HOLISTIC HUMAN CAPITAL DEVELOPMENT: DRIVER OF SUSTAINABLE SUPPLY CHAIN MANAGEMENT IN AFRICA IN THE 4IR ERA

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ABSTRACT

The future of supply chain management (SCM) has dawned, with global supply chains evolving from traditional linear models to dynamic demand-driven systems. Digitalisation and the advanced technologies of the Fourth Industrial Revolution (4IR) are transforming SCM, which is a crucial specialisation area in industrial engineering, and in which industrial engineers play a significant role in meeting SCM human capital requirements. This discussion paper explores SCM's holistic human capital development in the 4IR and its potential for driving sustainable SCM in Africa. The study employed a qualitative research approach, using a literature review to examine SCM competency requirements and development, and proposes holistic approaches and strategies for developing SCM competency. In addition, it aims to provoke enquiry and discussion among academics, practitioners, and policymakers to reimagine SCM competency development. The paper could enhance industrial engineers' specialisation and contributions to SCM.

OPSOMMING

Die toekoms van voorsieningskettingbestuur (SCM) het aangebreek, met globale voorsieningskettings wat van tradisionele lineêre modelle tot dinamiese vraaggedrewe stelsels ontwikkel het. Digitalisering en die gevorderde tegnologieë van die Vierde Industriële Revolusie (4IR) is besig om SCM te transformeer, wat 'n deurslaggewende spesialisasiegebied in bedryfsingenieurswese is, en waarin bedryfsingenieurs 'n beduidende rol speel om aan SCM se menslike kapitaalvereistes te voldoen. Hierdie besprekingsdokument ondersoek SCM se holistiese mensekapitaalontwikkeling in die 4IR en sy potensiaal om volhoubare SCM in Afrika aan te dryf. Die studie het 'n kwalitatiewe navorsingsbenadering gebruik, met behulp van 'n literatuuroorsig om SCM-bevoegdheidsvereistes en -ontwikkeling te ondersoek, en stel holistiese benaderings en strategieë vir die ontwikkeling van SCM-bevoegdheid voor. Daarbenewens het dit ten doel om ondersoek en bespreking onder akademici, praktisyns en beleidmakers uit te lok om VKB-bevoegdheidsontwikkeling te herbedink. Die artikel kan bedryfsingenieurs se spesialisasie en bydraes tot SCM verbeter.

1. INTRODUCTION

Natural disruptions such as the recent COVID-19 pandemic have underscored the importance of the supply chain in the global movement and distribution of goods and services [1, 2]. According to Chalmeta and Santos-deLeón [3], supply chain sustainability is a critical concern in the Fourth Industrial Revolution (4IR). Furthermore, digitalisation and the 4IR's advanced technologies are transforming logistics and supply chain management [4]. Willems *et al.* [5] highlight the potential of cyber-physical systems to revolutionise how companies manage supply chains at various levels. Consequently, the future of supply chain management (SCM) is here, with global supply chains shifting from traditional linear models to dynamic, demand-driven supply chains.

Adopting the 4IR's advanced technologies would be essential for competitiveness and survival in the current volatile, uncertain, complex, and ambiguous (VUCA) environment. However, African countries are lagging behind in logistics and SCM transformation. The disruptive nature of the 4IR could exacerbate difficulties in achieving sustainable SCM in Africa. SCM is a crucial specialisation area in industrial engineering [6], and industrial engineers could play a significant role in meeting SCM human capital requirements and driving sustainable SCM in Africa.

The 4IR also transforms graduates' competency requirements and the competency-development system [7, 8]. This shift raises the need to align the development of these competencies. In addition, the 4IR demands new and diverse skills to meet SCM competency requirements, with digital skills being particularly important [2, 9]. These developments could disrupt human capital stocks in SCM, especially in African countries. Could the industrial engineering skills development landscape mitigate these problems?

Bag *et al.* [4] identified the enablers of a sustainable supply chain, emphasising the importance of human capital development. Beyond focusing on economic and environmental sustainability, institutions and companies should also prioritise social sustainability by investing in human capital development [4]. Therefore, institutions and companies could achieve true sustainability by integrating and balancing their social, environmental, and economic responsibilities [10, 11].

