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Developing Framework for South African Airlines' Growth in the Era of Advanced Digitalisation

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Abstract

This study identified 4IR roles and developed a framework for the airlines' growth in the era of advanced digitalisation. The study adopted a qualitative method and engaged 56 experts in face-to-face interviews to achieve the aim. The participants were South African Civil Aviation Authority and Tourism industry staffers, top staffers of state-owned airlines, and selected passengers. The research utilised a thematic approach to analyse the collated face-to-face data. Findings show that most 4IR technologies can be useful to enhance airlines' growth in South Africa. Also, 4IR technologies can be used to improve the key components of airlines' growth framework (government factors, airline factors, sector competition, and strategic alliance) in South Africa. Besides using the suggested framework as a guideline to improve profitability, competitiveness, and airline sustainability, the study is encouraging airlines operators and other key stakeholders to improve their digitalisation operations.

Keywords: *Airline Industry, Fourth Industrial Revolution Technologies, Framework, Operators, South Africa.*

Introduction

Aviation sector is key to developing the economy, especially in developing nations. It has been projected that the developing countries, especially the African airline industry will continue to grow at an average of 4.7% annually in 2034 (International Air Transport Association (IATA), 2016). The outcome may be greater than markets in other continents and regions, such as North America and Europe, whose growth is 3.3% and 2.7%. Globally, records have shown that the airline sector is part of the transportation system. In the last few decades, the trustworthiness and safety of the aviation sector have improved (Hawkins and Orlady, 2017). Aigbavboa et al. (2023) affirmed that digitalisation is required to achieve this goal. They asserted that advanced digitalisation or 4IR technologies would improve the vanguard for advanced digitalisation in the aviation industry. The 4IR is described as "…. *an era where people are using smart, connected, and converged cyber, physical, and biological systems, and smart business models to define and reshape the social, economic, and political spheres…*" (South African Presidential Commission

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on the Fourth Industrial Revolution [PC4IR], 2020, p. 25). Alexander (2021) emphasised that developing economies capabilities to adapt digitalisation might impact the country's future development and growth. studies, including Schwab (2016), avowed that a fusion of advanced technologies brands digitalisation.

Past studies either addressed airline related-issues (Paelo and Vilakazi, 2016; De Gove, 2019; Matikiti *et al.*, 2020; Babatunde, 2020; Mhlanga, 2020; Nyatsumba, 2021) or 4IR related-maters (Mhlanga *et al*., 2018; 2021), apart from Aigbavboa et al. (2023). Aigbavboa et al. (2023) investigated the barriers the airlines in the era of 4IR and found 12 governance challenges. Babatunde (2020) found inadequate infrastructure, including the airport sector, as a key factor that has hindered Africa's economic advancement. While Nyatsumba (2021) focused on the continent (Africa) airlines and their business turnaround programmes and policies, including execution. Paelo and Vilakazi (2016) affirmed an increase in national carriers such as South African Airlines (SAA), Ethiopian Airlines, and Kenya Airlines. To sustain and expand this trend (airlines' growth in developing countries, using South Africa as a case study) in the era of digitalisation, policies and programmes need to be established via a framework. This was missing and justified the study's motivation. Digital technology plays a critical role and intends to enhance the vanguard for pioneering advanced technologies via 4IR in the aviation industry.

Digital technology is capital-intensive because of the equipment involved. Technological advancement has made the aviation sector more capital-intensive (Chen and Chen, 2012; Liou, 2012). The efficiency and competitiveness of airlines, especially in developing countries, are key to economic growth in the 4IR technologies era. This is pertinent to economic development and energetic governance systems in the era of digitalisation. Studies such as Aigbavboa et al. (2023) suggested that an integrated framework with 4IR may enhance airlines' growth and enhance safety measures in the sector. There is a paucity of studies about how an integrated 4IR framework can enhance airlines' growth in South Africa. Thus, besides the study contributing to the existing 4IR knowledge related to the airlines sector, the research intends to fill the literature gap concerning developing a framework for the airlines in the era of advanced digitalisation. This research will fill the present gaps (methodological and population) via a qualitative approach and engage participants in the South African airlines sector. The study may enhance policy reforms by implementing the framework for South African airlines in the era of 4IR. Thus, the study intends to identify 4IR roles and develop a framework for airlines' growth in the era of 4IR. The study's main aim will be achieved through the following:

i. To identify the role of 4IR in South African airlines' growth.

ii. To develop a framework for the airlines' growth in the era of 4IR.

