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# Developing a digital transformation model to enhance the strategy development process for leadership in the South African manufacturing sector

**Authors:**
Garth Gaffley[1]
Theuns G. Pelser[1]

**Affiliations:**
[1]Graduate School of Business and Leadership, College of Law and Management Studies, University of KwaZulu-Natal, Durban, South Africa

**Corresponding author:**
Theunis Pelser,
pelser@ukzn.ac.za

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**Purpose**: This study's aim was to gain insight into the transformative skills of business leaders in the South African manufacturing sector to drive their business' digital transformation process. Technology recources lead digital transformation requires skills not understood by leadership. Cloud computing has facilitated machine learning and artificial intelligence where human comprehension is limited, using algorithms for analytics requiring size and scale to provide data for decision-making and enabled disruptive technologies that have changed the face of industry sectors.

**Design/methodology/approach**: A pragmatic postmodern paradigm supports the theoretical framing of this study, conducted using descriptive research by e-questionnaire using quantitative analysis for deductive statistical evaluation.

**Findings/results:** The findings formed the basis of a model developed to assist chief executive officers (CEOs) to implement digital transformation successfully.

**Practical implications:** The CEO is responsible for the digital transformation of the business and must understand that data management is the most important asset in the digital era. The collection, storage, analysis, reporting and usage of data are key to competing in the digital economy, which requires the appointment of the chief information officer (CIO) to manage data and who should report directly to the CEO.

**Originality/value:** Reporting to the CIO would be data scientists and analysts who work with data; their roles focus on building algorithms from machine learning and developing predictive models from data and simulation models to test if technologies used to drive digital migration are optimal.

**Keywords:** digital transformation; technology; business leadership; data management; digital migration; digital capability; strategy development; CIO; South Africa.

## Introduction

The aim of this study was to source meaningful content to develop a digital transformation model for chief executive officers (CEOs) in the South African manufacturing sector to understand and lead their business' digital transformation process, a critical component to remain competitive in the digital economy. In addition, Ross et al. (2016) stated that human limitation of business leadership is a contributing factor to the lack of digital transformation. In a 2017 study of their customer base, Microsoft South Africa showed that 48% of South African businesses had embarked on a digital transformation journey, 44% had set a 12-month timeline to do so, whilst 8% had made no progress at all in this arena, indicating a low maturity level of digital transformation evident in these organisations (Hoosen, 2017).

South Africa's globally competitive manufacturing sector is not performing well and lags behind its other African trading partners, growing at a rate of 4.5% per annum (Cronje, 2018). According to Nam (2019), the International Monetary Fund (IMF) growth forecast for South Africa for 2019/2020 was between 1.4% and 1.7%. Statistics South Africa (2020) advised that the South African economy is in recession, having returned two negative growth rates in the third and fourth quarters of 2019. Jan Cronje, in an article published on 27 March 2020 by News 24, announced that Moody's Investors Services had downgraded the South African Investment

Index to 'junk status' following downgrades by the agencies Standard and Poor's Global Ratings and Fitch Ratings Inc. in 2017. This announcement coincided with the government's coronavirus disease 2019 (COVID-19) lockdown in South Africa. The South African manufacturing sector is a key contributor to the country's gross domestic product (GDP), contributing 14% in 2018 (Cronje, 2018) and thus needs to transform digitally to remain competitive. It further facilitates the growth of other sectors by achieving specific outcomes such as employment creation and economic empowerment, essential to the economy.

Against this backdrop, Kaldero (2018) stated that the digital age has manifested itself through digital transformation, sparked by artificial or machine intelligence enabled through cloud technology; embracing technology is essential to corporate survival in the digital economy. These are two of the most significant technology developments in recent times, with big data analytics and societal connectivity through the application of digital technologies having an unprecedented impact on businesses (Balachandran & Prasad, 2017; Gruman, 2016).

Mell and Grance (2011) defined cloud computing as a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable resources, released with minimum management effort or service provider interaction. Cloud technology places no limitation on data size and speed, nor on software development, and has facilitated digital disruption of traditional business with the rise of technology businesses, such as Uber and Amazon, dominating their industry sectors in a short period of time.

According to Chappell (2015), digital transformation is all about software, where hardware without software has no value at all and software development becomes one of the most important careers in the world. Kane, Palmer, Phillips, Kiron and Buckley (2015), in their 2015 Digital Business Global Executive Study and Research Project published in the MIT Sloan Management Review, concurred with Pyle and San Jose (2015), who identified the key driver in the digital transformation process as a strategy and not technology. A repeat study in 2017 showed that 63% of respondents were over the age of 45 years, and most were familiar with traditional strategy development processes but were not sufficiently technically astute to lead effectively in the digital economy. If digitally incompetent and there is hesitation on the part of these business leaders to take risks, invest in technological innovations, minimise the impact of digital disruption and delegate key decisions to more technologically astute individuals, the strategic direction of the business could be impaired. Their study showed that confident business leaders can make these decisions off an informed platform by having the correct data available in the right format at the required time, to drive the business. This view is supported by Andriole (2017), who is of the opinion that it is imperative for business leaders to become fully proficient in cloud computing as the first step in grasping the realities of leading the organisation's digital transformation process. These definitions led to the framing of the research question.

### Research problem and research objectives

The research questions which this study aimed to answer were:

- What is the content required to develop a digital transformation model in the South African manufacturing sector where business leadership could be grappling with the rate of unprecedented technological change in the digital economy?
- How can one strategise for it and effectively integrate and manage its implementation to create competitive advantage and success for these businesses in the future?

The linked research objectives are as follows:

- To determine the importance of data to the manufacturing sector
- To understand the societal influence of the digital economy and level of digital capability
- To determine the strategy and threat of digital disruption that limits investment and risk
- To investigate business leaders' human limitations and the lack of human capital investment

## Literature review

Strategy as a concept is defined by Grant (2016) as originating from the Greek word, 'Strategia', which means, from the office of the general, and interprets the strategic position of the organisation, where strategy is the plan for deploying resources to establish a favourable position. Binedell (2015) aligns strategy with warfare where 'Strategos' is the art of the general, CEO or business leader. According to Binedell (2015), the recent South African dynamic can be equated to Toffler's (1980) assertion in his book the 'The Third Wave' where he predicted that the future would come in unusual shapes and forms that would impact humans on various levels – personal, family, social and organisational. These predictions included the impact of new technologies which would facilitate the rise of new industries in information technology (IT), with changes in industrial output and production facilitated by data processing and computers.