2. PURPOSE OF THE STUDY

This discussion paper explores holistic SCM human capital development in the 4IR and its potential for driving sustainable SCM in Africa. Four research questions guide the study:

a. What is the impact of human capital development on promoting sustainable SCM in Africa?

b. How is 4IR impacting global SCM?

c. What competency requirements are needed to respond to the current disruptions in SCM?

d. How could we achieve the holistic human capital development of SCM in Africa?

3. METHODOLOGY

The study employed a qualitative research approach through a comprehensive literature review [12] to explore and discuss SCM competency requirements and development. The author investigated competency requirements that address current disruptions in SCM. In addition, the paper reviewed sustainable SCM concepts, the impact of the Fourth Industrial Revolution (4IR) on global supply chains, and the nuances of SCM competency requirements. Based on the literature and self-reflection on personal practice, the author has proposed a holistic approach and strategies for developing SCM competencies. Although not exhaustive, these proposed strategies could facilitate the comprehensive development of relevant competencies – knowledge, skills, and personal attitudes and behaviours – that are necessary for achieving sustainable SCM in Africa.

4. LITERATURE INSIGHTS

4.1. SCM sustainability

Chalmeta and Santos-deLeón [3] point out that integrating sustainability principles in SCM is made difficult by the need to balance the multidimensional aspects of social, environmental, and economic sustainability.

Achieving a truly sustainable supply chain involves upholding "economic viability while doing no harm to social or environmental systems" [13].

Bag *et al*. [4] note that there is limited research on the social aspects of supply chain sustainability. They also suggest that Industry 4.0 technologies could propel supply chain sustainability. However, companies adopting these technologies face the significant challenge of developing a "coherent strategy for managing total supply chain sustainability" [4]. To move towards sustainable supply chains, companies must drive the social, environmental, and economic aspects of sustainability. Skills development and enhancement significantly contribute to the social dimension of supply chain sustainability. Chalmeta and Santos-deLeón [3] support this idea, noting that training and generating new skills in the workforce are organisational elements that drive sustainable SCM.

Many African countries lack relevant SCM skills despite having a youthful population and high unemployment rates [14]. Adopting incompatible advanced technologies in these countries could negatively affect supply chain operations [4], worsening the skills challenge and hindering supply chain sustainability. Therefore, adopting advanced supply chain and logistics technologies must consider the contextual environment. The problems faced by African countries and by developed countries differ, and require different solutions. For example, developed countries have aging populations, and thus adopt advanced robotics and automation [14-16]. In contrast, African countries need advanced competency development strategies to ensure that their youthful population acquires the relevant competencies in diverse disciplines, such as SCM [14].

Social sustainability, an element of sustainable SCM, could be enhanced by securing and creating jobs [4]. Among the challenges that African countries face, the potential impact of Industry 4.0 disruptions on employment and human capital cannot be overlooked [4]. To ensure that adopting Industry 4.0 technologies would promote supply chain sustainability, the focus should be on innovating technologies that augment worker efficiency and effectiveness. Organisations should invest in reskilling and upskilling their workforce to ensure that they possess the right competencies [4].

Dubey and Gunasekaran [17] highlight a significant problem: the lack of sustainable supply chain talent in companies. The competencies required to manage a sustainable supply chain differ significantly from those needed for traditional supply chains. Training and developing a workforce with the relevant knowledge, skills, and abilities and behaviours would be essential to respond to the challenges of achieving sustainable supply chain networks [17].

One approach that African countries could use to achieve sustainable supply chains would be to ensure sufficient human capital. This aligns with the United Nations Sustainable Development Goal (SDG) number four, which promotes the development of relevant skills in technical, vocational, and tertiary education [18]. Furthermore, ISO26000 clause 6.4.7 provides guidelines on how human development and training could drive social sustainability.

