TOWARDS STRATEGIC MANAGEMENT OF DRONE APPLICATION PROCESS AND REGULATION IN SOUTH AFRICA

Q. Mokoena[1], I.A. Daniyan[1*], K. Mpofu[1] & O.A. Abisuga[1]

ARTICLE INFO

Article details
Submitted by authors 1 May 2022
Accepted for publication 06 Jul 2022
Available online 14 Dec 2022

Contact details
* Corresponding author
afolabiilesanmi@yahoo.com

Author affiliations
1 Department of Industrial Engineering, Tshwane University of Technology, Pretoria, South Africa

ORCID® identifiers
Q. Mokoena
0000-0002-1351-3767

I.A. Daniyan
0000-0002-7238-9823

K. Mpofu
0000-0003-3429-7677

O.A. Abisuga
0000-0001-7738-3132

DOI
http://dx.doi.org//10.7166/33-4-2691

ABSTRACT

This paper discusses strategies to improve the application process for drones and Part 101 of the regulations for the approval of applications. Drones have the potential to transform the world by doing things differently and improving technology in the future. The use of drones is growing fast, and the need for control is important for reasons of safety and privacy. A qualitative method of data collection and analysis was used in this study, using the South African Civil Aviation Authority (SACAA) as a case study. Telephonic interviews were conducted to collect data from participants and to understand the issues affecting the drone application process. Drone operators were interviewed to collect data on the drone application process and the regulations. The researcher discovered that there were issues affecting the existing drone application and approval processes, such as restrictive regulations, the inclusion of manned aircraft requirements, slow issuing of Remotely Piloted Aircraft Systems operators' certificates, and the capital needed to enter the drone business. Recommendations are made to improve the drone application and approval processes.

OPSOMMING

Hierdie artikel bespreek strategieë om die aansoekproses vir hommeltuie en art 101 van die regulasies vir die goedkeuring van aansoeke te verbeter. Hommeltuie het die potensiaal om die wêreld te transformeer deur dinge anders te doen en tegnologie in die toekoms te verbeter. Die gebruik van hommeltuie groei vinnig, en die behoefte aan beheer is belangrik vir redes van veiligheid en privaatheid. 'n Kwalitatiewe metode van data-insameling en -analise is in hierdie studie gebruik, met die Suid-Afrikaanse Burgerlugvaartowerheid (SABLO) as 'n gevallestudie. Telefoniese onderhoude is gevoer om data van deelnemers in te samel en om die kwessies rondom die hommeltuig-aansoekproses te verstaan. Hommeltuigoperateurs is onderhoude mee gevoer om data oor die hommeltuigaansoekproses en die regulasies in te samel. Die navorser het bevind dat daar kwessies was wat die bestaande hommeltuigaansoek- en -goedkeuringsprosesse beïnvloed, soos beperkende regulasies, die insluiting van bemande vliegtuigvereistes, die stadige uitreiking van RPAS-operateurssertifikate en die kapitaal wat nodig is om die hommeltuigbesigheid te betree. Aanbevelings word gemaak om die hommeltuigaansoek- en goedkeuringsprosesse te verbeter.

1. INTRODUCTION

The challenge of regulating the drone industry is a global problem; but at the same time, most countries are attempting to develop regulatory frameworks that will work for them. Like other countries, South Africa is trying to regulate drones effectively and efficiently. Therefore, there is a need to enforce an effective approach to regulation in order to deal with the drone technologies that are emerging in South Africa.

The view of Emma-Iwuoha [1], is that the regulation of drones in South Africa is in a difficult and worrying situation. Drones are also known as unmanned aircraft systems (UAS), unmanned aerial vehicles (UAV), or remotely piloted aircraft systems (RPAS). During a Newzroom Afrika interview, a representative of the South African Civil Aviation Authority (SACAA) stated that drones are currently being used in mines, to inspect power lines, and in other sectors [2]. Commercial drones are being used in construction, security, agriculture, and data collection; but in the future drones will also be involved in deliveries [3]. Drones are poised to become even more significant as the technology evolves and is applied in creative ways [4]. According to Hodgkinson and Johnston [5], the aviation industry is being transformed using unmanned aerial vehicles commercially, militarily, scientifically, and recreationally.

In South Africa, the SACAA is mandated to regulate drones. The regulation was gazetted in May 2015 as the eighth amendment to the Civil Aviation Regulations, Part 101: Remotely piloted aircraft systems, under the Civil Aviation Act No. 13 of 2009. Owing to the fast-growing rate of drone usage, the SACAA established and published regulations to monitor the safety and security of the drone industry [1]. The views expressed by Lawrenson and de Oliveira [6] are that the use of drones is gradually increasing and is expected to be prominent in the future. Part 101 of the regulations covers commercial, private, corporate, and non-profit drones. However, this study focuses only on the operation of commercial drones.

It has been established that commercial drone operators in South Africa need to comply with the eighth amendment of the Civil Aviation Regulations, Part 101 (mentioned above) and the Air Services Licensing Council (issued in terms of the Air Services Licensing Act No. 115 of 1990). The regulation consists of six sub-sections: general provisions; approval and registration; personnel licensing; RPAS operating certificates; RPAS operations; and maintenance [7].

The objective of this study is to investigate the factors affecting the management of the application process for and regulation of drones and the application process turnaround time (TAT) to understand their impacts on the growth of drone technology in South Africa, and to recommend strategies to improve the current situation. The findings of this study could assist drone regulators in South Africa to achieve sustainability in terms of the process for drone applications and regulations.

2. LITERATURE REVIEW

2.1. Application of drones

Drones perform their mission through the use of remote control or autopilot by the controller, in which wireless communication technology is used. In some parts of the United States (US), the police use drones in crowd control, accident scenes, crime tracing, monitoring crime suspects, and search-and-rescue operations [8]. Sandvik [9] explains that drone operators are viewed as the solution to the challenges of poor health and poverty in underdeveloped African countries. Hodgkinson and Johnston [5] argue that the aviation industry is being transformed by the use of UAVs in the commercial, military, scientific, and recreation sectors. This means that drones are slowly changing how things are done in the world. There are cases in which lives have been saved, showing footage captured in difficult situations and in other instances.

During the Covid-19 pandemic, drones proved to be the best technology to be used in areas such as the sanitising process [10]. Game reserves, the acting industry, agriculture, and other sectors are starting to recognise drones as a technology that could assist in their respective fields. In addition, drones have been employed for many military, surveillance, recreational, scientific, and research purposes [8].

Bödecker and Wackwitz [11] state that drone are complex devices, and inappropriate handling can lead to poor operational efficiency. They add that drone applications also include environmental protection, environmental law enforcement, and environmental crime prevention; and in Africa, drones have been used to deal with illegal poaching, which threatens the survival of some animal species. Sandvik [9] states that drones are being used to fight the poaching of elephant and rhino in South Africa, Namibia, Kenya, the

Democratic Republic of the Congo, Zambia, Zimbabwe, and Tanzania. A number of sectors are starting to integrate drones, and more will follow. Sandvik [9] expresses the view that drones are viewed as a game-changer in development in Africa, humanitarian aid, 'the war on poaching', and peacekeeping.

Figure 1 shows the application of drones at a mining site.

