Springer.
- Flyvbjerg, B 2006, Making organization research matter: power, values, and phronesis. in SR Clegg & C Hardy (eds), *The Sage Handbook of Organization Studies*. SAGE Publications, Thousand Oaks, CA, pp. 370-387.
- Fischer, G. 2000. Lifelong learning: more than training. *Journal of Interactive Learning Research*, 11:265–294.
- Ford, M. 2013. Viewpoint: could artificial intelligence create an unemployment crisis? *Communications of the Association for Computing Machinery*, 56(7):37-39.
- Franc, J.M. 2016. delphi technique: the do nots and the why nots. MedStatStudio Lecture. [Internet: <https://www.youtube.com/watch?v=GN6B8hgjQcw>; accessed on 15 April 2017].
- Funke, J. 2012. Complex problem solving. In N.M. Seel (Ed.), *Encyclopedia of the sciences of learning* (pp. 682–685). New York, NY: Springer.
- George, D. & Mallery: 2003. SPSS for Windows step by step: a simple guide and reference. 4th ed. Boston: Allyn & Bacon.
- Giannarou, L. & Zervas, E. 2014. Using Delphi technique to build consensus in practice. *International Journal of Business Science and Applied Management*, 9(2):65-82.
- Gläser, J., Laudel, G. 2009. On interviewing “good” and “bad” experts. In: Bogner, A., Littig, B., Menz, W. (eds) *Interviewing Experts*. Research Methods Series. Palgrave Macmillan, London.
- Goleman, D. & Boyatzis, R. 2008. Social intelligence and the biology of leadership. *Harvard Business Review*, 86(9):74-81.
- Goleman, D. 2004. What makes a leader? *Harvard Business Review*, 82(1):82-91.
- Good, D., & Yeganeh, B. 2012. Cognitive agility: adapting to real-time decision making at work. *OD Practitioner*, 44:13–17.
- Gordon, T.J. 2009. The Delphi method. futures research methodology version 3.0. Eds. Glenn, J.C. & Gordon, T.J. ISBN: 978-0-9818941-1-9 [Internet: http://millennium-project.org/FRMv3_0/04-Delphi.pdf; downloaded on 10 February 2017].
- Gottfredson, L.S. 1997. Mainstream science on intelligence: an editorial with 52 signatories, history, and bibliography. *Intelligence*, 24(1):13–23.
- Grime, M. M., & Wright, G. 2016. Delphi Method. In P. Brandimarte, B. Everitt, G. Molenberghs, W. Piegorisch, & F. Ruggeri (Eds.), *Wiley StatsRef : Statistics Reference Online* (pp. 1-6). New York, N.Y.
- Grint, K. 2008. *Wicked problems and clumsy solutions: the role of leadership*. clinical leader. California: BAMM Publications.
- Grint, K. 2010. *Leadership: a very shorth introduction*. Oxford: Oxford University Press.

- Gupta, V.K., & Waymire, E.C. 2008. Spatial variability and scale invariance in hydrologic regionalization. In S. Garrison (Ed.), *Scale dependence and scale invariance in hydrology* (pp. 88–135). New York, NY: Cambridge University Press.
- Hackett, S., Masson, H. and Phillips, S. 2006. Exploring consensus in practice with youth who are sexually abusive: Findings from a Delphi study of practitioner views in the United Kingdom and the Republic of Ireland. *Child Maltreatment*, 11(2):146–156.
- Hallowell, M.R. & Gambatese, J.A. 2010. Qualitative research: application of the delphi method to CEM research. *Journal of Construction Engineering and Management*, 136(1):99-107.
- Hancock, T. & Bezold, C. 1994. Possible futures, preferable futures. *The Healthcare Forum Journal*, 37(2), 23–29.
- Hartman, E. 2013. The virtue approach to business ethics. In D.C. Russell (Ed.), *The Cambridge Companion to Virtue Ethics* (pp. 240–264). Cambridge: Cambridge University Press.
