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Applying SWOT Analysis to Examine Quality 5.0 Adoption in the South African Manufacturing Sector

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Abstract

Quality 5.0 refers to the transition from technology-driven quality management systems to human-machine collaborative value creation, with an emphasis on environmental sustainability, ethical AI use, and employee well-being. Despite the increased interest in this concept, this research found no analysis specifically focused on South Africa's positioning or potential for transition to Quality 5.0. Because of differences in infrastructure, economics, technology, and policy, nations with developed economies may be able to transform more easily than developing/underdeveloped countries. This study addresses this gap in the literature by conducting a SWOT analysis of Quality 5.0 implementation in South Africa. The Delphi approach is used in the study to achieve this. The study revealed three critical strengths: an existing proactive quality culture, alignment with socio-ethical principles, and leadership commitment. The analysis then identified the country's primary shortcomings as energy and infrastructural vulnerabilities, employee and societal resistance, and economic instability. The study discovered that the main benefits of adopting Quality 5.0 were sustainable product development, sustainable growth, meeting societal demands, and improving product quality, while the main threats were political instability, cybersecurity risks, and a lack of standardization. This study provides critical insights for businesses attempting to implement Quality 5.0 in identifying their strengths and limitations on their path to embracing the advantages of Quality 5.0 initiatives. This study supports the United Nations' Sustainable Development Goals.

Keywords

Quality 5.0, Sustainable manufacturing, South Africa manufacturing, SWOT analysis

1. Introduction

Quality 5.0 is recommended as the next step beyond Quality 4.0, combining technological advancements from the 4th Industrial revolution with a human-centred, sustainable, and resilient quality management approach (Arsovski, 2019; Arıcı and Kitapci, 2021; Frick and Grudowski, 2023). The main focus of Quality 4.0 was bringing quality into the digital age by automating and digitalizing quality processes using technologies such as the Internet of Things (IoT), Cyber-Physical Systems (CPS), and Artificial Intelligence (AI) (Rowlands and Milligan, 2020; Sisodia and Forero, 2020), whereas for Quality 5.0, leveraging Quality-enabling digital technologies extends from stationary to social, and addresses societal needs, environmental sustainability, and inclusive growth, all which are traits of Industry 5.0 (Adel, 2022). According to the European Commission and recent research worldwide, Industry 5.0 is the shift from technology-driven manufacturing to human-machine collaborative value generation, with a focus on environmental sustainability, ethical AI use, and employee well-being (Leng *et al.*, 2022; Keenavinna and Wickramarachchi, 2024; Kovari, 2024; Narkhede *et al.*, 2024). Therefore, Quality 5.0 represents a focus on organizational rather than operational excellence in pursuit of social responsibility, sustainability, and human dignity. Quality in this new era

encompasses more than just performance and conformance; it also involves purpose and the impact on the planet (Arsovski, 2019; Arıcı and Kitapci, 2021; Fiałkowska-Filipek and Dobrowolska, 2024).

The ideas behind Quality 5.0 are in line with President Cyril Ramaphosa's recent call to use technology to address the "triple challenge" of poverty, inequality, and unemployment by 2030 (Mhlongo and Nyembwe, 2024). This national ambition is in line with Industry 5.0's vision of a people-centred, digital, literate, and healing economy. By fostering a culture of quality that encourages digitization in ways that benefit society, Quality 5.0, when strategically implemented, has the potential to support South Africa's national development goals.
Research regarding developing a Quality 5.0 transition model for organizations in developing economies, especially in African manufacturing contexts, is still scarce despite growing interest on a global scale. There hasn't been a Strength Weaknesses Opportunities and Threats (SWOT) analysis specifically done to look at South Africa's positioning or potential for this transition. The majority of previous research overlooks social or long-term quality considerations only putting emphasis on digital maturity or technology readiness. To close the gap and support strategic transition strategies, this article conducts a context-sensitive SWOT analysis of Quality 5.0 in the South African manufacturing environment.

The study aims to emphasize how the opportunities and strengths of Quality 5.0 outweigh the threats and weaknesses. The analysis is intended to act as a guide for businesses as they move from traditional quality management systems to Quality 5.0, which will enhance performance while also boosting social value, minimizing environmental harm, and getting ready for future global market competition. This study adds value by giving South African manufacturing organizations a context-specific perspective to evaluate their Quality 5.0 positioning, drawing inspiration from the work of and Maisiri et al. (2019), Maganga and Taifa (2022) and Mhlongo and Nyembwe (2024). The results of this study are firmly grounded in South African development, with global implications.