To achieve these objectives, the research reviewed existing literature, and adopted a qualitative research design method for the data collected from the knowledgeable participants. The research presentation is grouped into seven main parts. The first part focuses on the introduction. This includes the objectives and justification for the study. Next are the highlights of related literature. This includes preamble to 4IR and the airlines growth. Following is collecting data from 56 interviewees through face-to-face interviews. The 4th part is the analysed results by theme and discussion with previous results. The 5th part focuses on the implications (theoretical and practices). The sixth part focuses on the study's limitations and areas for future studies. The last part covers the concluding section.

Literature Review

4IR Technologies' Role in Airlines Growth

Towards the end of the 18th century, the 1st industrial revolution (IR) emerged and was driven by water to automate manufacturing and steam power (Schwab, 2017). Next was the 2nd IR. During the era of the 2nd IR, electric energy was used to create bulk manufacturing about 1890. Around 1960s, the 3rd IR utilised IT and electronics to mechanise bulk manufacturing. The 4IR is characterised by a fusion of innovative digitalisation blurring the lines between digital, physical, and biological spheres (Schwab, 2017). The attributes connected with the 4IR discoveries have no historical design. Ebekozien and Aigbavboa (2021) and Ebekozien and Samsurijan (2022) identified the Internet of Things, artificial intelligence, big data, digital fabrication technologies, autonomous vehicles, robotics, 3-D printing, energy storage, materials science, simulation model, quantum computing as technologies linked with the 4IR.

Studies (Schwab; 2016; 2017; Oesterreich and Teuteberg, 2016; Ebekozien and Aigbavboa, 2021) showed that advanced digital technologies such as AI and 4IR influence businesses across the supply chains. There is a paucity of studies concerning integrating 4IR technologies to enhance airlines' growth, especially in South Africa. The technology lowers the businesses' encumbrances, including the airline companies, generates wealth, and enables a safe work environment (Schwab, 2017). Physical products and services might improve with digitalised infrastructure that enhance their value (Ebekozien and Aigbavboa, 2021). Sanjog *et al.* (2015) asserted that advanced digitalisation could enhance airlines' growth. This is because of the continuous improvements in communication satellites, aircraft, internets, and global aligning mechanisms. Simulations and 3-dimensional (3-D) built through a digital human model (DHM) and digital mockups are cost-effective than the traditional ergonomic method (Chaffin, 2005; Sanjog *et al.*, 2015). Zheng and Fu (2011) reported that statistics from the National Aeronautics and Space Administration (NASA) showed that 70% of aviation crashes could be due to the ineffective performance of the operators, including the pilots. This crisis will be mitigated by integrating 4IR into the aviation sector's operation.

The South African Government has been proactive regarding integrating 4IR into various sectors, including the aviation sector. In February 2018, President Cyril Ramaphosa announced that '*the 4IR is upon us, some are even beginning to talk about the fifth industrial revolution, and this means that we urgently need to develop our capabilities in the areas of science, technology, and innovation*' (Adams, 2021, p. 6). In 2019, the South African Government established the Presidential Commission on the 4IR (Department of Communications and Digital Technologies, 2018). This was in response to South Africa's 4IR. The White Paper on Science, Technology, and Innovation offered the platform to comprehend the 4IR's states' broad trajectory (Department of Science and Innovation, 2019). The South African pattern aligns with global leaders in 4IR and artificial intelligence (AI), such as Russia, China, Germany, France, the United Kingdom, Canada, and the United States of America (Katzenbach and Bareis, 2018). Adams (2021) opined that to accomplish the aim of harnessing the 4IR for comprehensive economic growth, including the aviation sector, one critical policy is to focus on digital and data science training and re-training for youthful South Africans, reskilling and upskilling employees whose employment may be displaced because of automation replacement and robotics. Diversifying post-secondary academic education prospects and focusing on technical skills for the economy via education and training for digital jobs' future cannot be over-emphasised.