Binedell (2015) believed that disruption in the digital economy is changing the rules daily, which the South African economy is experiencing at an unprecedented pace through economic, psychological and sociological change. He advises that South African business leaders work to understand these dynamics and that the most important strategic insight is to encourage innovation, entrepreneurship and creativity in their organisations. This could be accompanied by one of the four types of strategic change proposed by Balogun, Hope Hailey and Gustafsson (2015): evolutionary, adaptive, reconstructive or revolutionary. Reconstructive and revolutionary changes accompany digital transformation as disruptive technologies cannot be predicted nor anticipated, with the resultant change having a major impact on the future business sustainability.

To facilitate digital transformation, a digital strategy model is needed, such as the one developed by Ross et al. (2016) and Sebastian et al. (2017) which offers strategic choice either through digitised solutions that transform the business model or through the customer engagement that transforms the go to market, enabled through the operational backbone that facilitates operational excellence. This is further complemented by a digital services backbone that enhances market capabilities through micro services, connectivity and sophisticated analytics (Table 1). Westerman, Bonnet and McAfee (2014) offer an alternative model, whereby the use of technology radically improves the performance and reach of the business, with executives transforming their businesses in three areas: customer experience, operational processes and business models. In terms of a traditional strategy development process, Kaplan and Norton (2008) had developed a four-dimensional measurement model, the balanced scorecard, comprising financial, customer, internal business processes, learning and growth segments (Table 1). Supported by Kaplan et al. (2008), they advise that after years of application, the balanced scorecard, initially introduced in 1996, has transformed from a performance management tool into a strategic planning tool. Synergy between the balanced scorecard parameters and those of the digital strategy basics model is linked (Table 1).

In reviewing human capital and generational influence, according to Codrington and Grant-Marshall (2011), no other issue has the potential to divide the generations as much as their adoption, or not, of technology at work. Successful digital transformation has technology at its core, but successful leadership directing culture change is foremost together with new business processes (Heavin & Power, 2018). This supports Codrington and Grant-Marshall (2011) who offer advice in managing the generational divide where today's students are born into technology as digital natives, fluent speakers of the digital languages of computers, video games and the internet. Those not born into the digital world are digital immigrants who acquire aspects of technology, learn and adapt to their new environment but are not technologically fluent. Digital natives are used to receiving information amazingly fast; they like to parallel process and multi-task. Business leaders from the Baby Boomer and X generations, digital immigrants, must appreciate these digital native skills when managing those from the Y generation and new entrant iFacebook generations and must develop their digital skills to be able to do so.

Boag (2013) added that senior management lack confidence in digital transformation, technology development and innovation because they do not really understand it, and they need a roadmap to assist them in navigating this unknown terrain. Bordignon (2017) provided an overview of key technological trends impacting the future timeline (Figure 1). It shows the x-axis as the level of technological progress and breakthrough with the y-axis being the technology adoption curve. Levels 1 and 2 (1994–2020) consist of the introduction of the internet, the Third Industrial Revolution in 1994 and cloud technology introducing the Fourth Industrial Revolution. Level 3 (2020) is about exponential breakthrough within the current situation, level 4 (2020–2025) requires risk-taking and experimentation with future technologies and level 5 (2025 onwards) is the futuristic endeavour not within the ambit of this study.

The similarity between the technological time horizons (Figure 1) with that of Sebastian et al. (2017) and Ross et al. (2016) (Table 1) shows that businesses capable of competing successfully in the digital economy must be platformed to enable seamless connection of humans with machines and data, ensuring secure ecosystem flows enabled through the operational backbone and digital services backbone brought about through the technologies of level 3. The migration of technologies from level 3 to 4 is paired (Bordignon, 2017) and includes artificial intelligence (AI) and machine learning with robotics; virtual and augmented reality (VR and AR); nanotechnology; three dimensional (3D) and four dimensional (4D) printing; cybersecurity; and blockchain. Technologically proficient CEOs can support the selection of correct paired technology to suit the requirements of their digital journey, to encourage risk-taking and innovation and to change their organisational culture to incorporate a data and model-driven mindset to effectively compete in the digital economy (Kaldero, 2018).

## Research methodology and design

The literature review underpinned the independent and dependent variables for this study (Table 2) and framed the platform on which the quantitative research design and methodology were planned. Saunders, Lewis and Thornhill