1.1 Objectives
The main objective of this study is as follows:

- To conduct a SWOT analysis of Quality 5.0 adoption in South Africa

2. Theoretical Background
2.1 Evolution from Quality 4.0 to Quality 5.0
Quality 4.0 is defined as a digitalized version of traditional quality management systems which uses industry 4.0 technologies like IoT, AI, cloud computing, big data, and CPS to help identify errors and reduce manufacturing waste. This modification introduced real-time data processing, automated quality assurance, and predictive analytics. Quality 4.0 enhanced traceability, process adaptability, and client satisfaction, according to studies by Sony et al. (2020), Dias et al. (Dias, Carvalho and Sampaio, 2021), and Mhlongo and Nyembwe (2023b). However, new research indicates that although Quality 4.0 increased operational efficiency, it was insufficiently ethical, sustainable, or human-centred, all of which are crucial in light of the current global social, economic, and climate issues (Fiałkowska-Filipek and Dobrowolska, 2024; Maljugić *et al.*, 2024). This deficit inspired Quality 5.0, a concept based on Industry 5.0 fundamentals that prioritizes not just technology growth but also social value, the well-being ecosystem, and human-machine collaboration (Arıcı and Kitapci, 2021; Fiałkowska-Filipek and Dobrowolska, 2024; Maljugić *et al.*, 2024).

2.2 Defining Quality 5.0
Digital quality is combined with systemic resilience, planetary sustainability (system), and human safety/connectivity in Quality 5.0 (Arıcı and Kitapci, 2021; Maljugić *et al.*, 2024). This quality regimen acknowledges the significance of creating excellent systems that are not only effective but also socially and environmentally responsible, inclusive, and regenerative. Arsovski (2019) found that adopting Quality 5.0 won't only improve the quality of the products and streamline processes but will ensure sustainable products which are not profitable but also environmentally responsible. According to Fiałkowska-Filipek and Dobrowolska (Fiałkowska-Filipek and Dobrowolska, 2024), Quality 5.0 puts people back at the centre of quality systems, which use intelligent automation to supplement intuition rather than totally replace it. It aligns with the SDG framework of the UN, which includes social welfare and environmental impact in quality performance metrics. Human-centricity, resilience, and sustainability are among the industry 5.0 principles that are applied to Quality 5.0 by the European Commission in 2021 (Ghobakhloo *et al.*, 2023; Narkhede *et al.*, 2024). These are gaining traction in the industrialized world and becoming relevant in underdeveloped countries such as Africa, where social inequality and climatic vulnerability coexist with industrial prosperity (Müller and Van Dyk, 2024; Mhlongo and Nyembwe, 2024).

2.3 Global Adoption Patterns and Trends

Global manufacturing economies are embracing Industry 5.0 and Quality 5.0 models in response to growing demands for workforce empowerment (Leng *et al.*, 2022), circular economy implementation (Revolutionized, 2024), and ethical sourcing (Hickey, 2023). To aid in the transition, organizations have begun making investments in reskilling, AI-enhanced production systems, and green innovation. Research and development toward inclusive, regenerative manufacturing ecosystems is encouraged by the European Union's Industry 5.0 framework (Narkhede *et al.*, 2024). There is a lack of empirical research on the application of Quality 5.0, despite its growing interest. The majority of the work is conceptual in nature or is set in developed nations (Arsovski, 2019; Narkhede *et al.*, 2024). Adoption of Quality 5.0 in developing economies may differ due to economic, institutional, infrastructural, and educational factors hindering its success.

2.4 South African Context

Through presidential commissions and national initiatives, South Africa has shown interest in the Fourth Industrial Revolution; however, the country's manufacturing sector is having challenges adjusting to digital transformation (Shivdasani, 2019; Maharaj, 2023). Even Quality 4.0 cannot be fully realized due to legacy systems, unreliable energy sources, a lack of digital maturity, and talent shortages. Other adoption hurdles identified in literature include systemic flaws like a lack of interoperability, financial gaps, and resistance to organizational change (Mhlongo and Nyembwe, 2023a; Mhlongo and Nyembwe, 2024). Nonetheless, South Africa offers an opportunity to apply Quality 5.0. The African Continental Free Trade Area, localization policies, ESG-focused investors, and high youth unemployment all present opportunities for quality transformation driven by purpose (Shivdasani, 2019; National Treasury, 2021). Green finance schemes and national digital skills development programs may help to make the Quality 5.0 model more competitive and accessible (National Treasury, 2021).

2.5 SWOT Analysis

SWOT analysis, a popular strategic planning tool in fields like business, engineering, policymaking, healthcare, and education stands for Strengths, Weaknesses, Opportunities, and Threats (Pereira *et al.*, 2021; Puyt, Lie and Wilderom, 2023). SWOT analysis, which was first credited to Albert Humphrey in the 1960s while working on a project at the Stanford Research Institute, offers a methodical way to assess both internal and external factors that can impact a strategy or project's feasibility and success (Benzaghta *et al.*, 2021; Puyt, Lie and Wilderom, 2023). A SWOT analysis is often preferred due to its ease of use, flexibility, and available to everyone. It is often used as a first step in diagnosis and encourages people to think about their own actions and get involved (Phadermrod, Crowder and Wills, 2019; Mashuri and Nurjannah, 2020; Pereira *et al.*, 2021). Its flexibility allows it to be used alone or integrated with other tools.