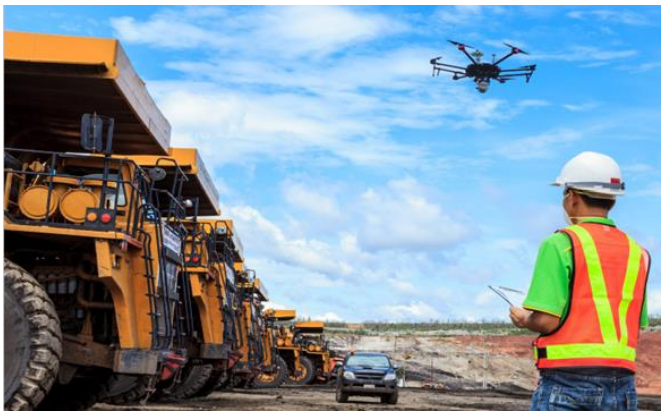

Figure 1: Drone at mining site [11]

The mining sector involves a lot monitoring and assessment of its infrastructure. It is important to monitor and evaluate mining sites and activities while operations are in progress. The growth of the mining industry is contributing positively to the growth of the market in South Africa [10]. Drones are the best technology to assess and record videos of these operations, especially in areas that are difficult to reach. The view expressed by Bright [12] is that mining clients are struggling with data collection by humans; drones could therefore be adopted to help in these situations.

The South African company Rocketmine conducts its business in South Africa, Nigeria, and Mozambique, alongside mining giants such as Anglo-American and BHP Billiton [12]. According to Jackson [13], mining industry drones have eliminated safety risks, conducted high-risk tasks, and produced high-quality data in less time and at a lower cost. Based on these views, it is evident that drones are beneficial to the mining industry.

2.2. Regulation process

In South Africa, in line with civil aviation regulation Part 101, the operation of drones takes place in the commercial, private, corporate, and non-profit sectors. According to the International Civil Aviation Organization (ICAO), an international agency that is responsible for regulating the safety of civil aviation around the world, drone operations are found in the private, corporate, and commercial sectors, and all RPAS operators should be approved in order to operate these devices [14].

Baldwin, Cave and Lodge [15] define regulation as a way of controlling a process by specifying rules that need to be followed. They add that it is important, when developing regulations, to keep in mind that the rules that are adopted might impact their implementation or prevent the achievement of their objectives [15]. According to Raj and Chirputkar [16], drone regulations are organised so that mandatory aviation law, non-mandatory aviation law, and technical standards cooperate with one another to form a regulatory infrastructure for the drone industry. It is vital to implement regulations that will benefit a country. According to Stöcker, Bennett, Nex, Gerke and Zevenbergen [17], a law prevented additional technological developments in the UK for thirty years while other countries benefitted from the new technology.

The SACAA is a member of the ICAO. Therefore, as a regulator, the SACAA follows the ICAO's guidance in drafting civil aviation regulations and standards. Dima [18] describes drone regulation as a field I which International, European, and national laws are applicable. Regulations are enforced to protect the public or consumers in situations where there are risks of safety, health, or performance. Regulations are usually enforced by governments. Sometimes there is self-regulation, but that is not effective in most cases. Clarke [19] is of the opinion that industry self-regulation tends to find it difficult to achieve an acceptable balance between complacency and undue interventions by regulators.

Hodgkinson and Johnston [5] state that some regions aim to regulate drones to the safety standards of required for manned aircraft. Manned and unmanned aircraft are two different technologies and designs; therefore, it is difficult for drones to comply with some of the manned aircraft regulations. Rawlins [20] expresses the view that the Part 101 regulations were established to respond to the evolving demands to regulate the drone industry in order to take advantage of the developing technology. Regulation can be a barrier to trade, or it can protect the public. In order to address the need to manage the widespread use of drones, Tsiamis, Efthymiou and Tsagarakis [8] believe that many countries have created legislation in order to control the use of drones by setting guidelines for ensuring the safety and privacy of the public.

A survey of US, United Kingdom, and European Union laws has indicated that the existing regulatory rules are not appropriate for drones [5]. Those authors add that a lot of countries have decided to exclude small drones below a certain weight level from compliance because of complex situations. Drone regulators tend to control and monitor drones used for commercial purposes because of their growing use and the risks to the public.

2.3. The Part 101 regulations and SACAA's application process and their impact on the drone industry

The number of drones in use in South Africa has been growing in the last ten years. Hodgkinson and Johnston [5] argue that, in most countries, regulators are failing to handle the growth of the drone industry. In support of that viewpoint, Zwickle, Farber and Hamm [21] argue that it is difficult for a government to regulate fast-growing new technologies. A lot of countries have decided to regulate drones to prevent the risks and the danger that come with this technology. Cunliffe, Anderson, Debell and Duffy [22] note that countries are developing regulatory frameworks to cope with the growth of drone technologies. Drones that are not monitored pose a risk and a threat to air navigation systems and to manned aircraft transport [23].

According to the Drone Council of South Africa [24], the progress made between 2015 and 2020 is nothing to be proud of, but that South Africa has a plan to catch up by 2023. The South African enforcement structure faces difficulties with compliance. The City of Cape Town purchased drones at a cost of R500 000, but city officials are waiting for the licence approval from the SACAA [25]. The Part 101 regulations were introduced in 2015, but the drone industry is still raising its concerns about the enforcement policy. The report of the Commercial Unmanned Aircraft Association of Southern Africa (CUAASA) [26] states that the SACAA has found it difficult to implement the regulations effectively. Nagiah [27] confirms that the SACAA is struggling to enforce compliance with the drone regulations.

In most cases it is a challenge to enforce regulations, especially when the product or service is still new. In these instances, both the regulator and the people who need to comply with the regulations encounter various challenges. According to Jackson [13], the SACAA application process is too strict for drone operators to meet its safety, security, and privacy standards, which appear to be set too high. The opinion of Gregorski [28] is that a lack of control leads to criminal acts and terrorist attacks, and places ethics at risk. Ayamga, Tekinerdogan, Kassahun and Rambaldi [29] believe that the illegal use of drones could lead to additional regulations and restrictions. The view of Cunliffe *et al.* [22] is that the increased use of drones in the UK has allowed the authorities to highlight the need for a safe operational practice.

The view of Rawlins [20] is that the Part 101 regulations were developed to monitor the drone industry and to take advantage of evolving drone technology in South Africa. Other countries, such as Australia, China, the UK, the US, and some EU countries, are already experiencing the benefits of this drone technology, while South Africa is not, owing to its slow adoption. Chen [30] notes that Australia has advanced in its use of commercial drones to deliver textbook.

2.4. Application process

According to Dumas, La Rosa, Mendling and Reijers [31], examples of organisational application processes are procure-to-pay, order-to-cash, issue-to-resolution, quote-to-order, and application-to-approval. The authors define the application-to-approval process as what happens when someone applies for approval and the approval is either granted or denied. This type of process is normally associated with government agencies when a person applies for a specific permit and it is granted. The application-to-approval process applies to the SACAA's process, because it involves either approving and issuing or denying drone licences and permits.

Figure 2 shows the RPAS's Part 101 regulations relating to the high-level approval process, which sets out the applicable steps according to the type of drone approval that is required. The approval includes a certificate of registration (CofR), an RPAS operating certificate (ROC), an RPA letter of approval (RLA), certification as an RPAS maintenance technician (RMT), or a remote pilot licence (RPL).