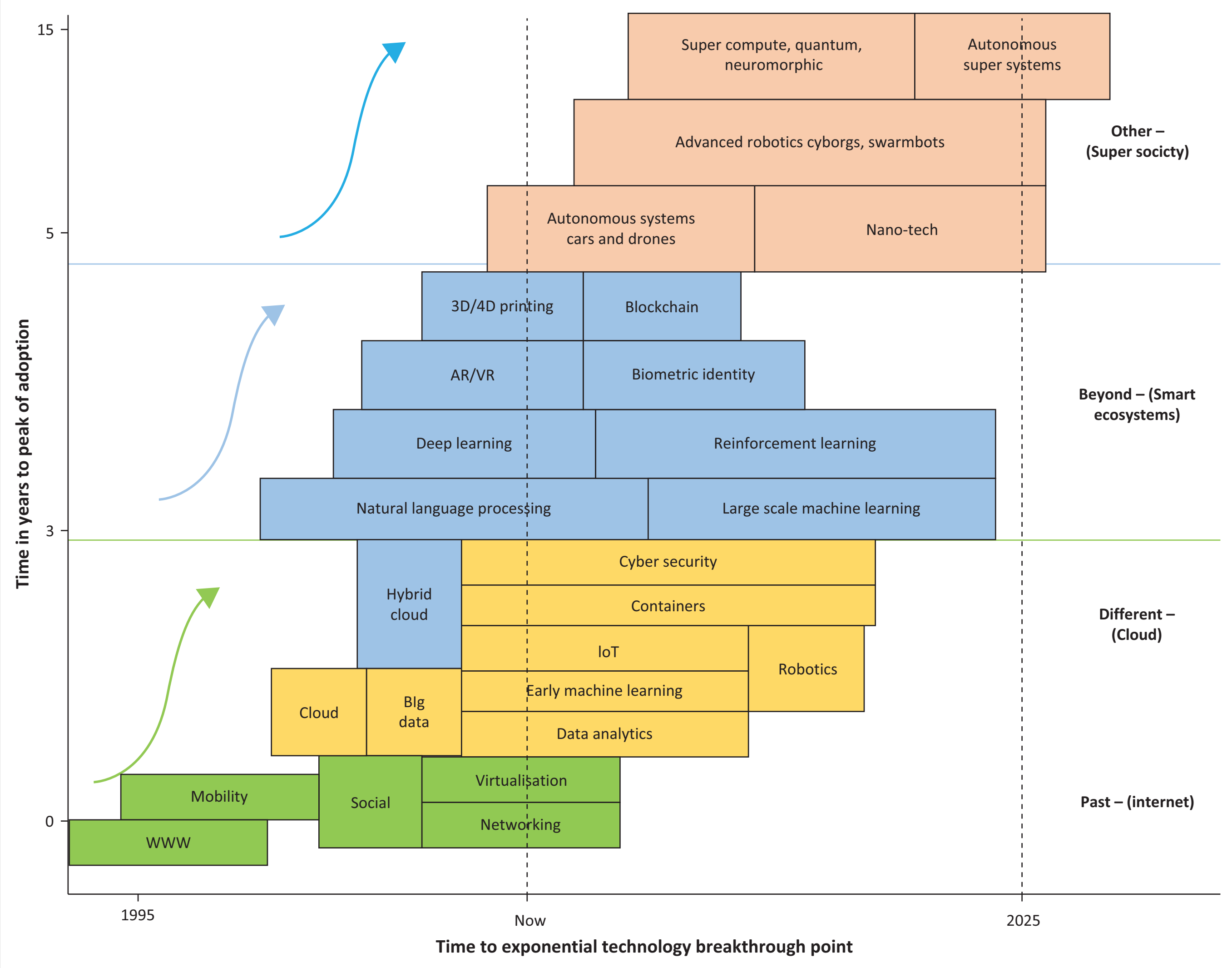
**TABLE 1:** Elements of showing alignment and synergy between the digital strategy basics, balanced scorecard and leading digitisation.

| Digital basics strategy model (Ross et al., 2016; Sebastian et al., 2017) | Digital basics support activity | Balanced scorecard (Kaplan & Norton, 2008) | Balanced scorecard support activity | Leading digitisation 4 core areas (Meffert & Swaminathan, 2018) |
|---|---|---|---|---|
| Operational backbone | Facilitates operational excellence | Internal business process & IT | Systems & IT development | Customer insights |
| Customer engagement | Transforms go to market | Customer strategy | Strategy development | Good customer relationship |
| Digitised solutions | Transforms business model | Learning and growth | Learning culture & organisation | The installed base |
| Digital services backbone | Market capabilities, micro services, connectivity, sophisticated analytics | Finance | Management control system, dashboards | Emotional ties |

*Source*: Kaplan & Norton, 2008; Meffert & Swaminathan, 2018; Ross et al., 2016; Sebastian et al., 2017

Note: Please see the full reference list of the article, Gaffley, G., & Pelser, T.G. (2021). Developing a digital transformation model to enhance the strategy development process for leadership in the South African manufacturing sector. *South African Journal of Business Management, 52*(1), a2357. https://doi.org/10.4102/sajbm.v52i1.2357, for more information.

IT, information technology.




*Source*: Bordignon, D. (2017). *The exponential digital world*. Dimension Data Australia, pp. 1–67. Retrieved from https://www.linkedin.com/pulse/exponential-digital-social-world-debra-bordignon/
IoT, Internet of Things; AR, augmented reality; VR, virtual reality.

**FIGURE 1:** Horizons of technological change in the digital enterprise maturity levels.

**TABLE 2:** The study variables relating to the research question.

| Independent variables | Dependent variables |
|---|---|
| Data as an asset | Management of data through technology. Managerial competence to lead a digitally transformed business |
| Level of digital capability | Managerial capability to lead a digitally transformed business, cyber-attack protection, digital disruption threats, assessment of risk, level of investment in technology and people |
| Data management by chief information officer (CIO) | Organisational design to incorporate a CIO responsible for all data and technology to manage data |
| Strategy development | Digital strategy as a component of overall business strategy, strategy planning cycles, investment in technology to facilitate digital transformation |
| Human capital | Human capital investment, skill development and requirements, organisational culture change, managing the generational divide |

CIO, chief information officer.

(2016) described the purpose of a research study as explorative, descriptive or explanatory. The descriptive purpose was best suited to explore the research question which was analysed quantitatively, applying statistical evaluation. According to Weaver and Olsen (2006), the approaches to research philosophies of post-positivism, realism, interpretivism and pragmatism are research paradigms, a view supported by Saunders et al. (2016) in their research onion. By way of research philosophy, the traditional scientific method for quantitative research originated in positivism, as described by Ary, Jacobs, Irvine and Walker (2018) supported by Bell, Bryman and Harley (2018) and O'Leary (2017) where ontologically, positivism incorporates objective data gathering, independence of social actors, with hypothesis testing to establish findings and causality. Saunders et al. (2016) indicated that epistemologically, only observable data, by being lawfully generalisable and systematically reduced to their simplest elements, can provide credible data and facts and are open to replication by other researchers. Axiologically, the researcher maintains objectivity by remaining independent of the data through the method of data collection by an electronic questionnaire survey, analysed and presented numerically using statistical interpretation. Tavakol and Dennick (2011) indicate the consistency and accuracy in which a measurement instrument returns a consistent result when the entity measured has remained the same. Zikmund, Carr, and Griffen (2013) define reliability as the degree to which results are error-free, producing consistent results.

Field (2013) uses Cronbach's 1951 alpha coefficients to determine the internal consistency reliability of the factors used, and a Cronbach's alpha coefficient between 0.7 and 0.8 is considered acceptable and is applied to the research variables (Table 2).