SWOT analysis is typically used in the strategic management process to help organizations identify:

- Internal factors: Strengths (S) and Weaknesses (W), often related to resources, competencies, and operations.
- External factors: Opportunities (O) and Threats (T), usually derived from environmental scanning, including market trends, regulatory changes, and socio-economic shifts.

3. Methods

In this research, the Delphi technique is adopted to identify strengths, weaknesses, opportunities and threats associated with Quality 5.0 adoption in South Africa. According to Habibi et al (Habibi, Sarafrazi and Izadyar, 2014), the Delphi methodology is a decision-making process that allows independent experts to work together without necessarily physically meeting. The Delphi method's primary goal is to collect expert opinions, not to decide which response is right or wrong (Habibi, Sarafrazi and Izadyar, 2014; Makhanya *et al.*, 2021). This approach is crucial for the growth and development of research fields, particularly emerging fields like Quality 5.0. Quality 5.0 is characterized by the integration of extensive digitalization with sustainability, resilience, and human-centred innovation styles.

The Delphi technique is an appropriate method for investigating expert opinions and capturing consensus in a systematic and iterative manner (Makhanya et al., 2021; Mhlongo and Nyembwe, 2024). The study followed the process stipulated in Figure 1. This research was conducted using an iterative approach in multiple stages. The first step in preparing for the Delphi iteration rounds was to select experts and obtain their consent to participate in the study. Then, they were briefed on the topic and ensured they had the necessary knowledge to contribute to the study. Finally, a brainstorming session was held to uncover essential concepts about Quality 5.0 drivers, inhibitors, and

transformations. This feedback from the panel was used in the subsequent survey rounds, in which participants were asked to rank and update their opinions on a Likert scale on Microsoft Forms. Following each round, feedback and statistical updates were generated to encourage convergence of opinions. Every participant as shown in Table 1, gave their informed consent, guaranteeing that they were aware of their liberty to withdraw from the study at any time.

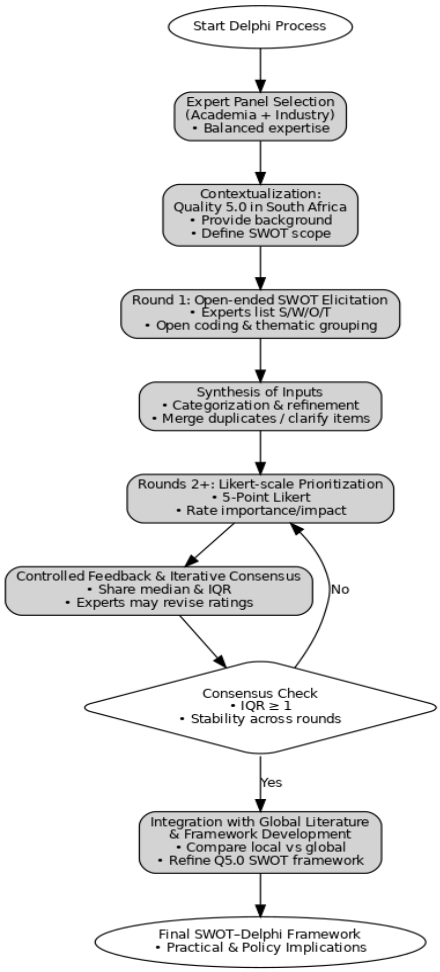

Figure 1. Research Process

3.1 Panel Formation

To provide a high-quality combination of opinions, experts were carefully chosen based on their expertise and relevance to the subject at hand. Participants were required to meet the following inclusion criteria:

a. Currently working in the South African manufacturing sector.
b. Understand quality management and/or sustainability methods.
c. Be knowledgeable about digital transformation, Industry 4.0/5.0 technologies, and quality frameworks.
d. Participate in quality and operational improvement programs.
e. Be prepared for participation in each Delphi round.

The technique sought for a panel size that represented a diverse spectrum of practitioners, engineers, managers, and academics in the discussion of technical and socioeconomic aspects of Quality 5.0 adoption.

3.2 Data collection and analysis

Multiple sources of data were used, and data analysis was guided by three main themes. Delphi round one was guided by open-ended questions including strategies with which to identify perceived determinants of strengths, weaknesses, opportunities and threats at the local level for participating stakeholders to address weaknesses and threats to ensure successful Quality 5.0 adoption. These open-ended answers were thematically combined in the quantitative survey tools of the Delphi rounds. As of round one, responses were scaled from 1-5 on a Likert-type scale (1 = very low

impact; 5 = extremely high impact). Candidate items for which there was consensus (defined as having an IQR ≤ 1) were eliminated for further rounds. Polished statements were submitted once more, along with generalized group responses, to receive the participants' further consideration. Consensus was monitored over three rounds of the Delphi, as suggested by Makhanya et al. (Makhanya *et al.*, 2021), balancing methodological rigor and participant fatigue. Participation and consensus development is summarized in Table 1 below.

