Ecosystem for 4th Industrial Revolution to Accelerate Sustainable Development Goals in the South African Context: A Conceptual Framework

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Abstract

Contextualizing technology and digitalization in a period of having to meet sustainable development goals (SDGs), requires a paradigm shift which calls for collaboration from multiple stakeholders. The current turbulent environment requires an investigation into ways of adopting the Fourth Industrial Revolution (4IR) as a pertinent mechanism for accelerating sustainable development goals. The need to formulate a conceptual framework and adapt it to the South African context, requires careful mapping of the elements of 4IR, the relevant infrastructure and resources There has been perceptions instigating resistance towards the SDGs, hence the need to develop the conceptual framework. The exploratory research method fitted well as its nature a systematic review to effect and respond to the abovementioned investigation. The study reviewed about 70 articles of which 53 of those were peer-reviewed articles within 4th industrial revolution in South Africa as set for ecosystem. Due to limited research on the topic, possible impacting variables that added immeasurable value were explored as contributing factors the study. Both reviewed literature and government archive on 4th industrial revolution revealed how the ecosystems of 4IR accelerated the achievement of SDGs in South Africa. The study further singled smart factories, smart cities, integrated systems, green technologies, cybernetics, the internet of people, the internet of energy, and the internet of things as contributing factors towards 4IR. The recommended the applicability of the ecosystems onto the South African context to advance innovation agenda to achieve green energy, sustainable water provision, waste management, trade in low-carbon products, cleaner and greener technologies, green buildings, green chemistry and sustainable transport, as well as improved air quality.

Keywords
Change management, Fourth Industrial Revolution, green economy, sustainable development goals, ecosystem.

1. Introduction

Scholarly research and its integration into the sustainable development goals (SDGs) of the United Nations framework, and the green economy as a whole are still in the initial stages, with no peer-reviewed publications on the latter available within the South African context. Similarly, there is a paucity of research into the formulation of the ecosystem of the Fourth Industrial Revolution (4IR) in transitioning to a green economy and attaining the SDGs. Although there have been efforts to research the SDGs, 4IR, sustainable development in international markets (Brand. 2012; Burma., 2016; Chala and Poplavska, 2017; Lu, 2017; Manda and Ben-Dhaou. 2019; Mosconi, 2015; Rüßmann, et al., 2015), no study has yet been done on mapping the variables involved into SDGs transition within the developing country such as South Africa. The researchers intended to report on a review of the extant literature related variables such as 4IR, SDGs, as well as possible exogenous variables to map their integration into the sustainable goals with the aim of building a South Africa based ecosystem. The building of such an ecosystem, as well as its application in the South African context, forms part of the focussed conceptual framework.

1.1 Research questions

The research study at hand intended to answer the highlighted questions below as a way of interrogating the available literature in building the anticipated the South African-based conceptual framework:

- How can 4IR technology be utilised to facilitate the attainment of SDGs, theoretically?
- Who are the key stakeholders in 4IR with respect to the SDGs?
- What resources and infrastructures required green economy transition in the 4IR era of?

The stipulated research questions guided the study to pay attention to the role of 4IR with reference to the SDGs in the literature review.

2. Literature Review

The literature review in this research paper focused on research studies that covered 4IR and Sustainable development goals to see how much work has been done in this area. It assisted the researchers to identify the gaps that needed to be closed within the South African context.

2.1 Fourth Industrial Revolution

4IR can be defined as innovative ways of handling programmes and materials, and transforming processes (Chala and Poplavska 2017). In the view of Dutton (2014), 4IR is Smart factory, where virtual copy of the physical world is displayed. 4IR is evolving due to pressures on entities to be world class and compete with other countries, and because the nature of work is changing, requiring errors to be minimized in efficient and effective ways (Chala and Poplavska 2017). In this regard, 4IR is building on the Third Industrial Revolution, the digital revolution that has taken place since the middle of the last century. 4IR is characterized by a fusion of technologies that cut across the lines between the physical, digital, biological and social spheres. This revolution differs from previous industrial revolutions, in terms of production and the impact(s) on the economy, since it includes governance, management, living, and working (Burma 2016) through improving processes related to cyber security and systems, big data, simulations, smart additive/sustainable manufacturing, analytics, the internet of things (Rüßmann, et al 2015, Mosconi 2015, Lu 2017). Some researchers argue that the role of 4IR is to disrupt, transform and connect societies, businesses and governments (Lu 2017).