To support local innovations into commercial products, collaboration between stakeholders such as research institutes, universities, and industry could facilitate "skills development, human resource training, and transfer" [4]. Knowledge and skills transfers to upstream and downstream partners at different tiers could minimise the risks of human capital shortages in SCM [4]. People with relevant skills in an organisation could transfer their skills to suppliers and customers at different tiers within their reach.

4.2. The Fourth Industrial Revolution's impact on global supply chains

The digital transformation era is changing industries and their business models, and having an impact on supply chains [19]. Consequently, this transformation affects how supply chains are managed. The 4IR compels organisations to consider not only developments and trends in their sector but also possible changes and disruptions in global suppliers and customers [20]. In addition, the 4IR is transforming customer demand, manufacturing processes, and the management of global supply chains [20], driven significantly by unpredictable customer behaviours and expectations.

It is noted that advanced technology deployment might shift investments back into developed economies [11]. As a result, international labour cost differences may no longer significantly influence production location decisions [20]. This shift could reduce opportunities for developing countries to offer "low-cost labour, an established pathway for development" [11, 21]. Consequently, African countries might become

more consumer-oriented rather than producer-oriented, requiring robust and resilient supply chains to ensure the uninterrupted supply of goods and service.

In the 4IR, digital supply chains are at the core of digital enterprises, and have various applications such as these [20]:

- integrated planning and execution,
- logistics visibility,
- smart warehousing, and
- prescriptive supply chain analytics.

The 4IR is transforming companies' supply chain models and how they deliver value to customers [22]. Smart supply chains, a key dimension of the 4IR [23, 24], complement and, to some extent, replace traditional supply chain approaches [22]. Supply chain innovation in the 4IR encompasses optimised productivity, scalability, and flexibility [22]. Adopting digital SCM would be essential for organisational survival and competitiveness in the 4IR. However, digital transformation in supply chain and logistics requires expertise in "orchestrating complex supply and manufacturing networks" [20].

Operating in the 4IR would require a shift from traditional supply chains to digital supply networks [24]. This transition could help organisations to make better-informed decisions on supply chain activities and improve supply chain resilience. Achieving these benefits would require developing and enhancing the relevant competencies [24].

Horváth and Szabó [15] state that digitalisation extends beyond product and process improvement to encompass business and supply chain processes. Describing Industry 4.0, a German initiative driving the 4IR, [15] highlight that it involves the digitalisation of the entire supply chain, enabling real-time data exchange among actors, objects, and systems. Thus organisations aiming to compete globally must align themselves to be compatible with the globally connected network.

The principles of the 4IR aim to achieve fully integrated supply chains that are transparent to all downstream and upstream partners [25]. Horizontal and vertical process integration would enable real-time interactions among partners regarding "operations, inbound/outbound logistics, market needs, and product-customer interaction" [25]. Future supply chains would be characterised by data and digital interconnection [20]. A failure to transform could prevent organisations from improving their overall supply chain performance, including "higher service levels, lower procurement costs, shorter cycle times, smaller inventories, reduction in forecasting errors, and quicker interactions across the value chain" [25].

Advanced 4IR technologies could be leveraged to enhance companies' internal supply chain operations [22]. Organisations that failed to adopt these technologies would risk falling out of the network of partners, potentially losing business and other opportunities such as providing bundled customer-specific offerings.

Digital transformation blurs the lines between manufacturing, retail, and logistics [20], leading to new supply chain models and competency demands. To achieve successful digital transformation and sustainable SCM, organisations must address the changing competency requirements. This would involve a structured approach to determining competencies, developing targeted IT skills, and fostering a "fast failure culture" to accelerate innovation cycles [20].

The 4IR's impact on supply chain ecosystems and models extends to changing knowledge, skills, and abilities requirements in logistics and SCM. The shift in competency requirements exacerbates the shortage of skilled personnel in logistics and SCM. This competency gap could threaten organisational performance in the global market [20], thus hindering sustainable SCM. Therefore, stakeholders must prioritise human capital development and view employee competencies as a competitive advantage.