Creswell and Creswell (2018), Ary et al. (2018) and Saunders et al. (2016) indicated that there are two types of sampling: probability and non-probability sampling. There are four types of probability sampling where the chance of being selected from the population is equal: simple random, stratified, cluster and systematic sampling. Cluster sampling was followed with individuals selected from a representative database of manufacturing organisations in South Africa. The researcher confined the sample to the following industry manufacturing segments: metals and machinery; chemicals and pharmaceutical; wood and paper packaging and publishing; food and beverage; transport and automotive equipment and textiles. In framing the sample and calculating the minimum sample size, the Saunders et al.'s (2016, p. 582) guidelines were followed. A target sample of 5201 businesses in the South African manufacturing sector was sourced from the Interact Direct database of 29 May 2019. From this, a representative cluster sample of 2064 manufacturing businesses was selected. A professional statistician advised that the cluster sample, which returned a 7.1% response rate, satisfied the minimum statistical requirements for the validity of the sample.

De Vaus (2002), Robson and McCartan (2016) and Sue and Ritter (2012) defined a questionnaire as a data collection technique where respondents are asked to respond to the same set of questions in a set order. They advise that questionnaires are best suited for explanatory research aligned with quantitative analysis, enabling the establishment of relationships between variables and their cause and effect. According to Dillman (2011), using an electronic questionnaire as the research instrument assists with: a more valid response rate, at around 11% or below; distribution to an IT literate sample; ensuring confidentiality as the delivery is to a respondent's e-mail address with a low contamination rate; reaching a large sample size; a relatively short completion time ranging from 2 to 6 weeks; low financial outlay required; no researcher influence in the process and finally the data input can be automated.

A structured web-based questionnaire survey powered by Google Forms was developed, and this required respondents to choose from a limited number of responses predetermined by the researcher. These were on a nominal scale, a choice between two answers and the Rensis Likert scale of 1932 as per Sullivan and Artino (2013), a psychological measurement device to gauge attitudes, values and opinions offering a choice of scale between five and seven. The six-point scale that was used consisted of the points: Strongly Agree; Agree; Slightly Agree; Slightly Disagree; Disagree and Strongly Disagree with 45 descriptive multiple-choice questions aligned to supporting the research objectives. The questionnaire was sent to recipients identified in the cluster sample by personalised e-mail, with a cover letter incorporating the ethical clearance code. On completion, the questionnaire was automatically captured and returned to the researcher by Google Forms for statistical evaluation.

### Ethical data management

Cooper and Schindler (2008, p. 34) defined ethics as, 'Norms or standards of behaviour that guide moral choices about our behaviour and relationships with others'. This definition is supported by Drydyk and Keleher (2018) who concurred with Shetty (2017) that businesses managing data are rethinking their codes of ethics and digital ethical practices because of blurred boundaries between technical capability and the participation of business in the digital era, with technology being an enabler.

## Findings

For data analysis and interpretation, the following statistical tests were selectively applied to the research variables (Table 2): descriptive statistics, one-sample *t*-test, the univariate chi-square goodness-of-fit test, Pearson's measure (*r*), Spearman's rank order correlation designated by ($\rho$), ANOVA (analysis of variances), factor analysis and a binomial test, as advised by Berenson and Levine (1999), Thompson (2006), Wickens and Keppel (2004) and Gravetter, Wallnau, Forzano and Witnauer (2020).

### Respondent demographic details

These were divided into details on *the respondent* and *the business* with descriptive statistics for the respondents showing the following: 63% were at CEO and 17.4% were at financial director level; 62.3% had more than 10 years' service and age profiles ranged from 19.5% between 20 and 40 years to 80.5% over 40 years, indicating a stable and experienced sample. The business detail showed that 79% of the businesses were over 20 years old with varying numbers of employees, turnovers ranged from 26.1% between R10 million and R50m; 11.6% between R51m and R150m; 15.2% between R151m and R500m; 10.1% between R501m and R1 billion; and 21.7% over R1b. The businesses were split equally between business to business (B2B) and business to consumer (B2C) interfacing.

### Data management with data as an asset in the business

The importance of data as an asset in the business showed, by applying a one-sample *t*-test (Table 3) significant agreement, that data are an important asset in the business; data are synchronised and made accessible as a single point of reference where IT configures data in a suitable format for analytical purposes; there is a collection of unstructured and structured data with good governance and ethical practices; there is neither significant agreement nor disagreement that despite combining structured and unstructured data, there is no significant effort made in collecting unstructured data (M = 3.68). Results from a factor analysis (Table 4) showed that the data were suitable for successful extraction

**TABLE 3:** One-sample *t*-test data management variables.

| Data management variable | *N* | Mean | Standard deviation | *t* | *df* | *p* |
|---|---|---|---|---|---|---|
| 1.1. The CEO and senior management of your business consider data to be an important asset to your business | 138 | 5.19 | 1.293 | 15.338 | 137 | < 0.0005 |
| 1.2. All business data (e.g. data on personnel, financial reports, marketing information and sales performance) are synchronised and made accessible at a single location | 138 | 4.07 | 1.564 | 4.299 | 137 | < 0.0005 |
| 1.3. Our business has a data warehouse or cloud storage location from where all data across the entire business are stored and can be accessed | 138 | 4.02 | 1.681 | 3.647 | 137 | < 0.0005 |
| 1.4. IT provides data storage and availability in the format required by the functions | 138 | 4.46 | 1.172 | 9.657 | 137 | < 0.0005 |
| 1.5. IT configures the data in a format suitable for analytical purposes | 138 | 3.9 | 1.426 | 3.283 | 137 | 0.001 |
| 1.6. Our business collects both structured data (e.g. data about financial indicators and data about manufacturing) and unstructured data (e.g. data from e-mails, Facebook, Twitter, social media marketing and websites) | 138 | 3.68 | 1.475 | 1.443 | 137 | 0.151 |
| 1.7. Our business combines structured and unstructured data | 138 | 3.84 | 1.374 | 2.913 | 137 | 0.004 |
| 1.8. Good data governance regulations and ethical practices are always followed in the management of data in our business | 138 | 4.73 | 1.187 | 12.19 | 137 | < 0.0005 |

CEO, chief executive officers; IT, information technology; *df*, degrees of freedom.