Airlines

The airlines sector engages in the use of systematic disciplines (Aigbavboa et al., 2023). IATA (2016, 2019) stated that airlines need about 40,000 new aircraft over the next 20 years, valued at $7 trillion. Global leaders recognise the role of air transport in economic advancement and growth. It further corroborated ATAG (2016) and opined that increased air transport might considerably enhance economic development. Paelo and Vilakazi (2016) and Bourguignon and Darpeix (2016) asserted that there is a link between economic growth and air transport demand, especially in developing countries. Inadequate infrastructure may have hindered many developing countries from achieving this goal (Babatunde, 2020). Thus, in ranking, Africa is the lowest connected continent (Patel, 2014).

In South Africa, the deregulation of the aviation industry started in 1991 because of the adoption of the Domestic Air Transport Policy and Air Services Licensing Act of 1990 (Pisa and Luke, 2018). Before adopting this Act, South African Airways (SAA) was the national carrier and operated from 1934 to 1990. Also, Mhlanga *et al.* (2018) found that many new airlines needed help contending with SAA, a state-owned enterprise. Scholars such as Oosthuizen (2013) found that most new airlines needed help contending with SAA because of their major market share. After deregulation, Flitestar was the leading airline to enter the airline business immediately after the deregulation (Goldstein, 1999). Oxford Analytica (2020) reported that in December 2019, the SAA was placed into business salvage to prevent a possible closure. This indicates that authority intervention provisionally stopped the bankruptcy of the airline. Theand other features, such as the history of major airlines in South Africa, landmark events, and the year is presented in Table 1.

Year	Event
1934	SAA was established
1949	Comair was established as a private airline
1978	Link Airways began operations (later known as SA Airlink) in 1978 (secondary routes)
1979	Bop Air began operations (later known as Sun Air)
1990	The industry was deregulated, but the private sector allowed a one-year grace period to prepare itself before re-entering international routes
1991	Flitestar was the first airline to enter after deregulation
1992	Comair began operating the main domestic routes starting with Johannesburg-Cape Town. SA Airlink started operations in 1992 following the collapse of an alliance between Magnum Airlines, Border Air, and City Air, operating as Link Airways, due to financial problems
1993	SA Airlink formed an alliance with SAA
1994	Flitestar ceased business in April when it went bankrupt. Phoenix Air began operations in December 1994 and focused on Johannesburg, Durban, and Cape Town routes. SA Airlink formed an alliance with SA Express
1995	Phoenix Air ceased operations due to failure to pay its debts Nationwide Airlines was established

1996	Comair entered into a franchise agreement with British Airways (18% shareholding). Sun Air enters the market
1998	Interlink Airlines began operations
1999	Sun Air ceased operations when taken over by SAA
2001	Kulula, a subsidiary of Comair, entered the market as the first LCC
2002	Intensive Air went bankrupt and ceased operations
2004	I Time entered the industry
2006	Mango, a subsidiary of SAA, entered the market as a low-cost carrier
2008	Nationwide ceased operations due to bankruptcy
2010	Interlink Airlines went into liquidation and ceased operations
2011	Velvet Sky entered the market in October on the Johannesburg-Cape Town route. Santaco Airlines launched with a publicity flight but failed to commence commercial flights
2012	Velvet Sky ceased operations due to failure to repay its debts 1 Time ceased operations when it went bankrupt
2013	CemAir launches full service domestic scheduled flights (mainly to smaller towns and cities in RSA)
2014	FlySafair began operations
2015	Skywise, Fly Go Air, and Fly Blue Crane began operations

Table 1: History of Major Airlines In South Africa

Source: Modified from Paelo and Vilakazi (2016) and Aigbavboa et al. (2023)