- Hayne, S.C. & Pollard, C.E. 2000. A comparative analysis of critical issues facing Canadian information systems personnel: A national and global perspective. *Information & Management*, 38(2):73–86.
- Hays, J. 2013. Transformation and transcendence for wisdom: The emergence and sustainment of wise leaders and organizations. In W. Kuepers & D. J. Pauleen (Eds.), *A handbook of practical wisdom: Leadership, organization and integral business practice* (pp. 111–132). Farnham, England: Gower.
- Herold, G. 2016. Leadership in the fourth industrial revolution. Stanton Chase. [Internet: https://executiveacademy.at/fileadmin_synced_assets/documents/White_Papers/Leadership-in-Fourth-Industrial-Revolution-Stanton-Chase.pdf; downloaded on 5 August 2017].
- Higgs, J. 2012. Realising practical wisdom from the pursuit of wise practice. In E.A. Kinsella, & A. Pitman (Eds.), *Phronesis as professional knowledge: Practical wisdom in the professions* (pp. 73–86). Rotterdam: Sense Publishers.
- Hitchcock, D. 2018. Critical thinking. *Stanford Encyclopedia of Philosophy*. [Internet: <https://plato.stanford.edu/entries/critical-thinking/>; downloaded on 18 September 2019].
- Holyoak, K.J., & Morrison, R.G. 2005. Thinking and reasoning: a reader's guide. In K.J. Holyoak & R.G. Morrison (Eds.), *Oxford Handbook of Thinking and Reasoning*. New York: Oxford University Press.
- Hsu, C. & Sandford, B.A. 2007. The delphi technique: making sense of Consensus. *Practical Assessment, Research & Evaluation*, 12(10):1-8.
- Huitt, W. 1992. Problem solving and decision making: consideration of individual differences using the Myers-Briggs Type Indicator. *Journal of Psychological Type*, 24:33–44.
- Inayatullah, S. 2008. Six pillars: Futures thinking for transforming. *Foresight*, 10(1):4-21. [<https://doi.org/10.1108/14636680810855991>].
- Ingusci, E., Spagnoli, Zito, M., Colombo, L., & Cortese, C.G. 2019. Seeking challenges, individual adaptability and career growth in the relationship between workload and contextual performance: a two-wave study. *Sustainability*, 11(2):422. [<https://doi.org/10.3390/su11020422>].
- Ishikawa, A., Amagasa, M., Shiga, T., Tomizawa, G., Tatsuta, R., & Mieno, H. 1993. The max-min Delphi method and fuzzy Delphi method via fuzzy integration. *Fuzzy Sets and Systems*, 55(3):241–253.
- James, E.H. & Wooten, L.P. 2011. Crisis leadership and why it matters. *The European Financial Review*, 60-66.
- Kaptein, M. 2019. The moral entrepreneur: a new component of ethical leadership. *Journal of Business Ethics*, 156(4):1135–1150. [<https://doi.org/10.1007/s10551-017-3641-0>].

- Keeney, S., Hasson, F. & McKenna, H. 2011. *The Delphi Technique in Nursing and Health Research*. Wiley-Blackwell, West Sussex UK.
- Kittell-Limerick, P. 2005. *Perceived barriers to completion of the academic doctorate: a delphi study*. Texas: Texas A&M University-Commerce.
- Kouzes, J.M. & Posner, B.Z. 2009. To lead, create a shared vision. *Harvard Business Review*, 87(1):20-21.
- Kwiotkowska, A., Wolniak, R., Gajdzik, B. & Gębczyńska, M. 2022. Configurational paths of leadership competency shortages and 4.0 leadership effectiveness: an fs/QCA Study. *Sustainability*, 14:2795.
- Lai, E., Bay-Borelli, M., Kirkpatrick, R., Lin, A., & Wang, C. 2011. *Critical thinking: a literature review*. research report. London, UK: Pearson.