Other authors believe that 4IR enhances the advancements of science and technology through Internet of Things (IoT) that manifests into Cyber-Physical Systems (CPS) and smart machines (Liao, et al. 2018). Liao et al. (2018) further mentioned that the advancements of 4IR supersede organizational and territorial boundaries that take advantage of its agility, intelligence, and networking. The emergence of 4IR brought along artificial intelligence that drives exponecial increase in computing power backed by the availability of data that translate into new drugs to algorithms, digital fabrication technologies, additive manufacturing and synthetic biology (Schwab 2017).

Morrar, Arman and Mousa (2017) agree that 4IR would grow exponentially with regards to technical change and socioeconomic impact. The authors continued to suggest that the coupling of the forces of technological innovation and social innovation were of necessity for sustainability purposes (Morrar et al. 2017). The support towards SDGs by the United Nations remained focused on committing to inclusive social and economic development (Morrar et al. 2017). Furthermore, among the proponents of 4IR, there are calls for technology to help achieve the SDGs which form part of the United Nations' objectives (Manda and Ben-Dhaou 2019).

2.2 Sustainable development goals

Transformation and sustainable development need to be kept closely aligned (Brand 2012, O'Brien 2012).Ways of contextualizing green economy efforts need to be revisited, given that sustainable development is socially constructed (Roundy 2016) The green economy can help to pave the way to achieving the SDGs, as it is characterized by economic growth which seeks to reduce carbon emissions, minimize pollution and energy use, ensure resource efficiency and maintain ecosystem services (which include biodiversity) by also addressing the economy, through sustainable employment (Greent 2020, Nhamo 2013, UNEP 2005)

The thematic areas encompassed by the green economy are inclusive of, but not limited to, green energy, sustainable water provision, waste management, agriculture, the trade in low-carbon products, cleaner and greener technologies, green buildings, green chemistry and sustainable transport (mini cars/cycles), as well as improved air quality Sustainability involves interrelated activities and benefits which can continue to meet technical, economic and institutional demands (UNEP 2005). Inputs from the environments controlled by external markets (e.g., political, financial and technological factors) may be inhibited, as governance and policy compliance serve as both barriers to entry and challenges in South Africa. Often, enabling the green economy is dependent on ensuring that the tools are sufficient, and the necessary resources are in place. One important factor which is often overlooked is capacity, especially when it comes to environmental issues. Enabling the green economy also involves information technology and innovation (Anthony and Majid 2016). Many researchers are of the opinion that once the milestones of capacity building – in terms of climate change and the green economy – are fully implemented, this mechanism can contribute to transitioning 4IR ecosystems to a green economy. Enabling a green economy needs to be explored by looking at current global models and learning from the success factors and challenges they faced. The green economy and sustainable development are seen as tools of innovation and advancement. Innovation can be expedited through information technology, which serves as an innovative tool for disseminating and communicating information related to the transition to a green economy.

The introduction of information technology brought about greater Symbiosis (Höjer and Wangel 2015) between entities. Energy efficiency and clean technologies also count amongst the enablers of a green economy (Barbier, 2011). Some researchers have proposed and created an ongoing research model on the use of 4IR technology to facilitate 15 of the 17 SDGs set by the UN (UNEP 2005). Currently, human behaviour is a significant obstacle in the process of transitioning to a green economy, albeit that in many instances people still need to man machines. Rather, a nexus is required. In addressing the SDGs, the aim is to eradicate poverty and hunger, foster good health and wellbeing, offer quality education, ensure gender equality, provide clean water and sanitation, make available affordable and clean energy, creating decent work and economic growth, encouraging industry, innovation and infrastructure, and reducing inequality Sustainable cities and communities, responsible consumption and production. climate action, and partnerships are needed to achieve these goals (Kajee et al 2018).