5. HOLISTIC APPROACH TO SCM HUMAN CAPITAL

One opinion in this discussion paper is that the terms 'skills' and 'competency' are often incorrectly applied in day-to-day life and in SCM practice. This misapplication could lead to an imbalance in developing relevant SCM competencies. The literature defines 'competency' as encompassing knowledge, skills, attitudes, and behaviours that enable an individual to perform a specific task successfully [11]. Definitions of competency in the literature include these:

- Competency could be regarded as [a] cluster of knowledge, skills, attitudes, and behaviours any individual must possess to perform a certain task successfully [26].
- Competency – knowledge, skills, mindsets, thought patterns, and the like – that when used whether singularly or in various combinations, result in successful performance [27].
- Competency is […] more than the mere attainment of skills as it also involves other qualities such as attitudes, motives, personal insightfulness, interpretive ability, receptivity, maturity, and self-assessment [28].

The development of SCM human capital should consider a holistic approach, producing individuals with the proper knowledge, skills, attitudes, and behaviours. The focus should be on finding the right mix of strategies and pedagogies that comprehensively develop individuals with the relevant competencies. Figure 1 presents a possible holistic view of SCM that could lead to sustainable human capital development. The competency development should emphasise not only theoretical knowledge but also practical experience and the development of appropriate personal attitudes. Consequently, this holistic approach could improve individuals' preparedness and readiness to address SCM problems effectively.

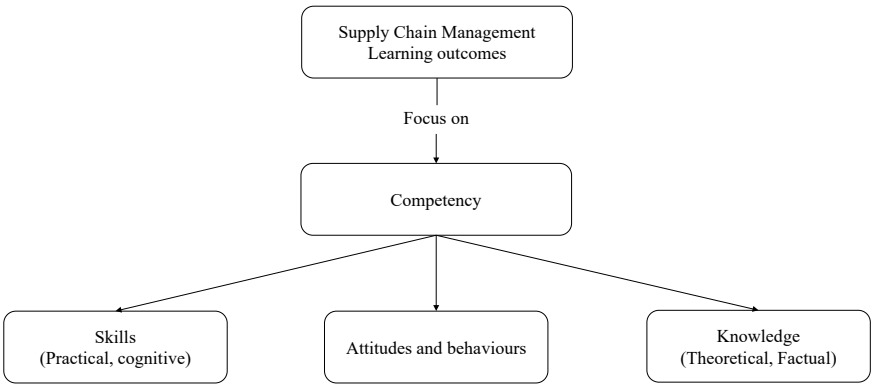

Figure 1: Holistic view of SCM human capital competency

5.1. SCM competency requirements

Adopting 4IR technologies and principles in logistics and SCM would demand a rethink of the relevant competencies that are required to drive successful and sustainable businesses. The emphasis should not be on skills alone but on the complete competencies needed for individuals to add value to their respective organisations. Thus, in addition to SCM knowledge, individuals require functional and generic skills, along with the right attitudes and behaviours.

Figure 2 presents the three organisational capability improvement areas: people, processes, and technology. These are the three pillars of successful SCM [29]. Curtis *et al*. [30] support this, pointing out that processes, technology, and people are essential aspects on which organisations could focus to improve their capabilities. However, while a significant focus has been put on processes and technology, not as much attention has been given to people. For sustainable SCM, there must be a shift towards the human aspect by identifying and developing the relevant competencies.

Table 1 provides a synopsis of the critical competencies that individuals should have in order to succeed in SCM in the 4IR. Although the competencies presented here are not exhaustive, a distinction between knowledge, skills, attitudes, and behaviours is emphasised, which could contribute to a mindset change in the development of SCM human capital.