- Lazovic, S. 2012. The role and importance of emotional intelligence in knowledge management. In proceedings of the Management, Knowledge and Learning International Conference, Celje, Slovenia (20-22 June, pp 797-805).
- Likierman, A. 2020. The elements of good judgment: how to improve your decision-making. *Harvard Business Review*, 98(1):102-111.
- Lindebaum, D., Al-Amoudi, I., & Brown, V.L. 2018. Does leadership development need to care about neuro-ethics? *Academy of Management Learning and Education*, 17(1):96-109. [<https://doi.org/10.5465/amle.2016.0220>].
- Livermore, D. & Van Dyne, L. 2015. Cultural intelligence: the essential intelligence for the 21st Century. SHRM Foundation's Effective Practice Guidelines Series. SHRM Foundation. [Internet: <https://www.shrm.org/foundation/news/Documents/Cultural%20Intelligence.pdf>; downloaded on 26 February 2017].
- Maak, T., Pless, N.M. & Wohlgezogen, F. 2021. The fault lines of leadership: lessons from the global covid-19 crisis. *Journal of Change Management: Reframing Leadership and Organizational Practice*, 21(1):66-86.
- Manda, I., & Dhaou, S.B. 2019. Responding to the challenges and opportunities in the 4th Industrial revolution in developing countries. The 12th International Conference on Theory and Practice of Electronic Governance (3-5 April 2019, Melbourne, VIC, Australia).
- Markowitz, C. 2019. Harnessing the 4IR in SADC: roles for policymakers, Occasional paper 303, South African Institute of International Affairs.
- Massingham. 2019a. A blueprint for innovation collaboration: implementing the coffee house concept. *Journal of Behavioural Economics and Social Systems*, 1(1):74-85. [<https://doi.org/10.5278/ojs.bess.v1i1.6456>].
- Massingham. 2019b. *Knowledge management: theory in practice*. London: Sage Publications.
- McAfee, A, Goldbloom, A, Brynjolfsson, E. & Howard, J. 2014. Artificial intelligence meets the C-suite. *Mckinsey Quarterly*, 3:66-75.
- McGregor, S.L.T. 2012. Complexity economics, wicked problems and consumer education. *International Journal of Consumer Studies*, 36(1):61-69.
- McVey, R.S. 1995. Critical thinking skills for leadership development. *Journal of Leadership Studies*, 2(4):86-97. [<https://doi.org/10.1177/107179199500200407>].
- Mihelič, K.K., Lipičnik, B. & Tekavčič, M. 2010. Ethical leadership. *International Journal of Management & Information Systems*, 14(5):31-42. [<https://doi.org/10.19030/ijmis.v14i5.11>].

- Mittleton-Kelly, E. 2003. Ten principles of complexity & enabling infrastructures. In: Mittleton-Kelly, Eve, (ed.) complex systems and evolutionary perspectives of organisations: the application of complexity theory to organisations. Elsevier, pp. 23-50.
- Mongeau, S.A. 2014. Manager-machine: analytics, artificial intelligence, and the uncertain future of management. BAM! Business Analytics Management. [Internet: <http://sctr7.com/2014/10/07/manager-machine-analytics-artificial-intelligence-and-the-uncertain-future-of-management/>; downloaded on 21 November 2015].
- Montuori, A. 2012. Creative inquiry: confronting the challenges of scholarship in the 21st century. *Futures*, 44(1):64–70.
- Moore, D.S., McCabe, G.P, Alwan, L.C., Craig, B.A. & Duckworth, W.M. 2011. The Practice of Statistics for Business and Economics. 3rd ed. W.H. New York: Freeman and Company.
- Morin, E. 2008. On Complexity. Hampton Press Inc., Cresskill, NJ: USA.
- Morrison, V. 2013. Wicked problems and public policy. national collaborating centre for healthy public policy, Montréal, Québec. [Internet: https://www.inspq.qc.ca/pdf/publications/1841_Wicked_Problems_Policy.pdf; downloaded on 20 August 2017].