To ensure the implementation and success of the system, making processes less complicated will contribute to efficiencies. Although still in an exploratory stage, that vision will open avenues for future research. Investigations have been undertaken in international markets on the effect and role of 4IR and accelerated sustainable development on a single sector, such as food security (de Amorim et. al. 2019). This study sought to focus on diverse avenues of sustainable development, including water, energy, green building, infrastructure, waste, sustainable production, and manufacturing. In addition, the study aimed to contribute by formulating an ecosystem for contextualising 4IR technologies and their applicability in a South African context.

3. Methods

This study adopted a systematic review approach to probe the selected literature for information on the ecosystem of 4IR as an accelerator of the SDGs. Thematic analysis was used to carefully choose the most appropriate results which met the criteria adopted by researchers. The criteria set was 4th industrial revolution technology, sustainable development goals and change management, managing perceptions, challenges, and benefits with regards to 4th industrial revolution and sustainable development goals. The thematic areas were analyzed by means of content analysis, included resources and infrastructure, benefits and challenges, key stakeholders, managing perceptions, and leading change. The focus and emphasis on humans were because most science, engineering, and systems as a whole lackde such focus (Diale, et al. 2019). Above all, 4IR seeks to close the gap in terms of the interaction

between people, machines, the environment and the economy, as supported by Dutton (2014) who mentioned 4IR as a virtual copy of the physical world.

Due to limited research on the topic of possible exogenous variables, the field was broadened to add value to the study. For the current purposes, an exogenous variable can be defined as a factor that can impact a system yet is independent and not influenced by the system (Pruyt 2013). In this context, the exogenous variables encompass the psychology behind machine learning, the benefits thereof and the challenges encountered, the leadership traits needed to spearhead 4IR, and the culture, norms and values involved. Purpose sampling was utilized, as that allowed the researchers to select themes/variables/factors to complement the study (Creswell 2009). In this instance, the researchers limited their search to peer-reviewed articles, with search keywords such as Fourth Industrial Revolution; sustainable development goals; and green economy (and permutations of these) from 2015–2020. The search engines employed included Google Scholar, Sustainability Journal and Science direct. Initially the researchers identified 70 entries, which were narrowed down by reading abstracts and findings. In the end, the researchers were left with a total of 53 articles that met the criteria of covering sustainable development, sustainable goals, green economy, and 4IR. As mentioned, limited research has been conducted on 4IRn and sustainable goals, sustainable development and the green economy.

4. Data Collection

The identification of how the ecosystem of 4IR technology affects sustainable development, was followed by manipulating key variables for sustainable development and 4IR technology. The ecosystem is depicted in table 1. The researchers subsequently removed duplicates and excluded grey sources such as media coverage, reports and newspapers. From the literature review, the researchers then developed variables from the systematic review to feed to the ecosystem. The broad themes as findings were arranged as resources and Infrastructure and key role players within 4th Industrial revolution and sustainable development goals, Benefits of adoption of the 4th industrial revolution, sustainability, managing perceptions and change, sustainable development goals, table 1.

Table 1. 4TH industrial revolution ecosystem to accelerate sustainable goals – a conceptual framework

Infrastructure and resources	Cyber society and technologies	Managing challenges and perceptions Sustainability	Key role players
Internet of energy (Manda and Ben-Dhaou. 2019) Communication, Urban regeneration (Carvalho, et al. 2018; Choi and. Kim, 2017; Okello, et al., 2019) Urban farming technologies (Lom, et al., 2016; Okello, et al., 2019. ;Thomaier, et al 2015)	Customer or client centric, meeting needs (Moavenzadeh, 2015)	Green change management programmes (Authors'contribution)	Community members Industrial psychologist Engineers Green economy specialists
Smart cities, integrated system (Safiullin, et al, 2019) Green technologies Cleantech (Townsend, 2018) Virtual training (Machado, 2020)	Transformation of business, sociotechnical digital transformation, digital economy (Asiimwe and de Kock, 2019; Chala and Poplavska. 2018; Manda and Ben-Dhaou. 2019)	Transforming and products and services and not systems (Moavenzadeh. 2015), Greening of technology, greening Internet of things (Maksimovic, 2018; Machado, 2020)	Engineers Green economy specialists Change managers

5. Results and Discussion

The results and discussions of the research paper paid close attention to infrastructure and resources, Managing change and perceptions, and practical applications of the ecosystem and contribution within South African context.