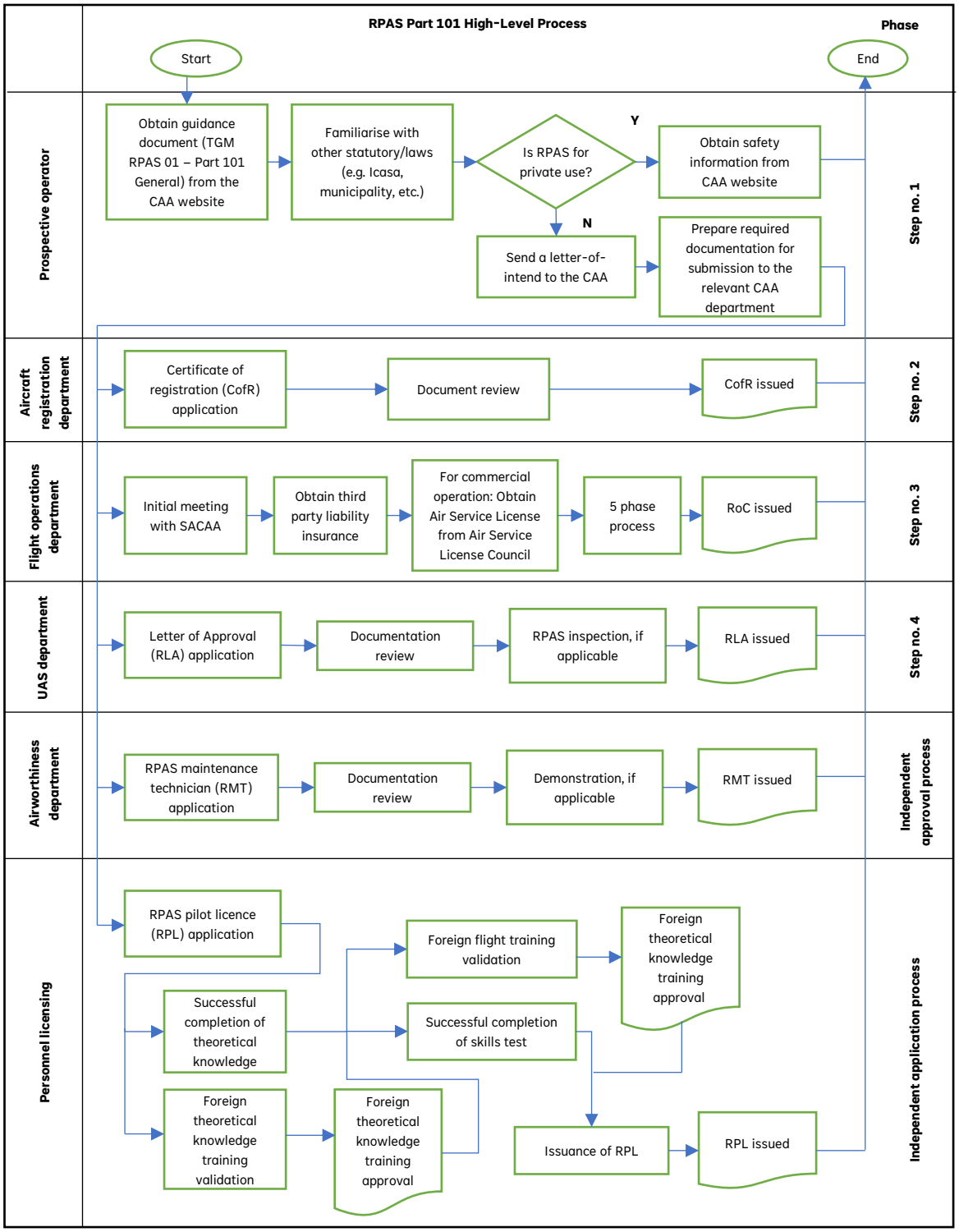

Figure 2: Part 101: Drone approval process [32]

Commercial, corporate, and non-profit drone operators are required to apply for an ROC, which includes the operational specifications. The ROC process involves five phases in the certification process: pre-application, formal application, documentation evaluation, demonstration, and certification. The SACAA [32] describes the ROC's five phases as follows:

a) Phase 1 – Pre-application: applicant makes contact and completes the letter of Intent. The applicant will be guided through the entire five-phase process.

b) Phase 2 – Formal application: submission of formal application for commercial operations; attach an ASL issued by the Air Service Licensing Council.

c) Phase 3 – Documentation evaluation: applicant submits all the required manuals to the CAA for approval and a thorough review. Thereafter, a decision will made about whether or not it complies.

d) Phase 4 – Demonstration: demonstrate ability to operate. The demonstration and inspection phase involves on-site evaluations of the documentation in accordance with the regulation and operations manual.

e) Phase 5 – Certification: the applicant is issued with a ROC, which includes the operational specifications.

2.5. Strategic management

Henry [33] defines 'strategy' as the purpose to assist companies to attain competitive advantage. The definition given by Hubbard, Rice and Galvin [34] is that strategy is about medium- to long-term decisions that have an impact on an organisation's activities. It could therefore be argued that good strategy helps companies to be competitive and to maintain high performance levels. According to Henry [33], if a strategy helps companies to align their resources and capabilities in order to achieve competitive advantage, the process could be referred as 'strategic management'. Strategic management helps an organisation to analyse a situation that it is facing by formulating a strategy and implementing that strategy [33].

Strategic management is the core of an executive's job [34]. According to Singh, Watson and Watson [35], the strategic management process (SMP) is complex, has no definite structure, and consists of five phases: organisational objectives, strategy formulation, strategy implementation, environmental scanning, and strategic control. The view of Hron [35] is that strategic management deals solely with the creation of value, and that the value is created by formulating and implementing strategies that are different from those of the organisation's competitors and that would be difficult or costly for them to duplicate. In support of this argument, Tikkanen and Halinen [36] explain that strategic management aims to find out how an organisation's performance could be improved.

Singh *et al.* [35] argue that the SMP often needs information that is not always accessible; and a lack of information can impact an organisation's performance negatively. The SMP helps organisations to improve and maintain their objective and goals. According to Tikkanen and Halinen [37], the transformation to a networked business environment has raised the question whether the existing theories of strategic management are still valid for a business strategy. The view of Hill and Jones [38] is that managers should formulate strategies that would be able to achieve competitive results, and that strategic management could be implemented through action to execute the strategy on three levels: corporate, functional, and business.

Kraus and Kauranen [39] argue that strategic management generates a relationship between an organisation's internal strengths and weaknesses and the external factors of opportunities and threats. Figure 3 shows the strategic management process model.

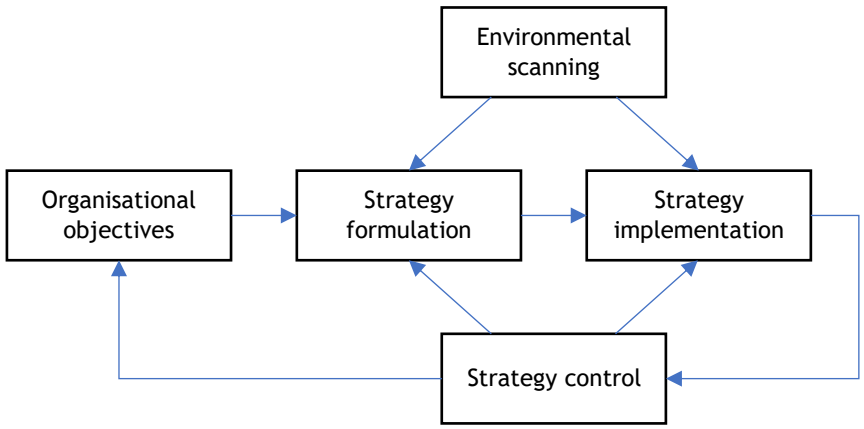

Figure 3: Strategic Management Process model [35]

The phases of the strategic management process shown in Figure 3 are explained below.

a) Organisational objectives

This is the first phase of the SMP. According to Kazmi and Kazmi [40], in this phase, the organisation set its strategies – its objectives, vision, and mission –in order to realise its strategic intent [40]. The focus of this first phase of the SMP is to formulate the organisation's objectives. Singh *et al*. [35] argue that organisational objectives should be strategic, administrative, or operational. They also define the three organisational objectives as strategic objectives that focus on overall organisational direction; administrative objectives that include the organisational infrastructure to accomplish the strategic objectives; and operational objectives that identify the tasks that need to be performed. For instance, the SACAA's vision is to be a world-class civil aviation regulator [32]; its mission is to ensure safety and security by regulating the civil aviation industry and to support the development of this industry in South Africa [32]. The overall objective of SACAA is to control, promote, regulate, support, develop, enforce and continuously improve the levels of safety and security theoughout the South African civil aviation industry [32].

b) Strategy formulation

This phase focuses on the development, evaluation, and selection of strategies [35]. Strategies are articulated on the basis of the application of a SWOT (strengths, weaknesses, opportunities, and threats) analysis. The authors add that the strategies should be developed to align with the organisation's critical factors [35]. Hill and Jones [38] explain that strategic thinking needs various strategic alternatives that focus on strengths, weaknesses, opportunities, and threats, and that the SWOT analysis approach identifies the strategies that fit the business model and the operation that the environment needs.