Table 1. Delphi consensus process

Criteria	Brainstorming Round	Delphi Round 1	Delphi Round 2	Delphi Round 3
Invitations	12	12	10	10
Responses	12	10	10	8
Items at consensus (IQR ≤ 1)	N/A	17	8	3

When using the Delphi technique, statistical methods come after the initial step of thematic analysis of qualitative data (Ramos, Arezes and Afonso, 2016; Makhanya *et al.*, 2021). The fourth and fifth steps, respectively, are data processing and panel comment interpretation. The median and the interquartile range, two descriptive statistics from the current study, were used to assess the panel members' comments. According to Ramos et al. (Ramos, Arezes and Afonso, 2016), the interquartile range (IQR) is robust and can withstand outliers, so this study used it to measure the panellists' level of agreement. The IQR seeks to explain the distribution of the middle 50% of the data set while taking the data set's range into account (Makhanya *et al.*, 2021; Mhlongo and Nyembwe, 2024). Equation (3) is used to calculate the IQR.

Equations Used:

$$Q1 = \left(\frac{(N+1)}{4}\right)^{th} \quad \text{Equation 1}$$

$$Q2 = \left(3\frac{(N+1)}{4}\right)^{th} \quad \text{Equation 2}$$

$$IQR = Q3 - Q1 \quad \text{Equation 3}$$

$$Median = \left(\frac{(N+1)}{2}\right)^{th} \quad \text{Equation 4}$$

Where N = number of items

An IQR less than or equal to 1 indicates that nearly all the experts gave the same rating. Expert responses are closely clustered around the median when the IQR is greater than 1. A high degree of agreement or consensus among the experts is suggested by the lack of variation in the opinions in this instance. On the other hand, responses with a high IQR are more dispersed. This suggests that the experts have a wider range of viewpoints, which could mean that there is less agreement on the subject. The panellists' agreement with one another, rather than with the item itself, is indicated by an IQR of less than one. Significant levels of relevance are indicated by a high median, while lower levels of significance are indicated by a low median. The degree of relevance or impact for each question or item was measured using the median, which was determined using Equation 4.

These actions allowed the researchers to form a balanced perspective on expert agreement and the importance of factors supporting, culminating from or impeding the adoption of Quality 5.0. In the end, the results of the Delphi process were validated by comparison with international research of Quality 5.0, Industry 5.0, and smart manufacturing transitions. This sheds light on where South Africa meets the global and where it diverges, allowing for a more complex reading of local readiness and strategic planning.

4. Results and Discussion

The Delphi study produced strong consensus on a number of internal strengths, weaknesses, opportunities, and threats influencing the adoption of Quality 5.0 in South Africa.

4.1. Strengths Items

The brainstorming session with the experts found seven (7) factors that symbolize the internal strengths as organizations embark on the journey of adopting Quality 5.0 initiatives in South Africa, as it can be observed in Table 2 and Figure 2.

Table 2 presents the consensus-based items, the IQR, the median and the items that reached the consensus, while Figure 2 presents the visual distribution of opinions per item on possible strengths that the organizations in the country possess internally to ensure adopting Quality 5.0 yields positive results.

Table 2. Delphi Strength Items

#	Strength Items	Median	IQR	Consensus
S1	Workplace Safety	3	0,5	Yes
S2	Flexible and self-learning processes	3,5	0,5	Yes
S3	Proactive Quality Culture	4.5	0	Yes
S4	Socio-Ethical Practices (Ubuntu, "Batho Pele", Active Equality and Equity Acts)	5	1	Yes
S5	Environmental Consciousness	4	1	Yes
S6	Leadership Commitment	4.5	0	Yes
S7	Active Collaborations	3,5	0,5	Yes

Experts rated proactive quality culture (S3), socio-ethical practices (S4), and leadership commitment (S6) as the most decisive strengths (Median ≥ 4.5; IQR ≤ 1). This reflects the institutional embedding of quality management in South African industry. Many firms, particularly in manufacturing, have relied on ISO standards, Lean Six Sigma, and TQM for decades to maintain quality and improved processes as noted by Mhlongo and Nyembwe (2024). Experts recognized that this ingrained culture of structured improvement provides fertile ground for Quality 5.0's integration, making adoption less disruptive than in contexts with weaker quality traditions.

The high consensus around socio-ethical practices reflects both cultural and institutional realities. Values such as *Ubuntu* ("humanity toward others") and *Batho Pele* ("people first") are not only social norms but also codified in legislation and corporate governance frameworks.