Research Method

The study adopted qualitative research design and phenomenology, respectively. A phenomenology focused on the interviewees' proficiency and experience during the interview (Creswell and Creswell, 2018; Ebekozien, 2021). Paley (2016) asserted the phenomenological derived meaning of the situation by interviewing a group of persons. The research collected the face-to-face data via chosen semi-structured interviews. This method is in line with Ebekozien (2020). Therefore, the study aligned with Hamad MA Fetais *et al*. (2021) and Aigbovboa et al. (2023). Hamad MA Fetais *et al*. (2021) carried out interviews with Qatar Airways executives to define airline approaches and focused on rebranding. The research adopted a purposeful sampling technique. Purposeful sampling targets participants considered knowledgeable in the subject area (Ebekozien, 2020; Ebekozien et al., 2025b). For this study, the interviewees were experts in airline matters and the role of advanced digitalisation industry. Regarding the research saturation, 56 face-to-face semi-structured interviews from chosen South African Civil Aviation Authority (SACAA) (P1-P2), South African Tourism Industry (SATI) (P3-P4), managers of state-owned airlines (ESOA) (P5-P6), and airline travellers (P7-P56), as showed in Table 2, were engaged and saturation was achieved. The study ethical clearance was approved on 20th February 2021. Regarding the duration of the interview, it lasted from March 2021 to May 2021. The investigators spent an average of 50 minutes on each interview. The interviewees' answers were presented in an unidentified form regarding the ethical issue. To improve the quality of the result, considering the concern of prejudice in a qualitative study, the research processes were guided, as illustrated in Table 3.

Item	Categorisation of interviewees	Code of interviewees	Number of interviewees
1	South African Civil Aviation Authority	SACAA (P1 - P2)	2
2	South African tourism industry	SATI (P3 – P4)	2
3	Executives of state-owned-airlines	ESOA (P5 – P6)	2
4	Regular passengers	pASSENGERS (P7 – P56)	50
Total number of interviewees			**56**

Table 2: Summary of Interviewees' Description

Source: Authors Work

Method	Assessment Strategies	The Phase of Research
Reliability	Interviewers' well-guided (consistent)	Data collection
Validity	The adoption of a recognised method (semi-structured interviews)	Data collection
Generalisability	Recognition of limitation due to sample size potential interviewer bias	Data analysis
Transferability	Compare the study's implications against reviewed literature.	Post data analysis
Credibility	Theme approach to establish a pattern from the data	Data analysis
Dependability	Developing semi-structured interview guidelines.	Research design

Table 3: The Study's Quality Assessment Strategies

Sources: Modified from Aigbavboa et al. (2023)

The study data were collected from the oral interviews conducted. The interview took place from March 2021 to May 2021 with 56 participants, as presented in Table 2. The interviewees are vast in 4IR and airline operations in South Africa. The study hid the interviewees' identities for confidentiality reasons and aligned with Jaafar *et al*. (2021) and Ibrahim *et al.* (2022). The research achieved saturation. The study analysed the primary data from the interviews through a thematic analysis. The investigators employed the snowball sampling approach to accomplish adequate saturation (Teddlie and Tashakkori, 2010; Ebekozien et al., 2025a). The face-to-face interviews lasted 45 minutes on average. The study engaged the participants with questions tailored to achieve the stated objectives. Concerning the collected data, they were analysed via a thematic approach and label assigned to the code to enhance achieving the objectives. Thus, the study utilised an open coding approach in the interview data transcription. Narrative, themeing, invivo, and emotion coding techniques were utilised (Corbin and Strauss, 2015; Ibrahim et al., 2022). Forty-seven codes emerged from the coding and were categorised into seven sub-themes (categories). From the seven sub-themes, two themes emerged.

Findings and Discussion

This section presents the main findings and discussion that emerged from the interviewees.