Process benchmarking emphasises studying process flows, process technology, operating systems, and an organisational target [56]. A process analysis helps to identify issues affecting an existing process [31]. The analysis of an internal environment aligning with the requirements of the external environment would allow the organisation to evaluate them and to identify where it could achieve a strategic fit between them [33]. The author adds that some decisions could be based on experience if an analysis were not done. The formulation of a strategy requires strategic thinking within a group. Strategy evaluation is a key part of strategy formulation, and it is done at the corporate and business levels in an organisation [33]. Kazmi and Kazmi [40] state that strategic formulation can also be referred to as 'strategic planning', which is usually a responsibility of the managers. A functional strategy focuses on the plan that defines the objectives of specific functions, assigning resources to the different activities and managing them in order to achieve the corporate level objectives [40]. Strategic decision-making should be used because it helps to identify the best alternatives and to determine the objectives to be achieved [40].

Lean Six Sigma is known for improving quality and enabling continuous improvement [41-42]. The acronym 'DMAIC' represents the five stages of the improvement cycle: define, measure, analyse, improve, and maintain [43-44]. The Lean Six Sigma approach is similar to the Business Process Management (BPM) lifecycle because both analyse, improve, and control process improvement. Dumas *et al.* [31] describe the issue register as another approach to help with the process analysis of the issues that are affecting processes. The issue register helps to analyse the root causes by analysing each issue and its impact, which are outlined by issue name, description, priority, assumption, qualitative impact, and quantitative impact [31].

c) Strategy implementation

This is the phase after the strategies have been formulated. Line managers are usually responsible for the management of the strategies that are implemented [35]. Henry [33] argues that an organisation's structure and design should be flexible for the strategic implementation to be effective. The author adds that strategies should be properly communicated to and understood by all stakeholders. Kazmi and Kazmi [40] explain that formulated strategies are implemented through managerial and administrative actions. According to Hill and Jones [38], managers put the implemented strategies into action, and add that the actions to be implemented should include a quality management system approach, prices, and choosing which service to keep or to discontinue. A value-adding analysis approach is used to identify gaps and unnecessary steps in the application process in order to eliminate them [31]. Korenova and Cepelova [45] assert that effective process management helps to reduce incompetence and the number of non-adding value activities.

d) Environmental scanning

In this phase, the implemented strategies are evaluated. This phase focuses on the future of the organisation, which mostly aligns with that of its executives [35]. Information is required in order for the executives to conduct analysis. Singh, Watson and Watson [35] argue that the required information is about competitors, suppliers, new technologies, labour markets, the economy, and the international scene. To access this information, executives rely on journals, internal sources, and close friends who are in similar industries. According to Kazmi and Kazmi [40], the environmental scanning phase ensures that the implemented strategies are evaluated and controlled to ensure competitive advantage. The authors add that improvements are carried out after the assessment of the strategies. Strategic evaluation and control are conducted by reformulating strategies [40].

e) Strategic control

This is the final phase of the strategic management model. To ensure effectiveness, processes need to be controlled to ensure positive results and, where necessary, to improve. Singh, Watson and Watson [35] are of the view that a well-articulated control approach could improve the possibility of implementing organisational strategies, whatever the situation an organisation faces. In the control phase, a strategic evaluation is performed, and control is often exercised [40]. The performance of the individual and of the organisation is compared with previous results, goals, and targets in order to make suitable modifications to strategies [35].

3. METHODOLOGY

3.1. Research methodology

This section discusses how the research was conducted. A qualitative research approach was adopted in this study. Mack [46] defines qualitative research as a type of scientific research that involves an investigation that seeks answers to a question, systematically using a prepared set of procedures to answer the question. This study used a qualitative research method to seek answers to the objectives of this study [46]. Guest, Namey and Mitchell [47] define qualitative research as that which applies methods such as studying participants' observation or case studies that lead to a description of an experience or practice. A structured interview approach was used to develop specific questions for data collection. Whitehead and Whitehead [48] define structured interviews as a list of set questions that are asked in a certain order and that are open-ended.

3.2. Data collection

The argument of Whitehead and Whitehead [48] is that there are no formal criteria for determining an ideal sample size in qualitative research. The authors add that no sample size is too small or too large if the 'richness' of the data that is collected satisfies the researcher, and that this is more important than the number of participants. Given this argument, eight approved drone operators and five drone operators waiting for SACAA approval – a total of 13 drone operators – agreed to participate in this study, and so made up the sample. A total of 13 interviews were conducted.

3.3. Data analysis

The view of Maxwell [49] is that qualitative data analysis is the process of explaining, grouping, and interconnecting occurrences with the researcher's theories. Thematic analysis (TA) is a method of detecting, analysing, and reporting re-occurrence within data to interpret different views of the subject matter in research [50]. The definition of Gavin [51] is that TA is a technique for systematically identifying and organising collected data to present an understanding using patterns. Gavin [51] adds that TA enables the researcher to make sense of the event or experience. Based on the arguments of the authors cited above, the data was analysed using TA, which was chosen because of its flexibility when using a qualitative approach.

4. RESULTS AND DISCUSSION

4.1. Participants' profiles

According to Kim [52], there is a need to improve drone regulations and the associated organisations to ensure growth in the drone market. In this section, the researcher sorts and analyses the collected data and reports the research findings. A descriptive analysis approach was used to describe and explain the data. The data was grouped using tables, graphs, and charts for interpretation, clarification, comparison, and understanding. Although 13 drone operators participated in this study. SACAA inspectors were not part of it; the reason given by SACAA was that there was no structure to accommodate students, but that it would be developed to handle students' request in the future.

Figure 4 shows the participants' years of experience. It can take years to acquire enough experience, and organisations rely on employees' experience for the company to be successful.

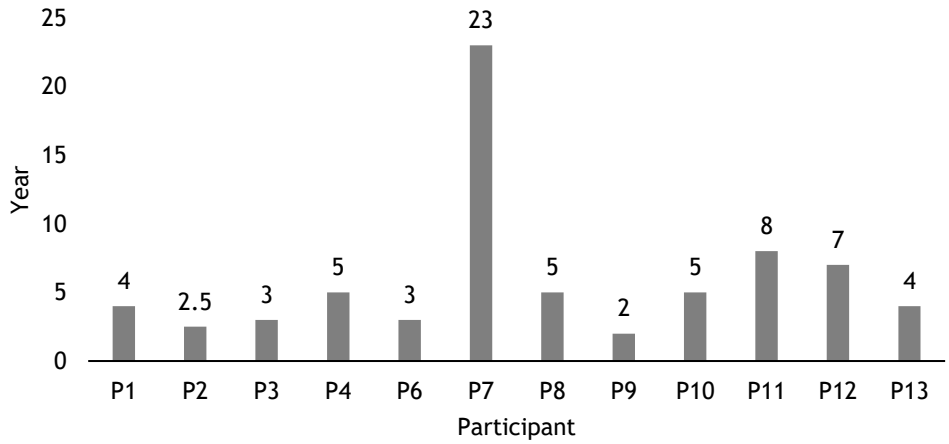

Figure 4: Participant's years of experience operating RPAS

Nine of the participants had experience of five years or less, and two participants had between six and ten years' experience. One had more than ten years' experience.