**TABLE 4:** Promax rotation on data management constructs.

| Item | Factor loadings | | Variance (%) | Cronbach's alpha |
|---|---|---|---|---|
| | Data handling factor 1 | Data type factor 2 | | |
| **Data handling** | - | - | 46.50 | 0.779 |
| 1.5. IT configures the data in a format suitable for analytical purposes | 0.738 | - | - | - |
| 1.2. All business data are synchronised and accessible at a single location | 0.707 | - | - | - |
| 1.3. Our business has a data warehouse or cloud storage location from where all data across the entire business are stored and can be accessed | 0.692 | - | - | - |
| 1.4. IT provides data storage and availability in the format required by the functions | 0.621 | - | - | - |
| **Data type** | - | - | 22.81 | 0.834 |
| 1.6. Our business collects both structured data and unstructured data | - | 0.902 | - | - |
| 1.7 Our business combines structured and unstructured data | - | 0.792 | - | - |
| Total variance explained (%) | - | - | 69.31 | - |
| Kaiser-Meyer-Olkin (KMO) | 0.688 | - | - | - |
| Bartlett's test: *p*-value | < 0.0005 | - | - | - |

IT, information technology.

(Kaiser–Meyer–Olkin = 0.688). Furthermore, the significant result of Bartlett's test, $p < 0.05$, indicated that the correlations between items were not too low for successful factor extraction. In this analysis, two factors accounted for 69.3% of variance in the data, and therefore, constructs 1.1 and 1.8 were excluded from the analysis.

Two factors emerged (Table 4) from the remaining constructs, the 'first data handling', $\alpha = 0.779$ and second 'data type', $\alpha = 0.834$, with both having a Cronbach's coefficient > 0.7, indicating reliability. An additional one-sample *t*-test on these two factor groups showed that data management was being exercised with 'data handling', $p < 0.0005$, used more than 'data type', $p = 0.022$. Spearman's correlation was used to test for the significance of relationships between demographic aspects of the business (age, turnover and number of employees) with the data management constructs or groups (data handling and data type), and no significant correlation was identified.

ANOVA analysis of variances tested the effect of the type of business sector on data management between 6 groups and within 131 groups. The results (Table 5) showed a significant difference across the manufacturing sectors with 'data handling' conducted more in the metals and machinery, automotive and transport equipment sectors, $F$ (6; 131) = 3.317; $p = 0.005$, than in the wood and paper packaging and publishing sector $F$ (6; 131) = 1.743; $p = 0.116$.

Haffke, Kalgovas and Benlian (2016) advocate a chief information officer (CIO) be responsible for data management. A binomial test shows that a significant 87 (63%) of the respondents indicated that their business did not have a person responsible for data management or digital transformation, $p = 0.003$. Of the 51 (37%) that had a CIO, in turn, a significant 37 (73%) of these reported to the CEO, $p = 0.002$. The result of a one-sample *t*-test showed a significant agreement ($M = 4.35$), $p < 0.0005$, that those with a CIO did configure data in the required format for the functions. When asked if their businesses had a data flow model, applying a binomial test, 84 (61%) did not have and 53 (39%) did; of those that did have a data flow model, the results of a one-sample *t*-test showed a significant agreement that the data flow model was communicated to all employees, $p < 0.0005$.

## Digital capability of business leadership and the business

The digital capability of the business and people, mainly leadership, was investigated. A one-sample *t*-test was applied to the seven constructs and showed a significant agreement that senior management understood the importance of the web and its ability to connect all in society; there was investment in technological systems to collect data; ethical practices were followed in managing and publishing data; social media and e-commerce platforms connect the business with society; and there is an impact on the business brand promise if social media is used by customers to express discontent. There was a significant disagreement that the business had invested in internal communication systems such as Slack, Asana and Trello to improve internal communication, $M = 2.66$. Factor analysis with Promax rotation (Table 6) applied to the seven constructs showed two groupings.

Results from the factor analysis showed that the data were suitable for reliable and successful extraction (Kaiser–Meyer–Olkin = 0.729). Bartlett's test, $p < 0.0005$, indicated that the correlations between items were not too low for successful extraction. In the analysis, two-factor groupings accounted for 64.004% of the variance in the data, and therefore, two constructs were dropped. These are 1.1, senior management being aware of the importance of the connectivity with society through the internet and world wide web and 1.4, the business ensuring that ethical practices in dealing with data are always in place. The analysis shows two factor groupings; Factor 1, 'connectivity impact' and Factor 2, 'digital practice' with the data suitable for reliable extraction and Cronbach's alpha > 0.7 for both; Factor 1, $\alpha = 0.766$, 'connectivity impact' deals with the connectivity of participating in the worldwide web with e-commerce and social media platforms that connect business with society; Factor 2, $\alpha = 0.725$, 'digital practice' deals with investment in technology to collect and analyse data, having a digital strategy as part of overall strategy in place and investing in internal communication systems. A Spearman's correlation was used to determine linearity between the factor groupings of the digital capability constructs and demographic variables of age, turnover and number of employees of the business (Table 7). There was a negative correlation between the age of the business and understanding the impact of connectivity on the business, through web presence, the internet and social media, $r = -0.244$, $p = 0.004$. The more perceived impact is associated with younger firms; there was a significant positive correlation between annual turnover and the application of digital practices in the business, $r = 0.217$, $p = 0.004$. More agreement with the presence of digital practices was associated with firms with a higher annual turnover. Analysis of variances results on the same manufacturing sectors as in Table 5 show that there was neither agreement nor disagreement for connectivity impact in the manufacturing sector, whilst for digital practices, disagreement was detected in the wood/paper, packaging and publishing sector, $F(6.131) = 4.93$; $p < 0.0005$.