5.1 Infrastructure and resources

Table 1 can be interpreted as follows:There have been efforts across the globe to introduce initiatives such as smart or sustainable cities. Smart sustainable cities as a social construct can be defined as the place where information technology is combined with infrastructure, architecture, everyday objects and even our bodies, to address social, economic and environmental problems for the future (Höjer and Wangel 2015). Establishing adequate infrastructure, in the South African context, involves investing in social and economic infrastructure and creating jobs (Manda and Ben-Dhaou. 2019). The latter objectives can be linked to the sustainable goal of eradicating poverty and ensuring equitable access to resources (Anthony and Majid 2016,, Diale, et al. 2019, Nhamo 2013, UNEP 2005).

A chain of conferences held since 1972 have sought to identify the environmental problems affecting both international and local markets. Competencies and skills are vital for taking such innovative solutions as the green economy and smart cities, and making them a reality (Höjer and Wangel 2015). Alternatives, such as solar, off-grid options – especially mini grids – have been suggested, particularly to grant rural areas access to energy (Bhattacharyya and Palit 2014, Oyedepo 2012). Infrastructure governance is another support mechanism where policies and training can be piloted with stakeholders. Saurian lilting low-cost solar lamps, as part of renewable energy have been suggested by previous authors (Choudhary and Patil 2015, Oyedepo 2012). The latter initiatives could be explored in the South African context. Still in the realm of infrastructure, cyber physical systems and virtualisations aligned to the principle of industry and would see such systems being implemented as part of the process of transitioning to, and accelerating the uptake of, the SDGs (Carvalho, et al., 2018). The implementation of renewable powered irrigation systems as advocated by (Oyedepo 2012, Thompson 2016) is a type of technology which seeks to minimise the challenges presented by a scarcity of resources. To expound on resources and infrastructure, the emergence or urban farming technologies were reported, which focus on green roof technology, mobile containers, and hydroponics (Thomaier, et al. 2015). The evolution of smart cities gives rise to the emergence of smart connections, virtual and wired cities, and urban cybernetics (Thompson 2016), all of which help with urban regeneration (Choi and Kim, 2017). Such regeneration of urban areas includes spatial planning and sustainable transportation, digital information, autonomous vehicles and digital infrastructure and connectivity (Carvalho et al., 2018)

5.2 Managing change and perceptions

The researchers propose that managing change and perceptions in the process of transitioning to a green economy are important elements which require the management of both negative and positive attitudes towards adoption of technology, an understanding of the green economy, and knowledge of each role which a society or stakeholder can play in bringing about this transition. Change is beneficial in the face of industrial discontinuities such as legal, economic and technological conditions that shift the basis for competition within an industry (Waddell et al. 2019). Changes in product life cycle shifts, which require different business strategies; and internal company dynamics related to size, corporate portfolio strategy or executive turnover, can easily be managed with change interventions (Gossage et al.. 2010). Furthermore, change can also be used as a competitive strategy which can bring about transformation. Some researchers Smith (2002) assert that managing change can be achieved through education, facilitation, participation and negotiation. Change programmes can benefit the organisation in terms of retaining its values and culture; and ensure that strategy is always aligned with the culture, vision and mission. Change management interventions can assist organisations to build optimistic and self-assured leadership, foster innovative and create collaborative environments with increased cohesiveness and heightened morale (Miller 2001). Organisations embarking on change are proactive, which leads to them becoming learning organisations which can focus on dealing with demanding external forces and pressures, and are able to put mechanisms in place to counter any threats (Waddell et al. 2019). Other initiatives effecting transition and enabling a green economy, involve ensuring that there are ambassadors or champions in different sectors, such as the private, public and tertiary, as well as schools. However, society at large or communities are often bypassed, which may hamper change or impede the adoption of new behaviors. Infrastructure and sponsorship need to be in place, to ensure that resources are adequate for change. Studies show that there is a need to do thorough project planning and management, as they are critical for ensuring project efficiency (Smith 2002).