4.2. Drone operators' perceptions of the drone approval process

Figure 5 presents the participants' perceptions of the length of time taken to complete the RPAS application process. These are participants response regarding the time taken to complete the application process.

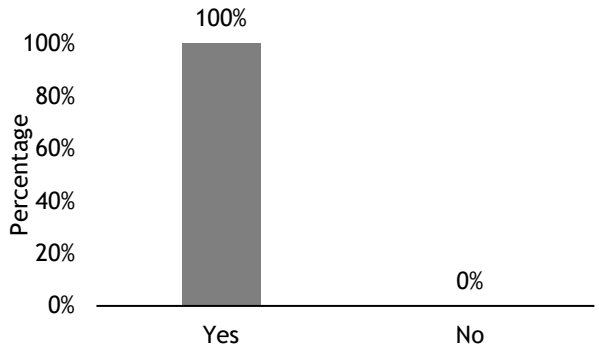

Figure 5: Participants' perceptions of duration of application process

All of the participants agreed that the application process took a long time for approval to be given. P4 mentioned that it was a complicated process. The results showed that none of the participants were satisfied with the existing drone application process. According to some of the participants' perceptions, the application process took longer to approve than that in other countries. This would have an impact on job creation in South Africa because drone companies would have to wait for longer to receive commercial operations approvals.

Figure 6 shows the results obtained in respect of the drone operators' views about the need to amend the existing Part 101 regulations.

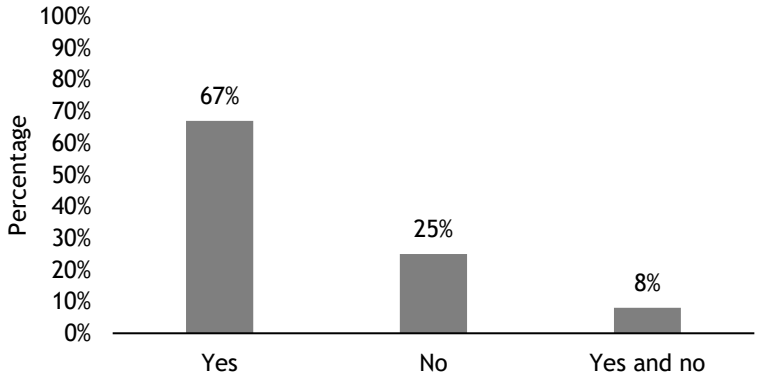

Figure 6: Need to amend the regulations

The majority of the participants (67%) indicated that there was a need to amend the regulations. P6 thought that the industry was over-regulated, and P8 believed that the regulations should be improved for better management. A quarter of the participants (25%) stated that the regulation should not be amended; P10 argued that that was how the industry would grow. Eight per cent were neutral, mentioning that the bar was unnecessarily high for drones, but that, on the other hand, the regulations were doing a great job to ensure safe operation.

The main issues were that the regulations created an obstacle because of their highly demanding requirements. This meant that the Part 101 regulations were not satisfactory for most of the drone companies, and that their amendment was needed. This addressed the research objective relating to the factors affecting the regulations and their impact on the growth of drone technology in South Africa.

Figure 7 shows the views of the participants about the need to improve the application process.

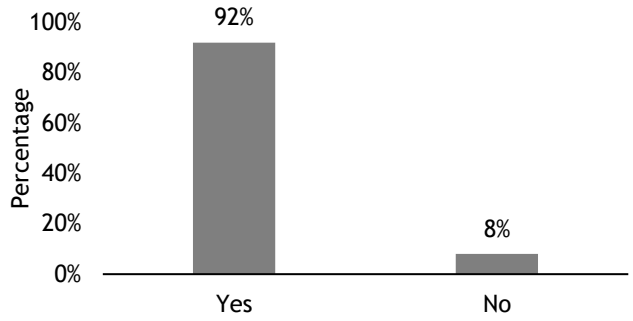

Figure 7: Application process improvement

The majority of the participants (92%) were of the view that the application process should be improved. P1 stated that the SACAA should consider digitalising some of the steps in the application process, including the confirmation of timelines for applications in order to prevent poor administrative governance and communication. P7 suggested that the demonstration phase should be improved.

Eight per cent of the participants were of the opinion that nothing should be improved, but that the SACAA needed to allocate additional personnel and that departments needed to be more efficient. This suggested that the current management process is not effective for the drone industry. Furthermore, there is a need to adopt a business process model to enhance the current application process. These results addressed the research objective about the factors affecting the management of the drone application process and regulation.

4.3. Improvements to the drone application process

Table 1 presents the responses from the participants about the validity period of the certificate or licence.

Table 1: Validity period of certificate or licence

Participant	Perception of validity period for ROC, RLA, and RPL
P1	– ROC is too short, and need to re-apply after nine months.
P2	– RLA should be changed to two years. – ROC and RPL are good.
P3	– Less than twelve months is too short. – It needs renewal three months before expiry date.
P4	– Perfectly fine.
P6	– It's normal for a year.
P7	– Lengthen the validity period.
P8	– it should be valid for three years.
P9	– Inspected once a year.
P10	– Costing is a bit expensive. – Complying yearly is perfect.
P11	– General aviation.
P12	– Way too harsh and waste of time and money.
P13	– Perfect.

Fifty-eight per cent of the participants were of the view that the twelve months' validity period of the certificates and licence was not sufficient. The issue was that drone operators were required to renew them three months before the expiry date; and if this were not done, it could impact their operations because their certificate or licence had become invalid.

Forty-two per cent of the participants stated that there was no need to increase the twelve months' validity period because it ensured that drone operators continued to comply annually and that there was constant contact between the regulator and the drone operators.

The majority of the participants preferred the validity period to be lengthened to at least twenty-four months. The results also revealed that the current twelve months' validity period contributed to delays because it created more work for the SACAA's inspectors: bottlenecks at the SACAA meant that SACAA inspectors had to deal with a lot of new applications and renewals at once, including the review of documentation, observing multiple demonstrations, and doing many inspections. The findings confirmed that the validity period of certificates and licences should be extended. This addressed the research objective on factors affecting the management of the drone application process and regulation.

4.4. Estimated turnaround time for all five approvals

The turnaround time (TAT) is used to assess a performance of a process. In this study, TAT was defined as the time taken to complete the application process at the SACAA from submitting the application to receiving the ROC. Figure 8 shows the participants' views of the adequacy of the SACAA turnaround time.