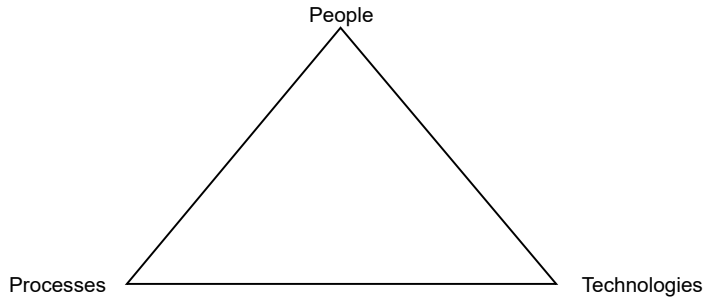

Figure 2: Organisational capabilities improvement focus areas [11, 30]

Table 1: SCM competency requirements

Competency category		Specific competencies	References
Knowledge requirements		SCM strategy, supply chain resilience, demand management; inventory management; operations management; supplier management; sales and operations planning; purchasing; project management; warehousing; risk management.	[29, 31-33]
Skills requirements	Functional/technical skills	Ability to perform inventory management; ability to conduct supply chain costing; ability to perform facilities location; master production scheduling, demand forecasting, distribution requirement planning, quality management, risk management, orchestrating complex supply and manufacturing networks.	[2, 20, 29, 31, 33, 34]
	Digital and analytical skills	Cyber security and cyber-risk management; predictive analytics; data analytics; use inventory and network optimisation tools; ability to work with advanced technologies such as Internet of Things, autonomous robots, 3D printing, and artificial intelligence (AI); information technology skills; quantitative modelling skills; ability to use spreadsheet/MS Excel and statistical tools; ERP integration.	[2, 8, 20, 29, 31, 33]
	Non-technical skills	Negotiating skills; cross-functional coordination ability; conflict management; customer awareness; knowledge of cultural differences; effective communication; teamwork/team orientation; problem-solving; critical thinking; innovation; leaderships skills; systems-thinking skills.	[8, 17, 29, 31, 33-36]
Personal attitudes and behaviours		Habit of continuous and lifetime learning and self-development; ability to prioritise; comfort with change; ability to comprehend big picture; sensitivity to the constantly changing environment; ability to logically organise thought; personal integrity.	[8, 17, 31, 33, 34]

A study by Wagner *et al*. [29] pointed out that non-technical skills are crucial in SCM. One of the difficulties faced by today's educational institutions is their failure to train students to acquire competencies that prepare them holistically for the world of work. Furthermore, there is a failure to develop non-technical skills such as collaboration and personal attributes [34]. Competency development strategies should focus on imparting knowledge, skills, and personal attitudes and behaviours that prepare students to work in volatile, uncertain, complex, and ambiguous environments.

5.2. SCM competency development

Amaeshi *et al*. [37] emphasise the correlation between human capital availability in respect of education and skills on the one hand and countries' economic competitiveness on the other. Furthermore, using the human capital theory, it has been determined that successful organisations invest well in human capital development [37]. Investment in SCM education and skills development contributes significantly to economic growth and social well-being.

A comprehensive approach to developing SCM competency could be achieved using the proposed skill development ecosystem that is presented in Figure 3. Considering the diverse economic backgrounds and preferences in African countries, there must be various channels and opportunities to impart SCM competencies. University degrees should not dominate as the sole relevant qualification; instead, competency development should promote alternatives to attract all individuals who are interested in the profession. A combination of university degrees, diplomas, post-graduate diplomas, professional courses and certifications, MOOCs, short learning programmes, and integrated modules in other degree programmes could reach a wider audience. Amaeshi *et al*. [37] propose a collaborative approach that "binds international investors, public, private, and non-governmental organisations (NGOs) sectors as sponsors and co-producers of human capital" to achieve sustainable skills development in Africa.