Theme 1: Role of 4IR in South African airlines' growth

The role of 4IR technologies in advancing airlines' growth in the 21st-century aviation industry

cannot be over-emphasised. Findings agree that integrating 4IR technologies into the influencing factors can improve airlines' growth in South Africa if the key stakeholders (policymakers and airline operators) embrace the mechanism fully. The government is gradually introducing digitalisation via policies and programmes to encourage 4IR technologies usage (Participants P2, P5, P23, & P46). P5 says, "…. *with the right education, training, and job-creating policies tailored towards AI, robotics, simulation model, 3-D printing, and internet-of-things, Africa, inclusive of South Africa fast-growing population, could be a great asset for socio-economic transformation*…" the 4IR technologies are revolutionising the business and industrial sectors, including the aviation sector for growth and profitability (P3). Findings agree with Adendoff and Collier (2015), and it was found that AI, a component of 4IR technologies, can reduce the cost of goods and services if applied in businesses. This makes life easier for the majority and becomes a win-win scenario for customers and operators. Findings agree that social media plays a significant role in airlines' growth. Social media is a component of the 4IR technologies. Participants P3, P6, P14, P28, & P44 affirm that many successful airliners target their customers via social media platforms with positive responses to queries and proffering solutions to issues raised. It is one of the simplest ways of two-way communication (P44). Results agree with Baghirov *et al.* (2019), and they affirmed that airline organisations could use it to improve their two-way communication with their passengers. In principle, they are growing their business. Zhang (2011) identified blogs, microblogs such as Twitter, media-sharing sites (YouTube), social networking sites (Facebook), and wikis (Wikitravel) as the major social media platforms.

Theme 2: Develop a framework for South African airlines' growth in the era of 4IR

The sub-section presents how the key components of airlines' growth (government factors, airline factors, sector competition, and strategic alliance) are integrated with 4IR technologies to develop a framework in South Africa. The study aims to accomplish the main aim. Referring to Figure 1, the major constructs were identified and highlighted. The study adopted South Africa's sustainable airlines' growth in the 4IR era as the dependent variable. For the independent variables, government factors (P1-P6), airline factors (P1-P5), sector competition (majority), and strategic alliance (P3, P4, & P6) were identified. Thus, the four variables were integrated with 4IR technologies (majority), as presented in Figure 1. Figure 1 is also known as "*the Mpume Mkhize Aviation Growth Framework (MMAGF) in 4IR Era*," as generated from the study. Participant P3 says, "*…unsustainability of growth in the airline's industry depends on the strategic alliances airlines undertake. This includes emerging technology in operations within the sectors do*…" The aviation sector needs a structured and stable environment in which to operate. The outcome will encourage the growth and sustainability of the industry (Participant P3, P23, P45, & P55). Findings agree that when visa application restrictions are very strict, that could impact the visitors' being granted visas in time, impacting growth sustainability (P11, P23, P33, P45, & P55).