- Mueller-Hanson, R.A., White, S.S., Dorsey, D.W., & Pulakos, E.D. 2005. Training adaptable leaders: lessons from research and practice. Research Report 1844. Minneapolis: Personnel Decisions Research Institutes.
- Muff, K., Liechti, A. & Dyllick, T. 2020. How to apply responsible leadership theory in practice: a competency tool to collaborate on the sustainable development goals. *Corporate Social Responsibility and Environmental Management*, 27:2254–2274.
- Mullen, M. 2003. Delphi: myths and reality. *Journal of Health Organization and Management*, 17(1):7–52.
- Murugan, M.S. 2016. Management principles and practices. New Delhi, India: New Age International Publishers.
- Nakatsu, R.T., & Iacovou, C.L. 2009. A comparative study of important risk factors involved in offshore and domestic outsourcing of software development projects: A two-panel Delphi study. *Information & Management*, 46(1):57–68.
- Nelson, J.K., Zaccaro, S.J., & Herman, J.L. 2010. Strategic information provision and experiential variety as tools for developing adaptive leadership skills. *Consulting Psychology Journal: Practice and Research*, 62(2):131–142.
- Nerantzidis, M. 2013. Corporate governance in the Greek private sector, in state-owned enterprises and organizations and in public administration: Comparisons, results and proposals for improvement (in Greek). (PhD thesis). Athens: Panteion University of Social and Political Sciences.
- Nevid, J.S. 2013. Psychology: concepts and applications. 4th ed. Wadsworth, Cengage Learning. Belmont, CA: USA.
- Nevo, D. & Chan, Y.E. 2007. A delphi study of knowledge management systems: scope and requirements. *Information & Management*, 44(6):583-597.
- Nielsen, S. 2010. Top management team diversity: a review of theories and methodologies. *International Journal of Management Reviews*, 12(3):301–316.
- Nonaka, I., & Toyama, R. 2007. Strategic management as distributed practical wisdom (phronesis). *Industrial and Corporate Change*, 16(3):371–394. [<https://doi.org/10.1093/icc/dtm014>].
- Nunnally, J. & Bernstein, I.H. 1994. Psychometric theory. 3rd ed. New York, NY: McGraw-Hill.

- Okoli, C., and Pawlowski, S.D. 2004. The Delphi method as a research tool: an example, design considerations and applications. *Information & Management*, 42(1):15-29.
- Oosthuizen, J.H. 2016. Entrepreneurial Intelligence: expanding schwab's four-type intelligence proposition to meaningfully address the challenges of the fourth industrial revolution' In proceedings of 28th Annual Conference of the Southern African Institute of Management Scientists, University of Pretoria, South Africa (5-7 September 2016).
- Oosthuizen, J.H. 2017. The determinants of fourth industrial revolution leadership dexterity' in proceedings of 4th international conference on responsible leadership 2017 (15-16 March 2017). University of Pretoria, GIBS, South Africa.
- Paul, R.W. 1993. The logic of creative and critical thinking. *American Behavioral Scientist*, 37(1):21–39. [<https://doi.org/10.1177/0002764293037001004>].
- Penprase B.E. 2018. The fourth industrial revolution and higher education. In: Gleason N. (eds) Higher Education in the Era of the Fourth Industrial Revolution. Palgrave Macmillan, Singapore pp 207-229.
- Perry-Smith, J.E., & Mannucci:V. 2017. From creativity to innovation: the social network drivers of the four phases of the idea journey. *The Academy of Management Review*, 42(1):53–79. [<http://dx.doi.org/10.5465/amr.2014.0462>].
- Pfadenhauer, M. 2009. At eye level: the expert interview – a talk between expert and Quasi-expert. In: Bogner, A., Littig, B., Menz, W. (eds) Interviewing Experts. Research Methods Series. Palgrave Macmillan, London.