**TABLE 5:** Analysis of variances factor grouping tested between manufacturing sectors.

| Digital capability construct | Manufacturing sector | *N* | Mean | Standard deviation | *df* | *F* | *p* |
|---|---|---|---|---|---|---|---|
| Connectivity impact | - | - | - | - | 6; 131 | 0.781 | 0.586 |
| | Metals and machinery | 36 | 4.8148 | 0.88172 | - | - | - |
| | Food and beverage | 25 | 5.0267 | 0.73232 | - | - | - |
| | Chemical or pharmaceutical | 24 | 4.7500 | 1.11316 | - | - | - |
| | Wood, paper, packaging and publishing | 10 | 4.4333 | 1.20749 | - | - | - |
| | Transport equipment | 13 | 5.0256 | 0.55213 | - | - | - |
| | Electronics | 10 | 4.7000 | 1.17010 | - | - | - |
| | Other | 20 | 5.0000 | 0.74927 | - | - | - |
| Digital practice | - | - | - | - | 6; 131 | 4.93 | < 0.0005 |
| | Metals and machinery | 36 | 3.8889 | 0.89332 | - | - | - |
| | Food and beverage | 25 | 4.2300 | 0.90692 | - | - | - |
| | Chemical or pharmaceutical | 24 | 3.9583 | 1.03122 | - | - | - |
| | Wood, paper, packaging and publishing | 10 | 2.6750 | 1.03448 | - | - | - |
| | Transport equipment | 13 | 4.4615 | 0.75585 | - | - | - |
| | Electronics | 10 | 3.9750 | 0.94612 | - | - | - |
| | Other | 20 | 3.5125 | 0.84866 | - | - | - |

Note: ANOVA analysis of variances tested the effect of the type of business sector on data management between 6 groups and within 131 groups.
*df*, degrees of freedom.

**TABLE 6:** Promax rotation on digital capability constructs.

| Digital capability constructs | Factor loadings | | Variance (%) | Cronbach's alpha |
|---|---|---|---|---|
| | Connectivity impact factor 1 | Digital practice factor 2 | | |
| **Connectivity impact** | - | - | 44.2 | 0.786 |
| 1.6. The business understands how social media and e-commerce platforms connect the business with society | 0.888 | - | - | - |
| 1.7. The business understands the impact that social media has on the business brand promise (e.g. If a brand promise is not met, customers will turn to social media to express discontent, which will negatively affect the business) | 0.783 | - | - | - |
| **Digital practice** | - | - | 19.804 | 0.725 |
| 1.5. The business has a digital strategy in place to incorporate digital strategies into the business strategy where possible | - | 0.744 | - | - |
| 1.3. The business has invested in communication systems such as Slack, Asana and Trello, etc. to improve internal communication | - | 0.709 | - | - |
| 1.2. Senior management has invested in technological systems to collect data | - | 0.577 | - | - |
| Total variance explained (%) | - | - | 64.004 | - |
| Kaiser–Meyer–Olkin (KMO) | 0.729 | - | - | - |
| Bartlett's test: *p*-value | < 0.0005 | - | - | - |

**TABLE 7:** Spearman's coefficient of linearity applied to the digital constructs making up factor groupings 1 and 2.

| Spearman's rho | Detail | Connectivity impact | Digital practice | 2. How old is the business? | 4. How many people are employed in your business? | 5. What is the annual turnover of your business? |
|---|---|---|---|---|---|---|
| Connectivity impact | Correlation coefficient | 1 | 0.369** | -0.244** | -0.022 | -0.084 |
| | Sig. (2-tailed) | - | 0 | 0.004 | 0.798 | 0.326 |
| | *N* | 138 | 138 | 138 | 138 | 138 |
| Digital practice | Correlation coefficient | 0.369** | 1 | 0.136 | 0.163 | 0.217* |
| | Sig. (2-tailed) | 0 | - | 0.113 | 0.056 | 0.011 |
| | *N* | 138 | 138 | 138 | 138 | 138 |
| 2. How old is the business? | Correlation coefficient | -0.244** | 0.136 | 1 | 0.320** | 0.384** |
| | Sig. (2-tailed) | 0.004 | 0.113 | - | 0 | 0 |
| | *N* | 138 | 138 | 138 | 138 | 138 |
| 4. How many people are employed in your business? | Correlation coefficient | -0.022 | 0.163 | 0.320** | 1 | 0.864** |
| | Sig. (2-tailed) | 0.798 | 0.056 | 0 | - | 0 |
| | *N* | 138 | 138 | 138 | 138 | 138 |
| 5. What is the annual turnover of your business? | Correlation coefficient | -0.084 | 0.217* | 0.384** | 0.864** | 1 |
| | Sig. (2-tailed) | 0.326 | 0.011 | 0 | 0 | - |
| | *N* | 138 | 138 | 138 | 138 | 138 |

Sig., significance.

*, Correlation is significant at the 0.05 level (2-tailed); **, Correlation is significant at the 0.01 level (2-tailed).

A binomial test on the functions responsible for the digital transformation process in the business is as follows: A significant percentage responded 'yes', showing that the CEOs and C-suite lead the digital strategy, $N = 118$ (85.5%), $p < 0.0005$, as advocated by Gale and Aarons (2018) and Siebel (2017), followed by finance, $N = 99$ (72%), $p < 0.0005$; IT, $N = 83$ (60%), $p = 0.021$; production, manufacturing, sales and marketing were not significant as the respondents answered almost equally between 'yes' and 'no'. The remaining functions have limited involvement. A binomial test applied to the use of technological tools and paired technologies employed showed that the highest frequency of application being customer engagement through interactive website alignment, $N = 63$ (45.7%), $p = 0.349$, had an almost equal split in responses 'yes' or 'no', showing neither agreement nor disagreement. Application (apps) development, $N = 49$ (36%), $p = 0.001$, and the Internet of Things (IoT), $N = 44$ (32%), $p < 0.0005$, showed agreement that they are the leading technological tools employed in the manufacturing sector in South Africa. Of concern is that 24.6% of the sample reportedly had no technological tools in place, with varying levels for the use of one or more technology tool. A Pearson's correlation applied to technology tool usage and the demographic variables of age, the number of employees and turnover of the business showed significant correlation with the turnover, $p = 0.002$, and the number of employees, $p = 0.002$, in the business.

## Strategy

One of the most significant findings of the research arose when respondents were asked to rate their businesses against a fully transformed business in their sector on an agreement or linear scale ranging from 1, being poor, to 10, being excellent. The *overall finding was that 4.47 out of 10 or 47.7% were on a digital transformation journey* (which is significantly lower than halfway 5.5, $p < 0.005$), and *this is a low score for the manufacturing sector in South Africa*. Analysis of variances review of the rating across manufacturing sectors showed no significant correlation between sectors. Chi-squared goodness-of-fit test was applied to the frequency of strategy development shows, and a significant 70 (50.7%) of the respondents indicated that their business embarks on a strategy development process at least once a year, $\chi^2$ (3) = 53.478, $p < 0.0005$. A significant 70 (50.7%) of the respondents also indicated that their business expects a return on digital initiatives in between 1 and 3 years, $\chi^2$ (3) = 55.101, $p < 0.0005$. A one-sample *t*-test applied to investigating strategy development constructs around risk, security, innovation culture and structure showed a high level of agreement amongst all constructs except for a structure where employees can learn from each other on digital disruption facilitated by cloud computing; the results showed no further agreement and a factor analysis did not yield two reliable factors.