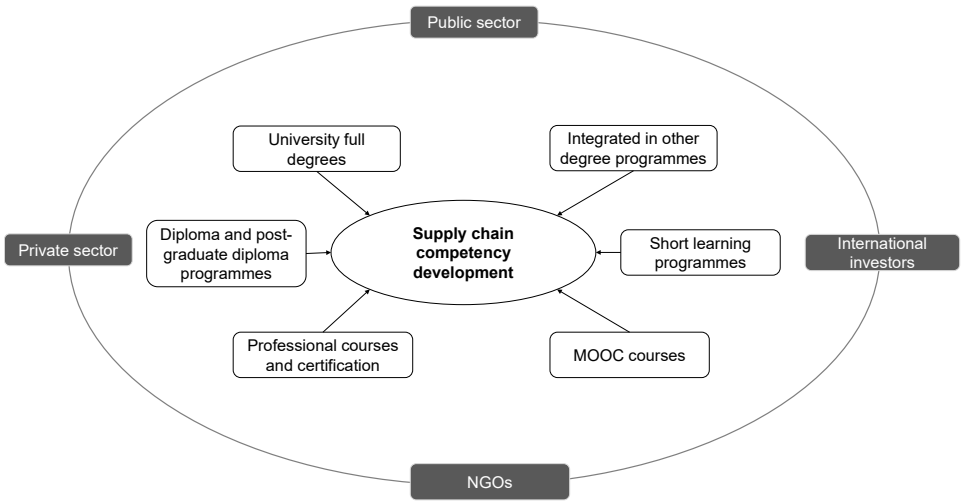

Figure 3: Holistic approach to SCM competency development

Chuang [32] confirms that SCM involves diverse concepts, including forecasting, inventory management, logistics and distribution, vertical and horizontal integration, and global issues. The nature of the content makes SCM a complex subject, and complicates competency development. Sparling [38] points out that teaching SCM faces the challenge of helping students to understand complex and ambiguous scenarios that are encountered in real life. Learning strategies that foster learning by doing are important in ensuring the development of relevant SCM competencies. Traditional approaches to SCM competency development, such as lectures, case studies, and projects [39], could be insufficient for developing the competencies that are required in the real world of work.

Dubey and Gunasekaran [17] have presented a sustainable talent development framework for SCM, including managerial coaching, executive coaching, theoretical inputs, case analysis, and live projects. However, the framework does not consider the aspects that cater to competency development at the entry level. On the other hand, Foroughi [2] states that competency-based and social-based learning could contribute significantly to SCM competency.

One strategy that could lead to the comprehensive development of SCM competencies is experiential learning. Experiential learning provides active learning environments that allow students to understand technical content in depth and to develop functional and non-technical skills through personal experience [40]. According to George Brown College [41], experiential learning could occur in educational, workplace, and practice environments. Therefore, the competency development approaches presented in Figure 3 could apply experiential learning universally.

Figure 4 presents the proposed competency development strategies that could help students to develop relevant SCM competencies.

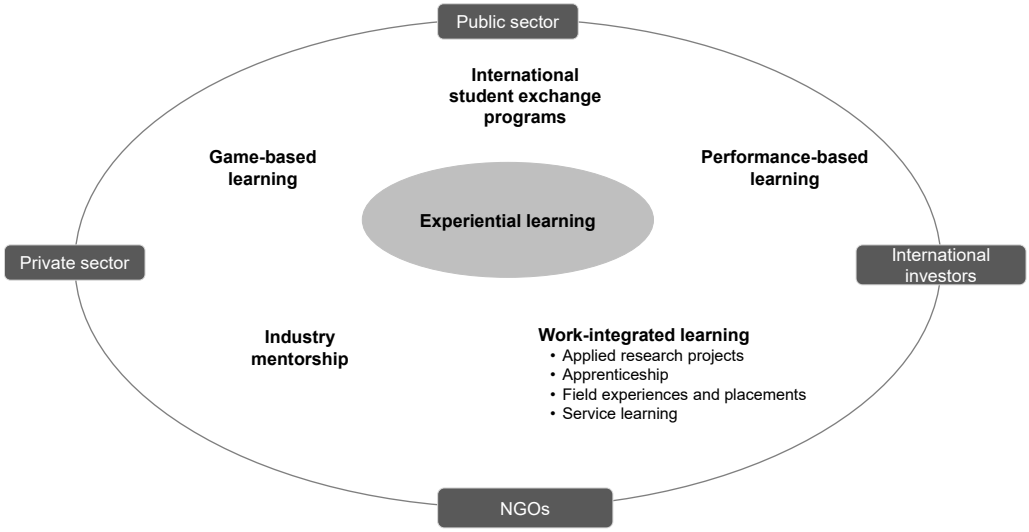

Figure 4: SCM competency development strategies (adapted from George Brown College [41])

A collaborative approach involving international investors, public and private sectors, and NGOs as sponsors and co-producers of human capital could drive authentic experiential learning in institutions offering SCM courses [37].