Communicating strategy throughout the change process is vital, and should be maintained (Smith 2002). A change champion needs to communicate – from an early stage – what support they might need, and what progress should be made in the form of milestones achieved, and these should be tracked and publicized. People need to understand the reasons for change and the level of attribution of value, if they have to embark on any change activities (Waddell et al. 2019). The culture of an entity is based on its business strategy and objectives, which feed into change interventions (Kotter and Schlesinger 2008, Palmer 2022). The feelings, behaviours and thoughts of employees who will be affected by change, need to be investigated and addressed by offering them support and training, and reinforcing suitable behaviours (Luthans, 2021). With minimal peer-reviewed publications on creating readiness to change within the era of 4IR and the green economy, the researchers propose that elements of 4IR which can be linked to SDGs be piloted as a framework and then implemented. This can be achieved by using a framework from the internet of people, as well as the psychology of human interaction between human and machine (Sundar, 2020). Leadership and change management division are core and crucial units in any organisational setting to support internal change management capabilities (Gossage et al. 2010). The process of internal capacity building in respect of change management can begin with process mapping the responsibilities of each change manager, matching and identifying talent pools which align with the criteria identified by the change manager (Maksimovic 2018) Exogenous variables such as benefits and challenges may affect the system positively and/or negatively, when adopting 4IR tenets, to facilitate the transition to sustainable goals.

A benefit of the industrial revolution is that is has boosted manufacturing and reduced emissions, allowing tailored or specific customer needs to be achieved and delivered in time (Maksimovic 2018). However, the complexity of the South African context is located at the level of the affordability of services, infrastructure and the cost of adopting related technologies. Load-shedding in South Africa poses a marked threat to the ecosystem. A 4IR committee, stakeholders and representatives of Eskom and the Department of Environmental Affairs, policy makers, politicians, citizens, engineers, psychologists, and government officials need to be included from the planning phase, through to implementation and evaluation. The benefits of 4IR in terms of transitioning to a green economy will include innovative and socially focused mechanisms with regards to waste management, water and energy conservation, and reduced packaging amongst others, which the latter will further be addressing the SDGs in South Africa.

Research into the integration of 4IR in societies in developing countries have shown that they fear the introduction of technology will replace their jobs and contribute to high unemployment, even in South Africa. One study (Burma, 2016) echoes the latter statement, identifying challenges related to cyber security and privacy problems resulting from more sophisticated hacking techniques. Some believe societies are missing out on the most important benefits of technology, since 4IR contributes to efficiency and can hasten the transition to sustainable goals. A number of barriers to the adoption of 4IR have been identified:

- Power cuts
- Lack of skills (Manda and Ben-Dhaou 2019)
- Lack of infrastructure such as Wi-Fi connectivity in rural and some urban areas
- Negative perceptions around the cutting of jobs
- A lack of finances
- Fear of change
- Social justice/injustice (Niravita 2020)

As 4IR works towards human–machine interaction and taps into social aspects, additional behavioral factors such as human wellbeing and coping mechanims need to be borne in mind. Confirming this statement (Lom, et al., 2016), the argument is made that communication and collaboration may increase due to cyberphysical systems, which can be aligned with SDGs related to health and wellbeing. An investigation into the most important elements of interaction between humans and machines revealed a number of psychological effects such as confidence, perceived capabilities, machine heuristics and locus of control (Sundar, 2020). This calls for a multi-disciplinary effort, where work/industrial psychologists, engineers, information system specialists, communities and politicians join forces in ensuring that all stakeholders are optimised, and the necessary frameworks are put in place to deal with such psychological issues.