## Human capital skill requirements

Human capital investigates: the investment in human capital to retain and improve skills; cultural change to facilitate risk-taking; and how to create a culture for digital learning. A binomial test on the type of business thinking – traditional regimented corporate or entrepreneurial – showed no significant agreement nor disagreement as statistically these were reported in equal numbers. With regard to traditional regimented thinking, the day-to-day affairs of the business showed that there was significantly more focus than in the 'big picture' thinking, more aligned with digital transformation and innovation.

## Age profile and skill recruited

There was significant agreement that the younger age groups were recruited into the business; the 30–35-year-old age group was highest, $N = 85$ (57.4%), followed by the 20–29-year-old age group, $N = 39$ (11.4%). These age groups are significant in that digital skills are more prolific in the younger age profiles. There was significant agreement that those with engineering, $N = 59$ (42.8%) and sales skills $N = 38$ (27.5%) were recruited the most into the businesses, followed by those with logistics, accounting, research and development skills. A low number of IT professionals, data scientists, data analysts and programmers recruited is of concern, indicating low levels or a scarcity of digital skills in the manufacturing sector. A one-sample *t*-test showed that two constructs were in disagreement: there was a noticeable divide across managerial levels regarding the implications and need for digital transformation, $M = 3.66$, $p = 0.148$ and the business investment in the training of staff to enhance their digital capability, $M = 3.61$, $p = 0.347$. Spearman's correlation used to test for significant relationships with demographic aspects of the business, age, turnover and number of employees and the human capital constructs showed no significant correlation between these. An ANOVA test to show the effect of the type of business sector on human capital constructs on the same industry sectors as in Table 4 showed more agreement in understanding the difference between a digital strategy and digital marketing strategy in the electronics sector over the chemical and pharmaceutical sector; and wood, paper and publishing sectors. In using cross-functional teams for digital projects, there is more agreement with food and beverage, electronics, transport equipment and automotive components over the wood, paper and publishing sector.

## Discussion developing a digital transformation model

A number of authors offered insight into the proposed digital asset leverage model and the research findings of this study. Kaldero (2018) spoke of leveraging the data assets in a business and that data can be considered as 'digital gold', the most important strategic asset. The challenge in developing a digital transformation model is to have it as a current objective within the overall business strategy. Pyle and San Jose (2015) stated that a good start to defining the data strategy is identifying the gaps in the data, to break down silos and fill those gaps which will take time, resources and investment. Digital innovation, through a prolific lens perspective by Hinings, Gegenhuber and Greenwood (2018), is about activating innovative new products and services through technology, and digital transformation is about managing and integrating several of these novel initiatives. Westerman et al. (2014) shared both these views and defined digital transformation as the leveraging and use of technology to transform organisations rapidly, to improve both their reach and performance.

Meffert and Swaminathan (2018) had a similar stance and defined digital transformation simplistically as driving the business forward by leveraging the opportunities from IT to the more advanced technologies of machine learning, AI, nanotechnology, 3D and 4D printing, robotics, analytics, cloud or social, mobile, analytics, cloud and IoT technologies as contained in the model of Ross et al. (2016) and Sebastian et al. (2017). Meffert and Swaminathan (2018) and Kaldero (2018) agreed that the urgency of digitisation is the responsibility of the CEO, and to capitalise on this and create a sense of urgency around digitising the business, the entire ecosystem must be involved. Meffert and Swaminathan (2018) continued that instrumental in setting the benchmark is to identify the relevant assets which form the core of the business, customer value and benefit and proposes four key areas of insightful examples of digital excellence: good and strong customer relationships, the installed base, depth of customer insights and emotional ties. Good, strong customer relationships enabled insights that make the service and product offer more meaning, such as the *My Disney Experience* website and app which offer all facility information on guests' arrival and on departure and ask for their suggestions to improve the overall Disney experience. The installed base is valuable, especially if it has a large number of contact points, as with Caterpillar in the agriculture and heavy industry which has 400 000 vehicles worldwide fitted with sensors to transmit data along with a software package to optimise vehicle use, cost and productivity. For the depth of customer insights, John Deere improved on Caterpillar, where in addition to optimising vehicle use, they offer significant advice on all aspects of ways to farm, via a John Deere app based on rainfall and weather conditions, accessed by the farmer via the machine. Finally, regarding emotional ties, The LEGO Group has involved the whole family across the generations of LEGO users to create new ideas for them to bring to the market. Meffert and Swaminathan (2018) concluded that businesses which digitise will remain competitive and have a long-term future. Meffert's four key components of digital excellence are combined with the synergised traditional and digital strategy models (Table 1). The Ross et al. (2016) and Sebastian et al. (2017) models worked on agility, innovation, integration of technology and a start-up mindset, where technology changes are revised in the digital strategy every 3 months.

This study's research findings for the manufacturing sector in South Africa are used to demonstrate the workability of the proposed 7-step digital assets leveraged model crystallised from the symbiotic relationship between the balanced scorecard and the digital basics strategy model (Table 1). The steps are as follows:

- **Step 1:** Set the digital benchmark by identifying the digital gap, 47.7% from the research or independently calculated.
- **Step 2:** Select independent variables pertinent to the digital strategy (Table 2).
- **Step 3:** Define the dependent variables or constructs (Table 2) and apply an impact and urgency analysis to all variables in Steps 2 and 3.
- **Step 4:** Prioritise, weight and rank the digital assets from the impact and urgency analysis (scale to be developed).
- **Step 5:** List the prioritised digital assets, by function using a digital planning map (to be developed), set a financial plan, develop and allocate detailed budgets for implementation.
- **Step 6:** Select cross-functional teams, assign responsibilities against key performance areas (KPIs) and return on investment (ROI) requirements.
- **Step 7:** Execute and review (Steps 1 to 6), set timelines, review dates and update digital strategy every 6 weeks to 12 weeks and incorporate them into the overall business strategy.