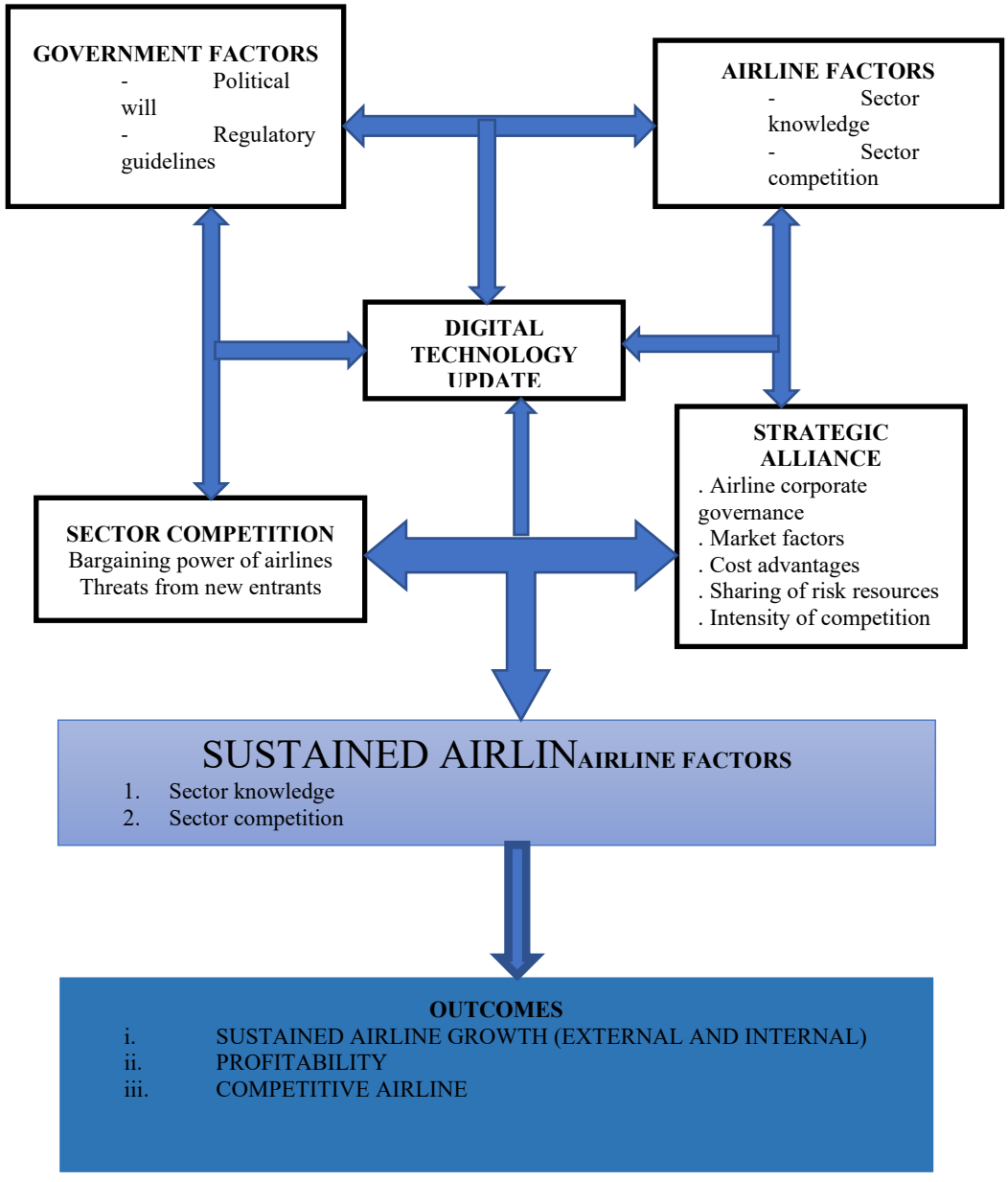

Figure 1: The Mpume Mkhize Aviation Growth Framework (MMAGF) in the 4IR Era

Source: Authors work

Regarding the digital technology update, findings identified artificial intelligence (AI), Internet of things, big data, and blockchains as the study's key technological innovations. AI described the system's capability to interpret external data accurately and take critical lessons from data.

Findings agree with Kaplan and Haenlein (2020), and it was found that AI offers human-like intelligence to the robotic machine to achieve specific goals via flexible adaptations. Participants P3, P5, P23, P34, & P47 opines that with big data analytics and AI, equipment and machines can handle intelligent tasks with ease. Findings agree with Keating and Nourbakhsh (2018), and it was found that robots and machines can perform tasks faster, more accurately, and at the lowest cost because of the information stored in them. For the internet of things, it facilitates the integration of machine or robot learning and big data technology in a manufacturing platform (P2, P4, P6, & P23). Findings corroborated Boyes et al. (2018), which discovered that smart-machines integration is more efficient than human beings regarding accurately and consistently communicating data. Participant P6 says, "…*this mechanism is needed in the aviation industry to mitigate human errors associated with aircraft crashes*…." Referring to Figure 1 dependent variable (sustainable South African airlines' growth in 4IR era), findings reveal that apart from the four variables, digital technology is key to the attainment of sustainable airlines' growth, profitability, and competitiveness airline. Also, airlines' profitability remains an encumbrance issue, especially in developing countries, such as South Africa. The findings agree with Maung *et al.* (2022). It was opined that profitability is a challenging issue for aviation worldwide and suggested ways to improve profitability, such as increasing growth and low-cost carriers.