5.3 Practical applications of the ecosystem and contribution within South African context

Table 2 can be interpreted as follows:The researchers are of the opinion that the Youth Development Agency should spearhead fundraising and the creation of a space or an enabling environment which allows young people to access

4IR tools, processes and systems. This will lay the foundation for enabling and allowing the youth a seat in strategic roundtable discussions with decision makers as true collaborators and ensure broad inclusivity. Change dynamics programmes, to manage readiness for the era of 4IR and SDGs in developing countries, should be introduced. As change dynamics programme tactics which focus on the latter ecosystem do not currently exist, the programmes explained above can serve as foundation to design and implement the ecosystem.

The South African Skills Development Act 97 of 1998 could be amended to facilitate this initiative, and allow entities to keep record of 4IR initiatives, of green skills for development, and help them monitor grants and incentives. Skills-related documentation and lessons learnt could be drawn from Europe, China and Taiwan, as regards their experience of development and innovation in the green economy, and technological advances in digitalisation. Furthermore, education and training to deliver highly skilled individuals will be needed to fill the gap and cope with the demands of the coming industrial revolution. Everyone must be able to use some elements of the latter, to drive sustainable goals, boost the modification of green policies, spur training and development, and kick off government programmes all of that will require an integrated system.

The need for curriculum review is vital, in respect of the inclusion of digitalisation, and skills which align with 4IR, especially where the goal is to successfully implement and enable the ecosystem. The formulation of a memorandum of understanding with countries which are leaders in innovative practices, and the integration of such innovative practices in green economy, can be formulated. Exchange programmes, a broadening of the scope of career guidance and mentoring, as well as the inclusion of commercialisation, bring entrepreneurship into play, and that is an important element in boosting the SDGs for eradicating poverty and minimising instances of social injustice.

The researchers wish to recommend a stronger focus on previously disadvantaged groups within the South African contexts, including youths, black people, women, and people living with disabilities. In their view, 4IR can assist with service delivery, by improving efficiencies in the municipal and government sectors. Furthermore, queries from the community can be handled and managed in real time, and prompt responses given, to combat citizens' dissatisfaction with service delivery. Scientific and engineering processes can be improved to function optimally, and for that to happen, social discourse needs to be considered.

A social change unit may be established in academic environments, awards may be handed out, and categories can be created in programmes such as the South African Women in Science Awards (SAWiSA). A studentpreneurship, intervarsity and Enactus initiatives can serve as a cornerstone for accelerating incubation programmes pertaining to the adoption 4IR technology and the green economy, in the quest to bring about sustainable development in South Africa at a university level.

Leadership traits in regard to 4IR and the green economy in an African context still need to be explored (de Sousa et al, 2018). However, transformational leadership appears to be the preferred leadership trait. A transformational leader is characterised as an individual who capitalises on delegation and advice, to bring about the personal development of his/her followers. From a change perspective, a transformational leader can increase awareness of problems, and influence their followers to view change from a fresh point of view (Vinger and Ciliers, 2006). Such a leader can contribute by communicating the vision and plans of the organisation and simplifying the process for everyone to comprehend.

Efforts have been made in South Africa to roll out electric vehicles with low direct emissions. Such steps are a way of working towards the transition to a green economy, in the form of sustainable transport. They further contribute to sustainable or smart cities. The phenomenon of *Botho* has also been investigated in Botswana, where it served as a key driver towards sustainable development (Mhigo, 2019), and can be explained as a social contract of mutual respect, responsibility and accountability, among members of a society. In this current study *Botho* is taken to form part of the exogenous variables to benefit the ecosystem. *Botho* can be implemented as part of 4IR and sustainable development goals through sharing of resources and knowledge culture [53], to ensure equality, and enabling the machine learning with integration of African norms.