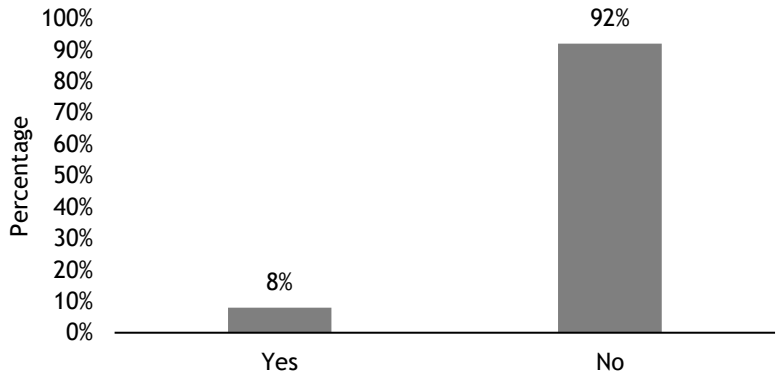

Figure 8: Turnaround time adequacy

Eight per cent of the participants believed that the application process was adequate, but also indicated that sometimes applicants needed to follow up and remind the SACAA to fast-track the process. The remaining 92% of the participants indicated that the TAT was not adequate, arguing that the application process was inefficient. This confirmed complaints by drone operators that the drone application process took too long to complete. This implied that there is a need to improve the TAT to satisfy drone operators. This addresses the question about the TAT of the application process at the SACAA.

4.5. Discussion of results

The participants expressed different views about the drone application process and the regulations. The experience of most participants of the application process and of the Part 101 regulations was that they are not well-structured and are not well-managed. Many of the participants did not support the Part 101 regulations, and proposed that they be amended to improve the current situation. It appears that the participants believed that some of the requirements of the Part 101 regulations were unnecessary, over-regulated, and complicated. This related to the research objective about the factors affecting the application process and the regulations.

Insights from the investigation revealed that the validity period of certificates and licences was another factor impacting the drone approval process. The results also revealed that annual renewals contributed to the flood of approval requests to SACAA's drone inspectors. Participants indicated that the validity period of ROCs and RLAs should be extended from twelve months to at least twenty-four months. Participants' sentiment was that drone regulations excluded SMEs and young entrepreneurs. Because drones are part of the Fourth Industrial Revolution, participation should be open to any South Africans, especially young people,e who wish to experience drone technology to the full.

Based on the evidence that the drone approval process is time-consuming, it is evident that applications will continue to pile up at the SACAA and so create more delays. This situation has led to drone operators believing that the SACAA has insufficient capacity and lacks resources. The findings revealed that there are insufficient staff to handle the number of incoming submissions. The SACAA's drone inspectors are heavily over-worked, meaning that they cannot handle incoming applications for approval. Therefore, a lack of capacity and resources is another factor contributing to the delays, as reflected in the research objective about the factors affecting the application process and regulation, as well as the growth of drone technology in South Africa. The findings confirmed that there a need to resource the SACAA to reduce the bottlenecks.

Huge amounts of capital are needed to participate in the drone industry business, which aligns with the research objective about what affects the growth of drone technology in South Africa. The system is designed in such a way that it limits people from joining the commercial drone business. Some of the participants' judgement was that it does not favour previously disadvantaged groups and young entrepreneurs, thus also contributing to the impact on the growth of drone technology in South Africa. It was clear from the respondents' views that the costs are too high, thus limiting participation in the drone industry.

It is evident that the drone industry is still growing in South Africa, and continues to build capabilities regarding this technology. South Africa is leading Africa in the regulation of drones; therefore, the SACAA should focus on addressing the concerns raised by the drone industry and improving its processes. The implications of all the factors mentioned above limit the opportunities to use drone technology fully, the growth of the drone technology, and the fuller participation of all who are interested. Therefore, it would be crucial for all stakeholders to consider and address the findings of this study. This would help South Africa to compete against and keep pace with countries such as Australia, the USA, and the UK in drone-related innovations.

4.6. Towards strategic management of SACAA's processes and regulations

4.6.1. Strategic objectives

It is vital for the SACAA to maintain the organisation according to it vision and mission. Where strategic objectives need to be re-visited, defining the corporate and business levels of strategy that are the focus of the company's executives should be performed [40]. The corporate strategy should define what the SACAA's business is, and how it is managed and structured [39], while the business-level strategy should focus on the development of competitive advantage to raise the service level of the organisation [39].

4.6.2. Strategy formulation

As a regulator, the SACAA should formulate strategies that improve the current situation. Strategies are formulated in conditions when there are rapid changes in the environment of the organisation [53]. These conditions include new technologies and rapid changes in the market or outside the organisation [53]. Drones are a new technology that needs to be effectively integrated into South African industries and public spaces. The findings of this study indicate that the application process and the regulation of drones are not implemented well; there is thus a need to formulate strategies to improve the application and regulation processes. Experience is no longer sufficient to cope with the new changes without bringing the strategy of the organisation to bear [53]. Therefore, it is important to evaluate the strategies and to ralionalise them where necessary.

Strategies that need to be formulated to manage the drone application and regulation processes are discussed below.

a) Regulation

Since drones are gaining the world's attention, Stöcker *et al*. [54] argue that market forces and national laws will drive the approach to regulation, and add that a risk-based approach could be used to drive the regulatory framework by focusing on the principle that the riskier that something is for an operation, the greater the need for requirements to be fully enforced. Baldwin *et al*. [15] describe good regulation as an enforcement that consists of action supported by legislative authority, fair procedures that are accessible to all, and sufficient expertise.

A drones stakeholders' forum could efficiently build this industry and come up with good ideas for it on the basis of their experience. Ivošević *et al*. [55] suggest that a separate research team be formed to generate ideas to support participation in the drone environment. Freeman and McVea [56] argue that stakeholders' management structures should develop ways to manage the various groups and relationships to ensure a strategic approach. Furthermore, to ensure smooth long-term operations and good management, management should understand stakeholders' needs [56]. A factual approach would be essential to making effective decisions that are based on the analysis of gathered data [57].

In addition, regulation of the industry should be developed with expertise that includes all stakeholders who are interested in ensuring the effectiveness of its enforcement. These are some of approaches that could be applied to the growth of regulation in South Africa.

Step 1: Selection of effective drone regulation for commercial drones

There are various approaches that previous authors have suggested to improve drone regulations. Figure 9 below shows the recommendation that the Part 101 regulations should be *amended* by including all stakeholders to ensure that the regulations that are implemented are practical and benefit all interested. The Part 101 regulations should be structured to allow quicker changes when *new technologies* arise, because drone technology keeps evolving. A regulatory approach should be *risk-based,* and should fully enforce requirements that would mitigate safety risks to the public.

A risk-based approach to regulation would allow for the enforcement of requirements for high-risk operations – meaning that the piling up of drone approval applications would be eased. This would allow the SACAA and the drone industry to implement changes that fit drone technology well. This should be implemented with the consensus of all affected stakeholders. Switzerland was the first country to adopt a risk-based approach to solving the issues of regulating drones [58]. The European drone steering group and the United States drone advisory committee have influenced a risk-based approach to drones [59].

To oversee the drone operations, European Aviation Safety Agency (EASA) recommended a risk-based regulatory approach to replace the existing drone regulations [60]. This approach could lower the high barriers and increase participation in the use of drone technology.

b) Process

Von Rosing *et al*. [61] define 'process analysis' as a breakdown of all the related aspects in each step, including the inputs, outputs, and process management functions during each step. Process analysis is a good way to analyse and identify issues in a process.

Zur Muehlen and Ho [62] regard BPM as a crucial strategy to maintain competitive advantage by the restructuring and monitoring of processes. The opinion of Russack and Menges [63] is that process models could be used in areas of application such as process analysis, process improvements, certifications systems, and training. BPM could be seen as a collection of methodologies, techniques, and tools that support the analysis of and improvements to business processes [64]. Process management plays an important role in maintaining a good process [65-66]. Dumas *et al*. [31] argue that process management manages how work is performed in an organisation to ensure positive outcomes. Korenova and Cepelova [45] state that process management leads to the growth of competitiveness, efficiency, and performance.