Gale and Aarons (2018) advised in their global research that the road to successful digital transformation is not a clear cut one, as only one in six businesses achieves the outcome they envisaged, for the others timelines have shifted and expectations have not been met. Their research has also shown that there is a lot of confusion around 'digital', a view also shared by Reis, Amorim, Melão and Matos (2018), where around 15% of management have digital as a core business approach and customer sales and services account for 54% of digital projects. They advocated that the business deoxyribonucleic acid (DNA) undergoes significant change and concurs with Kaldero (2018); the reason for this is that digital transformation requires a mindset change in thinking about a digital data- and model-driven business.

# Conclusion

The literature analysed in this study disclosed that the manufacturing sector is a key contributor to the South African economy, which is in recession, and the GDP expectation is low when compared to our trading partners and African contemporaries. The manufacturing sector can provide jobs and the stimulus for growth; to remain globally competitive, it must transform digitally. The literature also revealed that the CEO is responsible for driving and leading the digital transformation of the business. Analysis of primary data revealed independent and dependent variables in manufacturing as components essential to the development of a model to assist CEOs to facilitate and lead the digital transformation journey.

The study recognised components for a proposed digital asset leverage model, such that data management was divided into data handling and data type. It showed that data handling was used more than data type in the transport and automotive equipment, metals and machinery sectors than in the wood/paper and publishing sector. Data type showed structured and unstructured data being collected but not combined across all sectors. With data classified as digital gold, it becomes essential to collect, combine and store all data for succession planning and continuity of data flow in the business. It is essential to appoint a CIO to manage all aspects of data and provide the essential data inputs, analytics, algorithms and simulation models for the CEO to successfully lead the business's digital transformation. The CIO needs to provide data and communicate the data flow model to ensure all in the business understand the process. The most significant study finding was that the level of digital transformation in the *South African manufacturing sector was 47.7%*. This aligns with the research findings of the Microsoft study in 2017 which showed that 48.8% of their customer base, albeit across all sectors, had undertaken some forms of digital transformation. The current study shows that strategy development takes place annually across most businesses in the manufacturing sector. The study recommends that the business digital strategy be conducted every 6 weeks, with focus on closing the digital transformation gap, making it a key objective of the overall business strategy. The study highlights culture change for the need to establish a learning culture for employees to develop an understanding of digital disruption and cloud technology from their peers and a mindset focussed on a data- and model-driven business.

Managerial implications of the study show an agreement that CEOs should lead the digital transformation process and that digital capability has two factor groupings that emerge from the study, connectivity impact and digital practice. The study recommends that these benefits be fully understood by the CEO and leadership to minimise risk and to ensure acceptable return as younger firms are more connected and established businesses with higher turnovers invest more in digital practice.

A key study finding, of serious concern, in the manufacturing sector is that 24.6% of the businesses had no recognised technology tools in place with differential use of one or more technologies. Their digital strategy development should include investment in paired technologies to enhance operational efficiency.

Human capital in the study reflects that the manufacturing sector culture be equally divided between regimented day-to-day focus and entrepreneurial 'big picture' thinking. The literature indicates that digital transformation is better suited to an entrepreneurial and innovative risk-taking culture. The study shows that younger age groups are more readily recruited into the manufacturing sector, where the technical skills like engineering and sales skills are the most sought after. Lack of skills or lesser emphasis on recruitment of IT professionals, data analysts and scientists should be corrected to improve digital skill levels in manufacturing. Cross-functional team selection, responsibility and measurement are achieved by applying digital asset leverage mapping, where variables are allocated to the specific quadrants (Table 1). The research shows that the food and beverage, electronics, transport and automotive equipment sectors use cross-functional teams more than the wood/paper and publishing sector.

This study recommends that these recommendations and findings become the building blocks for the proposed 7-step digital asset leverage transformation model.

## Contribution of the study

This study specifies the lag in digital transformation in the South African manufacturing sector which is only 47.7% transformed. The gap of 52.3% indicates that some businesses are on a form of the digital journey or are not at all. The study identifies components for the proposed digital asset leveraged model as designed from the theory and research findings to assist CEOs and C-suite management to better understand, implement and lead digital transformation in their organisations. The study provides the base for continued research and contributes to the body of knowledge in the relatively new field of digital migration.

## Limitations and future research

The proposed model needs to be refined with worksheets developed around the independent and dependent variables and their constructs identified in the research to ensure user-friendly application by CEOs and leadership. Reworking the cluster sample to improve the response rate of 7.1% could be undertaken. The study could be strengthened by conducting mixed methods research to make the findings more robust. Qualitative research conducted through in-depth interviews with CEOs, financial directors and IT professionals in the manufacturing sector could reflect more significantly on skill level requirements, generational differences and culture change to lead digital transformation in the manufacturing sector. Both sets of data can be combined through triangulation into a convergent sequential mixed methods study to strengthen this study's findings and provide further in-depth understanding of digital transformation requirements at CEO level. Future research could focus on more details in the differences detected in the specific manufacturing sectors, for example, wood/paper and publishing were behind all other sectors across all the independent variables, data management, digital practice and cross-functional team utilisation for digital projects – this requires further in-depth analysis.

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## Competing interests

The authors have declared that no competing interest exists.

## Author's contributions

G.G. is a registered doctoral candidate in the Graduate School of Business and Leadership at the University of KwaZulu-Natal. This manuscript is derived from his doctoral thesis. He fulfils the function as an original researcher for this manuscript. T.G.P. is the supervisor of the doctoral candidate. He fulfils the function of the corresponding author and resource provider for the publication of this manuscript. He is actively involved with the review and editing of the different versions of the manuscript.

## Ethical considerations

Application for ethical clearance was submitted by the researcher to the Humanities and Social Sciences Research Ethics Committee with full approval granted against the protocol reference number: HSS/0585/018D.

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## Data availability

The quantitative data used in this study are available for sharing from the corresponding author, T.G.P., upon reasonable request.

## Disclaimer

This article is the result of the analysis carried out by the authors associated with the University of KwaZulu-Natal. However, the article does not purport to represent the views or the official policy of any member of the University of KwaZulu-Natal.

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