Table 2. Mapping SDGs onto 4IR elements

Input	Element of 4th industrial revolution	Output	Sustainable development goals
Raw materials i.e., environment, infrastructure, architecture	Robotics Spatial planning Urban regeneration and cybernetics Internet of energy and water Sustainable manufacturing	Smart cities and spaces Virtual city, urban cybernetics Enhanced service delivery of the eight green economy thematic areas	Goal 9: Industry, innovation, and infrastructure Goal 6: Access to clean water Goal 7: Affordable and clean energy
Training Change Ambassadors or champions/society Youth and women empowerment development agency SAWiSA *Studentpreneurship*/academic entrepreneurship Broadened career guidance and mentoring Infrastructure, resources South African skills development Act Curriculum review, memorandum of understanding, exchange programmes	Internet of people and Psychology of human interaction between machine and a person (Sundar, 2020) Virtual training and automated learning environment	Social entrepreneurship ecosystem	Goal 11: Sustainable cities and communities Goal 17: Partnership for achieving the goals Goal 4: Quality education Goal 5: Gender equality Goal 1: No poverty Goal 8: Decent work and economic growth

Table 2 can be interpreted as follows: The use of robotics, smart technology and connectivity can help to create jobs for disabled people and the elderly, to reduce waste, and manage recycling and the reuse of resources (Machado, 2020), in working to meet sustainable goals such as access to services, water and health benefits, and the alleviation of poverty. 4IR has accelerated food security (de Amorim et al 2019), especially in rural areas where poverty rates are high.

The current author asserts that lack of quantification of impact of 4IR onto sustainable development goals in South Africa serves as a research agenda. To date there is no publication on mapping the 4IR and sustainable development goals in South Africa. According to fourth industrial revolution South Africa (n.d), artificial intelligence has decreased Greenhouse gas emissions by 13%, improved power efficiency by 11%, helped reduce waste by 12%. When translating the latter statistics on the current study, the authors deduce that sustainable development goals, 7 and 9 can be achieved through the fourth industrial revolution to supplement the mapping of the depicted-on table 2. The adoption, mapping and projection of the 4th industrial revolution onto the South African economy serves as a missing link and current authors asserts that if the correlation of 4th industrial revolution with the economy and green economy can be shown will, play a huge role in transitioning in facilitating increased urgency or agility to adopt the technology.

Reflecting on the challenges related to infrastructure or Wi-Fi connectivity in large parts of South Africa, raised questions about this country's readiness for 4IR. To this end a networked readiness index (Burma, 2016) has been formulated, in which – amongst ten of the leading countries – no African country features.

Some researchers discovered that the top countries with leading networks and resources are Japan, Singapore, the United Kingdom, the United States and Turkey, to name but a few (Burma, 2016; Mosconi, 2015; Rüßmann, et al 2015). These latter countries are influenced by several pillars or factors, namely a politically astute leadership, and environment which fosters business and innovation, suitable infrastructure and digital content, and affordability.

Amongst the factors or pillars confronting a developing country such as South Africa, are challenges of inequality and funding.
4IR calls for an effort to be made to understand societies, processes and people, and the interaction between the environment, machines and the economy, thus the evolution of sociotechnical and digital transformation (Asiimwe and de Kock, 2019; Manda and Ben-Dhaou. 2019) This can be achieved by strengthening the internet of people, and managing human interactions with machines, keeping in mind the psychological effect, cultures, values and norms of a particular society.

As some researchers (Anggusti and Siallagan, 2018) assert, 4IR is more effective where processes and transformations can survive during power cuts, where storage capabilities are available, and there is access to knowledge.

Reflecting on the challenges in this country, brought on by power cuts and a lack of access to information, training, development and raising awareness are necessary as technical skills and education is needed within the area. Thus, 4IR requires certain technologies to be broadly used, and related processes must be able to take place, despite power outages.

Industrialization offers technologies that can be used in e- waste to deal with separation at source and avoid human degradation, offering less exposure to hazardous waste and chemicals. Affected people should be given an allowance and/or compensated, to ensure that no one loses his/her job. Citizens should be educated to ensure that goals such as quality education, health and wellbeing, and decent work for all, become achievable. Rural farming can be facilitated by means of technology, to ensure access to markets, and achieve the SDG of reducing poverty. In this regard, a study Quiroz-Niño (2017) asserts that training communities, facilitating technology transfer, and the use of technology to allow individuals to gain skills and develop, can help to achieve sustainable goals. Training and development in respect of green technologies may reduce poverty, as members of any society will have the necessary skills to create and conceive of products or services which allow them to be self-sufficient, to create jobs and train others. In this regard, NGOs which seek to achieve sustainability, by building green and smart cities, must be encouraged.