These framework of Ubuntu as noted by (Müller and Van Dyk, 2024), emphasizes interconnectedness, compassion, and collective well-being which directly resonates with Quality 5.0's human-centricity and emphasis on social responsibility (Arsovski, 2019; Arıcı and Kitapci, 2021; Frick and Grudowski, 2023). Similarly, the Batho Pele ("People First") principles, rooted in service delivery, reflect a national ethos of prioritizing human dignity, wellness, and inclusivity in organizational practices (Joel, 2022; Mojapelo, Modiba and Saurombe, 2023). These values underpin employee engagement, participative leadership, and well-being which are all central to Industry 5.0 and Quality 5.0 paradigms (Arsovski, 2019; Arıcı and Kitapci, 2021; Müller and Van Dyk, 2024). Furthermore, national efforts toward decolonizing education and labor systems aim to dismantle structural inequality and promote inclusive upskilling and recruitment, all key pillars of Quality 5.0 (Maisiri and van Dyk, 2019; Maisiri et al., 2021; Mhlongo and Nyembwe, 2024). This commitment to inclusivity and equality, especially in human capital development, offers a strong foundation for adopting advanced quality approaches. Experts appear to have identified this as a unique national advantage: while global discourses frame inclusivity and ethics as emerging priorities, in South Africa they are already institutionalized, giving Quality 5.0's human-centric vision strong normative legitimacy.

Leadership commitment emerged as another key strength. South African executives are accustomed to aligning strategies with national imperatives such as Broad-Based Black Economic Empowerment (B-BBEE), sustainability reporting, and inclusive development (Maisiri et al.,2021); Alexander, 2022; Uzenzele, 2024). This institutional pressure has cultivated a leadership culture that prioritizes transformation alongside profitability. Experts' strong agreement here suggests that the executive buy-in for Quality 5.0 is not only feasible but expected.

The research also found that experts unanimously believed that S2, S5 and S7 are very high impact strengths to successful adoption of Quality 5.0 in South Africa (median $3.5 \geq 4$; IQR ≤ 1). This indicates that environmental consciousness, flexible self-learning processes, and active collaborations are important to ensure successful adoption.

A study by Kovari (2024) found that Industry 5.0 initiatives put significant emphasis on sustainability and environmental protection. In South Africa, organizations of higher learning place their strategic priorities on sustainable development and protection, monitoring their energy and natural resource utilization to preserve the planet. Collaborations between private and public sectors and institutions of higher education were recognized as critical drivers of successful adoption of Quality 5.0.

Conferences such as the Annual Conference of the Southern African Institute for Industrial Engineering and the Annual International Conference on Industrial Engineering and Operations Management – Africa Chapter where manufacturing and quality innovations are discussed by academic and industry leaders to exchange insights on continuous improvement, digital transformation, and sustainable industrial practices. Professional networks, shared learning platforms, and strong leadership commitment improve organizational agility and reinforce South Africa's ability to adopt the transformative ideas (Maisiri and van Dyk, 2019; Sony and Naik, 2020; Mhlongo and Nyembwe, 2024). Workplace safety (S1) was identified as having high impact as a strength to implement Quality 5.0 in South Africa (median =3; IQR ≤ 1). This suggests that experts believe that the current standards of workplace safety would integrate well with the vision of Quality 5.0. Together, these strengths suggest that experts saw Quality 5.0 adoption as a natural extension of existing quality traditions, ethical values, and leadership practices, rather than a wholesale cultural shift.

4.2. Weaknesses Items

Despite the strengths, experts highlighted profound weaknesses that could undermine adoption. The brainstorming session with the experts found eight (8) factors that symbolize the internal weaknesses in organizations in South Africa as they adopt Quality 5.0 initiatives, as it can be observed in Table 3 and Figure 2.

Table 3. Delphi Weaknesses Items

#	Hindrances to Quality 4.0	Median	IQR	Consensus
W1	Economic instability	5	1	Yes
W2	Outdated skill sets	4	1	Yes
W3	Technology integration and legacy systems interoperability	4	0	Yes
W4	Rigidity in 4IR	4	1	Yes
W5	Data Security	4	1	Yes
W6	Resistance (Due to fear, social heterogeneity, confusion, and rigidity)	4.5	1	Yes
W7	Absence of consensus definition and confusion	3.5	0.5	Yes
W8	Energy and infrastructure vulnerability	5	1	Yes

Economic instability (W1), resistance to change (W6), and energy and infrastructure vulnerability (W8) were rated as extreme weaknesses (Median $\geq$ 4.5; IQR $\leq$ 1). Economic instability reflects the reality of sluggish growth, recessionary pressures, and constrained budgets. This indicates that experts believe that energy and infrastructure vulnerabilities, resistance from employees and society, and economic instability are weaknesses that are currently or will potentially hinder successful Quality 5.0 adoption. Experts likely rated this highly because in a survivalist economy, investments in emerging paradigms such as Quality 5.0 are easily deprioritized. According to Olaitan et al. (2021), the South African economy is not growing at an acceptable rate and the industry's lack of productivity impedes readiness to adopt any new technological advancements. Reports also show that South Africa is in the middle of a recession, particularly post Covid-19, and as such organizations cannot reserve funds for new initiatives with no clear return on investment (Mhlongo and Nyembwe, 2024).