Step 2: Documentation of the drone approval process for improvement

Processes should be continually improved to keep up with changes and new technology. Figure 9 shows that the process should be analysed for improvement. A process analysis approach could assist the SACAA to identify weaknesses and their impact on the existing process. Also, *information technology* should be integrated, where relevant, to improve business performance.

The drone approval process should be updated, made more *transparent*, and allow the participation of all interested *stakeholders*. It is important to ensure that all employees accept and adopt new or updated processes. It is also important that all personnel with expertise participate during process improvement [67]. Process management plays a crucial role in the performance and output results of a process. Good process management leads to growth.

c) Capacity

Martin [68] asserts that there is a relationship between TAT and effective capacity. In most cases, a longer TAT is created by a lack of capacity and resources. Bolger [69] defines 'capacity' as the understanding, attitude, ability, skills, values, motivation, and conditions that enable organisations to function in order to meet their goals. Capacity helps organisations or individuals to meet set objectives. The suggestion by CUAASA [26] is that the creation of a dedicated unit to focus on drone approval processes is important. Effective capacity allows processes to run smoothly in order to complete work within a reasonable period.

Capacity is usually measured by involving human, technological, and financial capital resources [70]. Human resources are a crucial element to ensure sufficient capacity. Bolger [69] describes capacity development as an approach, strategy, and method to improve individual and organisational performance. A positive approach to the development of capacity is essential to ensure that it is effective and efficient.

Step 3: Capability to handle the drone approvals workload

The recommendations in Figure 9 are that roles and responsibilities should be *assigned* to personnel to ensure an effective process. The figure also shows that training personnel should be *prioritised* to ensure that all are competent to do their work. Capacity means having personnel who have adequate training and competence to do so. Blokland, Alaerts, Kaspersma and Hare [71] affirm that capacity enhancement should be about establishing a suitable environment and opportunities to motivate personnel. Hiring additional inspectors, having a good financial standing, and integrating technology would help to improve the SACAA's capacity.

The ongoing training of personnel who have expertise is essential, as it gives the organisation more experience to compete with other organisation in the same field. Therefore, a continual assessment of expertise is necessary to *reinforce* and enhance the knowledge and skills of personnel. The involvement of personnel in process management would allow the process to benefit from their expertise [71]. Training and competence should be prioritised to ensure employees' growth and to establish opportunities for growth.

d) Turnaround time

According to Martin [68], a quick TAT is a requirement for a company that needs to be competitive. A quick TAT helps to reduce the work-in-progress in a process [64]. An effective TAT improves productivity and reduces workloads. A study by Zelt, Recker, Schmiedel and Vom Brocke [72] indicates that the efficient partial automation of processes could help to fast-track and improve their TAT. Automation helps to eliminate some of the unnecessary or exhausting tasks that leads to human error [73].

Competence also plays a vital role in ensuring a good TAT. Epstein and Hundert [74] argue that competence involves technical skills, good reasoning, emotions, values, and reflection in daily practice. Dumas *et al.* [31] explain that processes can be fast-tracked by conducting some of the activities in parallel. Such parallelism allows a company to assess its processes and to see whether some of the activities could be done in parallel. A realistic timeline is key to ensuring that a stated TAT is met. The view of CUAASA [26] is that a TAT of three months could grow the drone industry. Introducing technology into a process can improve its productivity. Sujova and Marcinekova [75] found that the use of technology that supports the market's needs is essential to improve processes.

Step 4: Effective approach to conducting activities within turnaround time

This study recommends that the lead time of the application process be shortened to meet a three-month TAT. Technology is being used by many organisations to replace some of the activities in their processes. Likewise, Figure 9 shows that *the digitilisation* of process activities wherever possible would help to improve their TATs. The integration of partial automation and the digitisation of some of the steps would help the SACAA to minimise the time taken to complete the drone approval process. Technology integration could include conducting virtual inspections and assessments, hosting one-on-one meetings, and observing testing or flying instead of visiting the customer's premises. Having additional personnel to reduce the workload would also be important.

Another way to improve TAT is to conduct work in parallel and to re-arrange process activities [76]. *Re-arranging* activities is done during the re-designing of the process, and checks which activities could be moved or removed. Unnecessary activities that reduce the process's efficiency should be identified and *eliminated*. Eliminating unnecessary steps should not affect the output of the process.

Figure 9 illustrates the strategies that should be used to manage the drone application process and regulation.

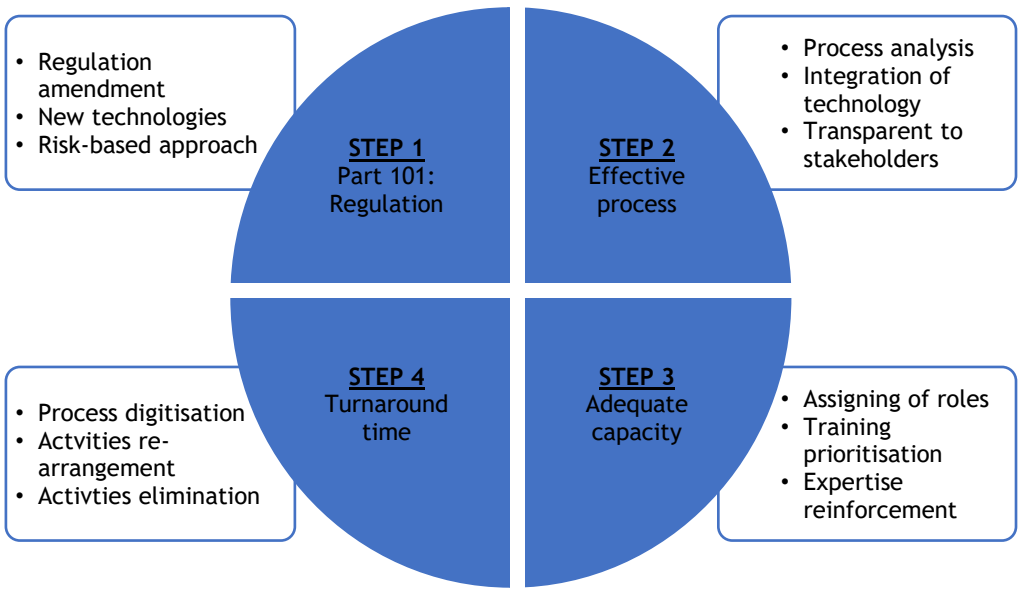

Figure 9: Recommended strategies

5. CONCLUSION AND RECOMMENDATIONS

This study was conducted to investigate the factors affecting the drone application process, its regulations, and their impact on the growth of drone technology, as well as the turnaround time. It is evident that

commercial drones will be one of the major contributors to the South African economy. Therefore, strategies for addressing the existing challenges were developed.

The researcher recruited drone operators to participate in order to meet the objectives of this study. The investigation was done by interviewing the drone operators and by conducting an extensive literature survey. Various views from the participants were noted, and the findings of the research were captured. Factors affecting the management of the drone approval process were identified, and then strategies to improve the situation were developed. The strategies were developed in the form of a framework that could be used to improve the structure of the drone industry.

The conclusions of this study are the following:

a) The turnaround time of the application process is too long, and there is inadequate capacity to handle the applications. The ensuing delays have caused drone operators to be financially impacted.

b) The existing drone regulation framework needs to be amended to accommodate the majority of the drone industry.

c) To manage the application process better, a few changes need to be made by the SACAA, as indicated in the strategies formulated in this study.

d) The validity period of certificates and licences contributes to delays in the drone approval process.

e) The drone approval process needs to be improved.

There is a dearth of information about the present situation at the SACAA and the status of strategies to improve the drone application process. The Part 101 regulations for drones in South Africa have not been sufficiently highlighted in the literature.