- Pless, N. & Maak, T. 2011. Responsible leadership: pathways to the future. *Journal of Business Ethics*, 98:3–13.
- Pollitzer, E. 2019. Creating a better future: four Scenarios for how digital technologies could change the world. *Journal of International Affairs*, 72(1):75–90.
- Postle, D. 1989. The mind gymnasium. London: Macmillan.
- Probst, G. & Bassi, A.M. 2014. Tackling complexity: a systemic approach for decision makers. Greenleaf Publishing, Sheffield, UK.
- Puscas, V. 2010. Management of post-crisis global interdependencies. International Economics Congress: Berlin. (4-7 February 2010).
- Ritchey, T. 2013. Wicked Problems: modelling social messes with morphological analysis. *Acta Morphologica Generalis*, 2(1):1-8.
- Rittel, H. & Webber, M. 1973. Dilemmas in a general theory of planning. *Policy Sciences*, 4(2):155-169.
- Sanders, M., & Moulenbelt, J. 2011. Defining critical thinking: how far have we come? *Inquiry: Critical Thinking Across the Disciplines*, 26(1):38–46. [<https://doi.org/10.5840/inquiryctnews20112616>].
- Sandrey M.A. & Bulger, S.M. 2008. The delphi method: an approach for facilitating evidence based practice in athletic training. *Athletic Training Education Journal*, 3(4):135-142.
- Salovey, P. & Mayer, J.D. 1990. Emotional intelligence. *Imagination, Cognition and Personality*, 9(3):185–211. [<https://doi.org/10.2190/DUGG-P24E-52WK-6CDG>].
- Sardar, Z. & Sweeney, J.A. 2016. The three tomorrows of postnormal times. *Futures*, 75:1-13.
- Saunders, M.N.K., Lewis, & Thornhill, A. 2009. Research methods for business students. 5th ed. London: Pearson Education.

- Schöttle, A., Haghsheno, S., & Gehbauer, F. 2014. Defining cooperation and collaboration in the context of lean construction. Oslo: IGLC. (23rd Annual Conference of the International Group for Lean Construction, 25-27 June 2014).
- Schwab, K.M. 2016. The fourth industrial revolution. World Economic Forum, Geneva, Switzerland.
- Shin, Y. 2012. CEO Ethical leadership, ethical climate, climate strength, and collective organizational citizenship behavior. *Journal of Business Ethics*, 108:299–312.
- Shotter, J. & Tsoukas, H. 2014. In search of phronesis: leadership and the art of judgment. *Academy of Management Learning & Education*, 13(2):224–243.
- Sison, A.J.G. & Ferrero, I. 2015. How different is neo-Aristotelian virtue from positive organizational virtuousness? *Business Ethics a European Review*, 24(S2). [<https://doi.org/10.1111/beer.12099>].
- Sosik, J.J. & Zhu, W. 2020. Facing and embracing the fourth industrial revolution with character. *The Journal of Character and Leadership Development*, 7(1):54–68.
- Stein, M.I. 1953. Creativity and culture. *The Journal of Psychology*, 36(2):311-322. [<https://doi.org/10.1080/00223980.1953.9712897>].
- Sternberg, R.J. 1985. Beyond IQ: a triarchic theory of human intelligence. London: Cambridge University Press.
- Sternberg, R.J. 1999. Successful intelligence: finding a balance. *Trends in Cognitive Sciences*, 3(11):436-442.
- Sternberg, R.J. 2003. Wisdom, intelligence, and creativity synthesized. Cambridge: Cambridge University Press.
- Sternberg, R.J. 2005. The Theory of Successful Intelligence. *Interamerican Journal of Psychology*, 39(2):189-202.
- Sternberg, R. J. 2018. Successful intelligence in theory, research, and practice. In R. J. Sternberg (Ed.), *The nature of human intelligence* (pp. 308–321). Cambridge University Press.