A smart cities model which emphasises communication between rural and urban areas, will serve to accelerate the SDGs of eradicating poverty thought food security, sustainable agriculture and farming, while using technology to share knowledge and communicate best practices across regions and countries (Okello, et al., 2019). This meets the requirement of 4IR to offer augmented solutions across industries, through the integration of systems and people, and by ensuring sustainability. To achieve that will require new ways of operating and acting, to ensure that there is efficiency, minimal waste, and a well-equipped and skilled nation.

The latter argument adds to the triple bottom line of environment, people and economy. To reinforce the smart city model, production or transformation through 4IR can happen anywhere, at any time: for instance, a home may be turned into a mini factory (Burma, 2016) or best practices in sustainable manufacturing may be communicated widely, to ensure connectivity and collaboration (Carvalho, et al., 2018). Using 4IR tools to create renewable and alternative energy will ensure quality and grant equitable access to energy for South African communities, as reported in a study conducted in Indonesia (Anggusti and Siallagan, 2018). Furthermore, to accelerate access and reach the objective of granting access to energy, the internet of energy can help to implement social and economic infrastructure in creating jobs (Lom, et al., 2016, Manda and Ben-Dhaou. 2019)

This objective can be linked to the sustainable development goal of eradicating poverty, and ensuring equitable access to resources for all. Green building and 4IR require a stronger focus on the design of new equipment and products, by transforming the production processes to bring about a quality life and reduce energy consumption, in line with sustainability goals (Nistor and Herman, 2018). How technology can be utilised in food security, is by ensuring that urban farming technologies reuse water to water plants. Automated heat from other building can be used to heat plants for growth, as is the case with a heating system adopted in New York (Thomaier, et al 2015). The

revolution of urban regeneration includes spatial planning and sustainable transportation, digital information, autonomous cars, and connected digital infrastructure (Choi and Kim, 2017) . This must be linked to equal access to resources. Industrial psychologists can assist with policy formulation when it comes to the interaction between people and machines, systems, and processes, to meet the requirements of 4IR.

6. Conclusion

A review of the literature along with the insights which the researcher offered led to the emergence of a conceptual framework which makes a solid contribution to the body of literature in this regard. An illustration of the elements of 4IR, and how they can be used to accelerate the transition to attaining the SDGs from a theoretical point of view, served to answer research questions 1, 2 and 3, on mapping the resources, identifying the stakeholders, as well as optimizing 4IR in South African markets. The current paper has opened up possibilities for testing and validating the scope of the identified 4IR elements, in transitioning to the SDGs. The recommendation is that 4IR technologies be piloted and tested with the eight thematic areas, so that stakeholders' roles and potential threats can be managed with tailored programmes to counter resistance to change and influence perceptions. As a point of depature, the researchers propose that key thematic areas, such as sustainable energy, water, agriculture and transport, be optimised first. In order to accelerate the thematic area of sustainable energy, renewable and alternative energy can be implemented in facilitating access, minimising the use of candles and paraffin. The use of osmosis technology, waste-water treatment and technology can help grant communities access to clean water, by piloting programmes within the 'Sustainable water' thematic area. Digital or e-agricultural technology, urban farming, poultry farming and the integration of the mix of water, energy and food security, can be piloted in urban and rural areas. Through digitalisation, efficiencies can be leveraged to minimise nations' carbon footprint and ensure affordability, while minimising the number of cars on the road to form part of the pilot stage in the sustainable transport sector. If SDGs can appropriately be adopted within the South African econo0mic and social systems, ills such as poverty, diseases, water shortages, energy crieses etc. can be cubed to benefit the rest of Africa as well as other developing countries.

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