Furthermore, loadshedding, unreliable internet, and infrastructure vandalism are systemic risks that disrupt industrial operations, leaving experts skeptical about the feasibility of sustained adoption. Unlike weaknesses such as outdated skills or interoperability, infrastructure deficits are largely beyond firm-level control, making them existential barriers to progress. Olaitan et al. (2021), Mhlongo and Nyembwe (2024) and Maisiri et al. (2021), found that energy insecurity due to loadshedding would highly hinder adoption and spreading of any new technologies in South Africa. Furthermore, Alexander (2022) and Nethamba and Grobbelaar (2022) found that corruption, theft and infrastructure vandalism were significant hindrances in South African organisations. Resistance to change was also rated critically, stemming from transformation fatigue and conceptual ambiguity. Experts found that firms are still grappling with Industry 4.0 adoption, and the absence of consensus definitions for Quality 5.0 compounds skepticism. This aligns with global findings that conceptual uncertainty breeds resistance and undermines stakeholder buy-in (Arsovski, 2019; Arıcı and Kitapci, 2021; Frick and Grudowski, 2023; Shabir, 2023; Fiałkowska-Filipek and Dobrowolska, 2024).

Factors W2-W5 were collectively recognized as having a very high impact weaknesses to successful Quality 5.0 adoption in South African organizations (median = 4, IQR $\leq$ 1). These items highlight the experts' shared beliefs that signifying their outdated skillsets, Technology integration and legacy systems interoperability, rigidity in 4IR and data security would all effect Quality 5.0 adoptions. This rating by experts suggests that without simultaneous investment in skills, secure digital infrastructures, and interoperability, even strong leadership and cultural alignment may not translate into successful adoption.

4.3. Opportunities Items

The brainstorming session with the experts found ten (10) factors that symbolize the external opportunities to be yielded by organizations in South Africa as they adopt Quality 5.0 initiatives successfully, as it can be observed in Table 4 and Figure 2.

Table 4. Delphi Opportunities Items

#	Opportunities Items	Median	IQR	Consensus
O1	Sustainable product development	5	0	Yes
O2	Sustainable growth	4.5	1	Yes
O3	Competitiveness	3.5	2	No
O4	Resilience	4	1	Yes
O5	Meeting societal demands	4.5	0	Yes
O6	Market Growth	3.5	2	No
O7	Innovation and entrepreneurship	4	1	Yes
O8	Shared growth and development	4	0	Yes
O9	Addressing global challenges	4	1	Yes
O10	Improved quality	5	1	Yes

It can be observed that O1, O2, O5, and O10 were identified as extremely high-potential opportunities for successful Quality 5.0 adoption in South Africa (median $\geq$ 4.5). There was strong consensus among experts regarding these opportunities, with an interquartile range (IQR) of $\leq$ 1), indicating broad agreement on their importance. Experts saw clear alignment between Quality 5.0's sustainability agenda and South Africa's national push for green industrialization and circular economy principles. Firms that embrace these opportunities stand to benefit from compliance legitimacy and global market advantages. According to Maisiri et al. (2021) and Müller and Van Dyk (2024), the transition to sustainable manufacturing practices not only aligns with global environmental targets but also positions local industries for future trade benefits in an increasingly eco-conscious market. The South African government's commitment to green industrialization and circular economy principles creates an enabling policy environment for sustainable growth initiatives (Ohiomah and Sukdeo, 2022).

Meeting societal demands was also rated highly, reflecting South Africa's pressing social challenges of inequality and unemployment. Experts recognized that Quality 5.0 could help firms meet consumer expectations for safe, ethical,

and traceable products, thereby strengthening legitimacy and trust. This was consistent with local research by Mhlongo and Nyembwe (2023a, 2023b) which noted that improving quality standards and integrating digital quality tools could help South African organizations meet rising societal demands. Other opportunities, including innovation, and entrepreneurship, resilience, shared growth, and addressing global challenges (O7-O9), were seen as very high potential (Median = 4; IQR ≤ 1). These reflect optimism about Quality 5.0's role in fostering inclusive economic participation and positioning South Africa as part of global solutions to climate and inequality.

These findings are consistent with global literature, for instance, Adel (2022) argues that Industry 5.0, with its human-centric and sustainability-focused approach, opens the door for innovation, entrepreneurship, and inclusive market participation, especially in underserved regions. Furthermore, Narkhede et al. (2024) and Ghobakhloo et al. (2024) emphasize that as the world grapples with climate change and socio-economic inequalities, nations that position themselves to address these global challenges through Quality 5.0 will become more resilient and competitive in the international market. Interestingly, competitiveness and market growth (O3 and O6) did not reach consensus (IQR > 1), suggesting divergent expectations. According to experts, larger export-oriented firms may anticipate competitive advantages, while resource-constrained SMEs perceive adoption as costly compliance rather than an avenue for expansion. This divergence highlights a critical contextual tension that in developing economies, Quality 5.0's perceived value may rest less on market competitiveness and more on resilience and legitimacy.