- Sternberg, R.J. & Lubart, T.I. 1991. An investment theory of creativity and its development. *Human Development*, 34:1–31. [<http://dx.doi.org/10.1159/000277029>].
- Sternberg, R.J. & Lubart, T.I. 1995. *Defying the crowd: cultivating creativity in a culture of conformity*. New York, NY: Free Press.
- Storsletten, V.M.L. & Jakobsen, O.D. 2015. Development of leadership theory in the perspective of kierkegaard's philosophy. *Journal of Business Ethics*, 128:337-349.
- Talanker, S. 2016. Problem-solving is decision-making. 2016 Annual Meeting of the Decision Sciences Institute. [Internet: https://www.researchgate.net/publication/310844404_Problem-solving_is_Decision-making; downloaded on 3 March 2019].
- Taylor, S.P. 2017. What is innovation? a study of the definitions, academic models and applicability of innovation to an example of social housing in England. *Open Journal of Social Sciences*, 5(11):128–146. [<https://doi.org/10.4236/jss.2017.511010>].
- Temelkova, M. 2018. Studying the leadership style of business organizations' management under the conditions of the Fourth Industrial Revolution. *Asia Pacific Journal of Research in Business Management*, 9(2):1-15.
- Tiemann, T.K. 2010. Introductory business statistics. [Internet: https://textbookequity.org/Textbooks/Tiemann_IntroductoryBusinessStatistics.pdf; downloaded on 16 April 2017].
- Tully, C. 2016. *Applying foresight and alternative futures to the United Nations Development assistance framework*. New York: United Nations Development Programme.

-
- UIL. 2010. Confintea VI: Belém Framework for Action: harnessing the power and potential of adult learning and education for a viable future. Hamburg, UNESCO Institute for Lifelong Learning (UIL). [Internet: <http://unesdoc.unesco.org/images/0018/001877/187789m.pdf>; downloaded 14 March 2018].
- Vaismoradi, M., Jones, J., Turunen, H. & Snelgrove, S. 2016. Theme development in qualitative content analysis and thematic analysis. *Journal of Nursing Education and Practice*, 6:100–110.
- Vernon, W. 2009. A Delphi technique: a review. *International Journal of Therapy and Rehabilitation*, 16(2), 69-76.
- Waldman, D.A. & Galvin, B.M. 2008. Alternative perspectives of responsible leadership. *Organizational Dynamics*, 37:327–341.
- Waller, S. 2015. Digital Intelligence: how digital intelligence can help you manage your information load, generate new opportunities and create business value. [Internet: <http://www.simonwaller.com.au/wp-content/uploads/2015/04/Digital-Intelligence-white-paper.pdf>; downloaded on 2 February 2017].
- Walker, S.M., Earnhardt, M.P., Newcomer, J.M., Marion, J.W. Jr. & Tomlinson, J.C. 2016. Crisis leadership during the great recession of 2008. *International Journal of Leadership and Change*, 4(1):5-12.
- Waters, D. 2011. Quantitative methods for business. 5th ed. Pearson Education Ltd, Essex: UK.
- Wells, J.R. 2012. Strategic IQ: creating smarter corporations. San Francisco, CA: Jossey-Bass.
- Wisniewski, M. 1997. Quantitative methods for decision makers. 2nd ed. Pearson Education Limited, Essex: UK.
- World Economic Forum. 2018. The future of jobs report 2018. [Internet: http://www3.weforum.org/docs/WEF_Future_of_Jobs_2018.pdf; downloaded on 22 November 2018].
- Woudenberg, F. 1991. An evaluation of delphi. *Technological Forecasting and Social Change*, 40:131-150.
- Ziglio, E. 1996. The Delphi method and its contribution to decision-making. in: Alder M. and Ziglio, E. (Eds.), Gazing into the Oracle, The Delphi Method and Its Application to Social Policy and Public Health. London: Jessica Kingsley Publishers, 3-33.