The study's implications

The study contributes to present South Africa's airlines industry and 4IR knowledge. It has far-extending benefits for major stakeholders, especially policymakers and airlines operators, regarding upgrading their facilities to meet the minimum global best practices. Besides the economic advancement via 4IR applications, the framework via updated digital technology will enhance sustained airline growth in South Africa. The output will improve competitive airline governance for productivity, profitability, and competence. This is an all-inclusive advantage to the stakeholders, including the owners and users. Therefore, achieving Mpume Mkhize Aviation Growth Framework (MMAGF) in the 4IR era should be all-inclusive via policies. Findings reveal that the 4IR technologies are revolutionising the business and industrial sectors for growth and profitability, including the aviation sector. Also, it shows that 4IR technologies can reduce the cost of goods and services if applied in businesses, especially in airlines growth. However, academic materials about South Africa's airline growth framework in the advanced digitalisation era has yet to be heard. The study intends to fill this theoretical gap, among others. Also, the proposed framework (MMAGF), as shown in Figure 1, emphasising the part of the research theoretical implications regarding the main variables, such as government and airline factors, sector competition, and strategic alliance via digital technology update. These new variables, such as government factors, airline factors, sector competition, and strategic alliance can be tested and validated in future research.

Concerning the study's practical contribution, the results will support MMAGF in the advanced digitalisation era in South Africa. The research intends to stir up policymakers and airline operators regarding the proposed framework that will enhance or promote South Africa's airline growth in the era of advanced digitalisation from the interviewees' viewpoint. One output is to promote advanced digitalisation application within the airline operations. It will enhance competitiveness and increase profitability via improved product and services delivery within airline sector. The advantages of this study to the South African airlines in the advanced digitalisation era may resuscitate key stakeholders, such as the policymakers and operators to re-evaluate the proposed framework within the aviation industry. This is germane to improving service delivery for the stakeholders, especially the users. From the interviewees' perception,

the study reveals that the proposed framework might enhance sustainable airline growth, increase profitability, and improve the competitiveness of South African airlines with the assistance of digital technology upgrades.

The Study's Limitations and Areas for Future Studies

The research has limitations. First, the researchers adopted a qualitative approach to the collection of data. Future studies should consider a mixed-methods research design to accomplish the generalisability of the findings. Second, an investigation into the possible hindrances in implementing the proposed framework within the airline sector is germane. It will assist the stakeholders, especially airlines policymakers, in driving policies and programmes tailored towards implementation-free across South African airports. Also, the proposed framework can be further investigated by other developing countries with similar challenges to achieve empirical validation.

Conclusion

This study explored the key variables to develop South African airlines' growth in the 4IR era framework. The developed framework is also known as MMAGF in the 4IR era. The research adopted a qualitative research design via phenomenology. Fifty-six participants were interviewed to arrive at the study's saturation. It was discovered that 4IR technology's role in South African airlines' growth cannot be over-emphasised. The developed framework intends to improve airlines' growth. The overall South African airlines' growth may be transformed, profitable, competitive, and sustained if embraced by the key stakeholders. Embracing policies and programmes tailored towards promoting 4IR technologies is key. South Africa is among the few African countries that have domesticated the 4IR in their strategy policy, but more action is needed to bridge the existing gap in the aviation sector. Thus, this framework needs to rekindle the stakeholders, especially the airline operators and the government agencies linked with the aviation sector. The study's findings should make a critical practical contribution to existing knowledge. In practice, the framework (MMAGF) should enlarge the knowledge of airlines' growth regarding the 4IR era in South Africa and other developing countries.

Data Availability Statement

Data not available – participant consent: The participants of this study did not give written consent for their data to be shared publicly, so due to the sensitive nature of the research supporting data is not available.

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