4.4 Threats Items

The brainstorming session with the experts found six (6) factors that symbolize the external threats posed to organizations in South Africa as they adopt Quality 5.0 initiatives, as it can be observed in Table 5 and Figure 2.

Table 5. Delphi Threats Items

#	Threats Items	Median	IQR	Consensus
T1	Cybersecurity risks	5	0	Yes
T2	High Initial Investments	4	1	Yes
T3	Rapid Technology changes	3,5	2	No
T4	Overshadowing by 4IR thereby slowing adoption	3,5	1	Yes
T5	Political Instability	4,5	0,5	Yes
T6	Lack of Standardization	4,5	0,5	Yes

Experts identified cybersecurity risks (T1), political instability (T5), and lack of standardization (T6) as the most critical external threats (median ≥ 4.5; IQR ≤ 1). Experts gave cybersecurity issues a high rating because they believed they reflected both a lack of organizational investment in effective security measures and inadequate national infrastructures. The severity of this threat in South Africa is demonstrated by the fact that in 2020, there were 19 cyberattacks, up from 3 in 2015 (Pieterse, 2021). Mhlongo and Nyembwe (2024a; 2024b) warn that increased digitization exposes organizations to cybersecurity threats, especially where systems are inadequately protected or monitored which raises concerns about data privacy and operational continuity. Political instability was rated as a threat due to policy uncertainty, corruption, and governance challenges that undermine long-term planning.

According to Alexander (2022), a South African researcher, political instability and governance issues are compromising long-term planning and disrupting funding pipelines essential for infrastructure upgrades. Kovari (2024) stretched this and argued that global conflicts such as that by Ukraine/Russia may heighten complexities and hinder the harmony and success of Industry 5.0 initiatives. Lack of standardization signals risks of fragmentation and ad-hoc adoption, which could escalate costs and hinder scalability. This is consistent with findings in literature. Olaitan et al. (2021) argue that the absence of cohesive digital standards and lack of interoperability between emerging technologies in South Africa creates fragmentation and duplication of efforts. These conditions not only slow down integration but also increase implementation costs. This is consistent with findings from this research where high initial costs (T2) and overshadowing by 4IR (T4) were considered by experts unanimously as very high impact threats (median ≥ 4; IQR ≤ 1). These highlight financial barriers and timing challenges, wherein firms still struggling with Industry 4.0 adoption may deprioritize Quality 5.0 initiatives.

Rapid technological changes (T3), though highly rated, did not reach consensus, with experts divided between seeing them as destabilizing or as opportunities to leapfrog. Together, these threats highlight a volatile environment where systemic risks (political and infrastructural) intersect with organizational challenges (cybersecurity and costs). This suggests that even with strong internal strengths and promising opportunities, external instability could delay or derail adoption.

4.5 SWOT Framework for Quality 5.0

Figure 2 presents the SWOT framework that was developed using expert opinions and ratings during the Delphi rounds. Although the study discovered consistency in most factors in the literature, factors such as economic instability, outdated skill sets due to mismatches in education offerings and industry requirements, resistance due to a high unemployment rate, energy and infrastructure vulnerability due to loadshedding and crime, and political instability were more prominent in developing countries. Customised attention is required during the migration planning process. Furthermore, adoption strengths such as Socio-Ethical Practices (Ubuntu, "Batho Pele", Active Equality, and Equity Acts) were identified as South African strong points, which will facilitate acceptance of Industry 5.0 because they represent similar values.