6. DISCUSSION

Behind effective, efficient, and sustainable supply chains are people. Therefore, human capital development plays a crucial role in driving sustainable SCM in Africa. While technological advancements contribute significantly to functional supply chains, it is essential to balance the improvement of three organisational capabilities: people, processes, and technology. African countries face structural inequalities, low educational levels, and high unemployment rates, which have a negative impact on social sustainability goals. Emphasising human capital development contributes directly to social sustainability, thus helping to achieve sustainable supply chains and advance the sustainability agenda.

This paper argues that competency involves knowledge, skills, and personal attitudes and behaviours. A holistic approach to competency development should address all these dimensions. Oyedijo *et al.* [42] highlight that behavioural issues and a lack of accountability in SCM personnel significantly contribute to SCM problems in Nigeria, suggesting imbalances in human capital development. SCM professionals with the relevant knowledge, skills, and personal attitudes and behaviours could enhance supply chain processes and integrate technology effectively. Emphasising authentic learning environments that develop these competencies holistically would be crucial. Thus this approach could propel sustainable SCM in Africa.

The complex nature of SCM and our volatile, uncertain, complex, and ambiguous world demand a significant change in competency development. African countries must move beyond traditional approaches to develop sufficient SCM human capital to drive sustainability. Authentic experiential learning could foster relevant supply chain competencies. However, strategies such as work-integrated learning face difficulties such as limited company access, especially in developing countries, which has been exacerbated by the COVID-19 pandemic [43]. Therefore, alternatives such as game-based learning [44] could be used. Maisiri and Hattingh [45] highlight that integrating business simulation games strengthens graduates' development in both technical and non-technical skills. Game-based learning helps students to understand technical content in depth and to acquire skills such as complex problem-solving, teamwork, communication, and strategic vision. Thus educational institutions should foster creativity using various strategies to develop SCM human capital.

The discipline-specific training guides for registration as professional engineering technicians, technologists, and professional engineers in industrial engineering [6, 46, 47] highlight SCM as a specialisation area, underscoring the significant role of the industrial engineering profession in addressing human capital challenges in SCM. This suggests the significant role of the industrial engineering profession in addressing difficulties with human capital in SCM. Balancing the training of technicians, technologists, and engineers in the industrial engineering profession ensures a comprehensive approach to meeting SCM human capital requirements at various levels. The author believes that the SCM concepts in industrial engineering curricula differ from those in business courses and contribute significantly to sustainable SCM. The technical and analytical focus, integration of operations research, process improvement, systems engineering, and use of technical tools and software make industrial engineering's contribution to SCM human capital substantial. Therefore, besides offering SCM modules in industrial engineering degree and diploma programmes, industrial engineering could also offer specialised SCM degree and diploma programmes, short learning programmes, and professional courses and certifications.

The development of SCM competencies in Africa requires significant collaboration among international investors, the public and private sectors, and NGOs as sponsors and co-producers of human capital. For instance, to achieve work-integrated learning, the private and public sectors could provide opportunities for apprenticeships, service learning, field experiments, and placements. In addition, international investors could support initiatives that drive authentic experiential learning. Both developed and developing countries could benefit from SCM human capital development in Africa. Developed countries, by supporting such human capital development, could address the problems related to an aging skills population through potential skills migration from Africa's youthful workforce.

7. CONCLUSION

The success of policies, frameworks, and technology hinges on people. Developing robust SCM human capital in Africa is crucial for sustainable SCM. This paper has emphasised the impact of human capital development on promoting sustainable supply chains in Africa, and addressed the influence of the 4IR on global SCM. It has also outlined the competency requirements that would address current disruptions in SCM, and proposed holistic approaches and strategies for competency development. The paper has encouraged enquiry and discussion among industrial engineers, academics, practitioners, and policymakers to reimagine SCM competency development in the 4IR era and beyond. It has also suggested directions for broader empirical investigations that are aimed at promoting and achieving adequate human capital requirements to drive sustainable SCM in Africa.

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