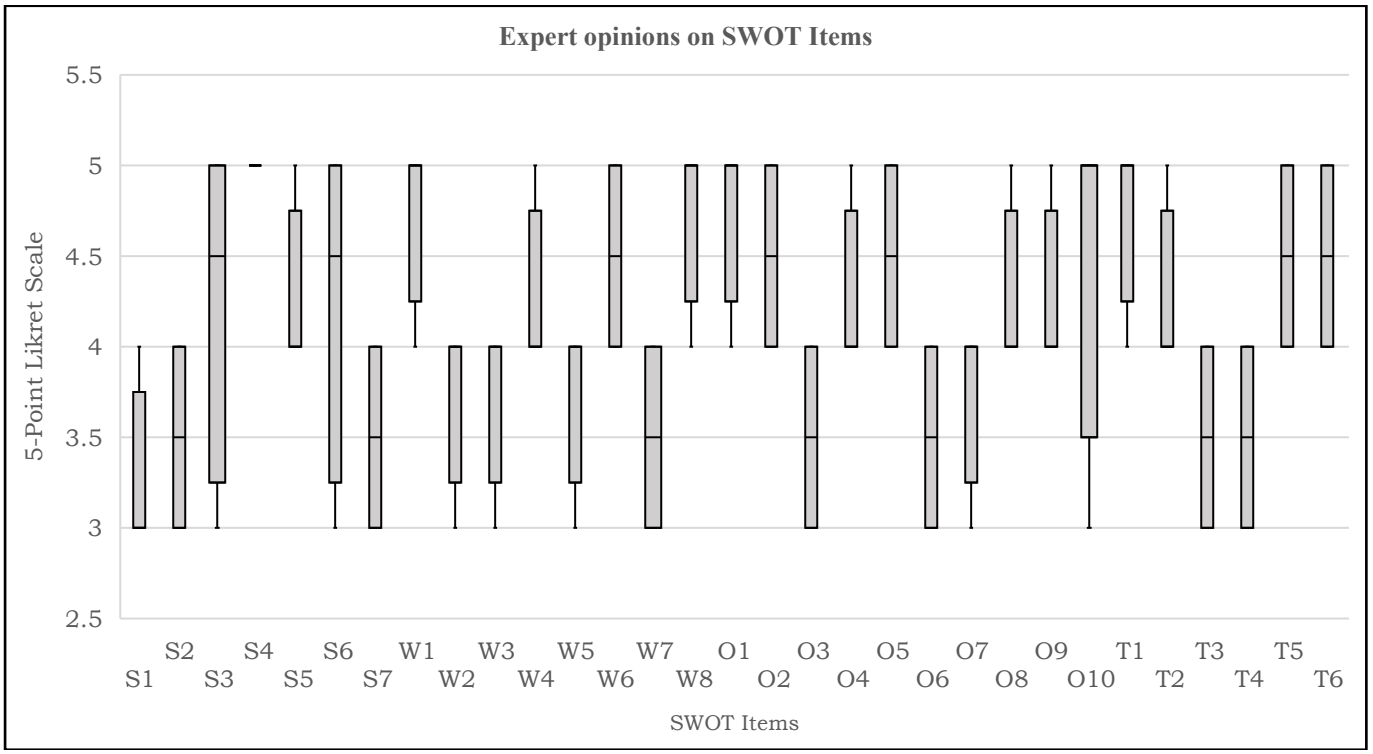

Figure 2. SWOT framework for Quality 5.0 adoption in South Africa (Based on the study's output)

5. Conclusion

This study applied a SWOT–Delphi approach to evaluate the viability of Quality 5.0 implementation in the South African manufacturing sector. The analysis reveals that the transition towards Quality 5.0 is supported by significant strengths, hampered by notable weaknesses, and influenced by both opportunities and threats that reflect the broader local and global industrial environment. From a practical standpoint, South African manufacturers should first leverage strengths that are already present, particularly the commitment to leadership in quality improvement and the integration of socio-ethical philosophies such as Ubuntu and Batho Pele. These elements provide a cultural and managerial foundation for a proactive quality culture that aligns with the human-centric and sustainability principles of Quality 5.0. At the same time, urgent attention must be given to weaknesses, especially the prevalence of obsolete skills and the fragility of infrastructure. Without addressing these constraints, attempts to implement advanced digital and human-centric practices may exacerbate inequalities and operational vulnerabilities. Targeted reskilling programs, supported by both government and industry, are therefore essential. On the opportunity side, alignment with the UN

Sustainable Development Goals (SDGs) and the pursuit of regional industrial partnerships create pathways for South Africa to position itself as a leader in sustainable and inclusive manufacturing across the continent. However, these opportunities can only be fully realized if key threats are mitigated, most notably economic instability and fragmented policy frameworks.

For policymakers, the findings highlight clear priorities: (i) incentivizing sustainable technology adoption, (ii) investing in workforce development programs tailored to emerging Quality 5.0 skills, and (iii) strengthening industrial infrastructure resilience. Such interventions will not only enhance the readiness of the manufacturing sector for Quality 5.0 but also ensure that its adoption supports inclusive growth and long-term competitiveness. While the framework developed here is grounded in the South African context, the challenges it addresses including skills gaps, infrastructure vulnerabilities, and economic uncertainty are shared by many developing economies.

6. Limitations and Future Research

The objective of the research was to conduct a SWOT analysis to uncover strengths that may accelerate Quality 5.0 implementation in South Africa, as well as weaknesses that could impede it. The study also identified emerging opportunities as well as potential challenges. The study was completed successfully, although there are certain limitations to note. The Delphi approach was used to achieve expert consensus in the research. While this technique is ideal for new and underexplored topics like Quality 5.0, it is still essentially subjective. The insights are based on the viewpoints of a selected population of South African manufacturing professionals and may not represent a full spectrum of experiences across various sectors or regions. Increased stakeholder involvement could validate and strengthen the findings. Furthermore, comparative case studies should investigate how leading South African organizations are addressing these weaknesses and threats in practice. Finally, the study recommends that future research could extend this SWOT–Delphi framework into a regional Quality 5.0 readiness index, enabling benchmarking across countries and guiding policy at a continental scale.

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