Several recommendations could be made to improve the current situation:

a) Review the validity period to extend it by including relevant stakeholders (Drone TC, SACAA, drone operators).

b) Ease the drone regulations to remove barriers to participation.

c) Establish a drone support structure and funding to help increase the growth of drones in South Africa.

d) Increase the ROCs' productivity by improving processes and resources.

e) Consider the strategies developed in this paper to improve the drone approval process.

REFERENCES

[1] **Emma-Iwuoha, L.** 2018. *Drone law or regulations in South Africa: Get up to speed.* [Online]. Available from: https://www.michalsons.com/blog/drone-law-in-south-africa/16543 [Accessed: 03/03/2020].

[2] **Newzroom Afrika**. 2020. *Captain Eric Mataba from Civil Aviation Authority, 15 Feb '20*. [Online]. Available from: https://www.youtube.com/watch?v= 4XLlCOTT1zo [Accessed: 06/04/2020].

[3] **Khan, R., Tausif, S. & Javed Malik, A.** 2019. Consumer acceptance of delivery drones in urban areas. *International Journal of Consumer Studies*, 43(1):87-101.

[4] **Fernandez, P.** 2016. 'Through the looking glass: envisioning new library technologies' understanding artificial intelligence. *Library Hi Tech News*, 33(3):20-23 [Online]. Available from: https://doi.org/10.1108/LHTN-03-2016-0013 [Accessed: 04/04/2020].

[5] **Hodgkinson, D. & Johnston, R.** 2018. *Aviation law and drones: Unmanned aircraft and the future of aviation*. Abingdon: Routledge.

[6] **Lawrenson, T. & De Oliveira, R.** 2018. *South Africa. Without DRONE-ing on: A legal overview of drones in South Africa*. [Online]. Available from: https://www.mondaq.com/southafrica/aviation/746350/without-drone-ing-on-a-legal-overview-of-drones-in-south-africa [Accessed: 05/03/2020].

[7] **Republic of South Africa**. 2015. Eighth amendment of the Civil Aviation Regulations, Part 101: Remotely piloted aircraft systems. *Government Gazette*, No. 38830, 27 May.

[8] **Tsiamis, N., Efthymiou, L. & Tsagarakis, K.P.** 2019. A comparative analysis of the legislation evolution for drone use in OECD countries. *Drones*, 3(75):1-15.
[9] **Sandvik, K.** 2015. African drone stories. *Behemoth: A Journal on Civilization*, 8(2):73-96.
[10] **Industryarc**. 2019. *South Africa small drones market – Forecast (2021 – 2026)*. [Online]. Available from: https://www.industryarc.com/Report/18573/south-africa-small-drones-market.html [Accessed: 26/02/2021].
[11] **Bödecker, H. & Wackwitz, K.** 2017. *Drone industry insights. Rough and tough – Drones for Australia's industry. How to select a drone for multiple industrial applications.* [Online]. Available from: https://droneii.com/wp-content/uploads/2017/09/ Rough-and-Tough-Drones-for-Australias-Industry.pdf [Accessed: 21/10/2020].
[12] **Bright, J.** 2016. *Africa's commercial drones take off*. [Online]. Available from: https:// techcrunch.com/2016/03/02/africas-commercial-drones-take-off/ [Accessed: 12/05/2020].
[13] **Jackson, T.** 2016. *NewAfrican: Can drones propel Africa's infrastructure?* [Online]. Available from: https://newafricanmagazine.com/20495/ [Accessed: 22/10/2020].
[14] **International Civil Aviation Organization.** 2015. *Manual on remotely piloted aircraft systems (RPAS)*. Montreal: International Civil Aviation Organization.
[15] **Baldwin, R., Cave, M. & Lodge, M.** 2011. *Understanding regulation: Theory, strategy, and practice*. New York: Oxford University Press.
[16] **Raj, P.K. & Chirputkar, A.** 2020. Conceptual framework for use of drones in manufacturing industry. *PalArch's Journal of Archaeology of Egypt/Egyptology*, 17(6):4462-4470.
[17] **Stöcker, C., Bennett, R., Nex, F., Gerke, M. & Zevenbergen, J.** 2017. Review of the current state of UAV regulations. *Remote Sensing*, 9(4590;1-26.
[18] **Dima, F.** 2017. Recreational vs commercial drone use under new drone laws: Drone technology and human rights. BSc. thesis, University of Twente, Netherlands.
[19] **Clarke, R.** 2016. Appropriate regulatory responses to the drone epidemic. *Computer Law & Security Review*, 32(1):152-155.
[20] **Rawlins, L.K.** 2018. *Drone fever attacks South Africans.* [Online]. Available from: https://www.itweb.co.za/content/rW1xL755WPj7Rk6m [Accessed: 06/04/2020].
[21] **Zwickle, A., Farber, H.B. & Hamm, J.A.** 2019. Comparing public concern and support for drone regulation to the current legal framework. *Behavioral Sciences & the Law*, 37(1):109-124.
[22] **Cunliffe, A.M., Anderson, K., Debell, L. & Duffy, J.P.** 2017. A UK Civil Aviation Authority (CAA)–approved operations manual for safe deployment of lightweight drones in research. *International Journal of Remote Sensing*, 38(8-10):2737-2744.
[23] **Tobór, D., Barcik, J. & Czech, P.** 2017. Legal aspects of air transport safety and the use of drones. *Scientific Journal of Silesian University of Technology. Series Transport*, 97:167-179.
[24] **Drone Council of South Africa.** 2020. *Drone Council South Africa launch*. [Online]. Available from: https://www.youtube.com/watch?v=sqlwJ0rzzjA&feature=youtu.be [Accessed: 20/10/2020].
[25] **Charles, M.** 2020. *R500k drones purchased by City of Cape Town fails to get off the ground*. [Online]. Available from: https://www.iol.co.za/capeargus/news/r500k-drones-purchased-by-city-of-cape-town-fails-to-get-off-the-ground-40254853. [Accessed: 03/03/2020].
[26] **Commercial Unmanned Aircraft Association of Southern Africa**. 2019. *CUAASA and Department of Economic Development host drone policy dialogue*. [Online]. Available from: https://cuaasa.wixsite.com/cuaasa/single-post/2019/03/31/CUAASA-and-Department-of-Economic-Development-host-Drone-Policy-Dialogue [Accessed: 27/02/2021].
[27] **Nagiah, K.** 2020. *#BizTrends2020: The future of flying drones in South Africa*. [Online]. Available from: https://www.bizcommunity.com/Article/196/727/199607.html [Accessed: 06/04/2020].
[28] **Gregorski, M.** 2018. Analysis of international law on unmanned aerial vehicles through the prism of European Union law. *Przegląd Europejski*, 4(50):73-93.
[29] **Ayamga, M., Tekinerdogan, B., Kassahun, A. & Rambaldi, G.** 2021. Developing a policy framework for adoption and management of drones for agriculture in Africa. *Technology Analysis & Strategic Management*, 33(8):970-987.
[30] **Chen, G.Y.** 2017. Reforming the current regulatory framework for commercial drones: Retaining American businesses' competitive advantage in the global economy. *Northwestern Journal of International Law and Business*, 37(3):517–541.
[31] **Dumas, M., La Rosa, M., Mendling, J. & Reijers, H.A.** 2013. *Fundamentals of business process management*. Berlin: Springer-Verlag.
[32] **South African Civil Aviation Authority**. 2017. *Drone regulation.* [Online]. Available from: http://www.caa.co.za/Pages/About%20Us/Our-Strategic-Intent.aspx [Accessed: 05/05/2021].
[33] **Henry, A.** 2008. *Understanding strategic management*. Oxford University Press, London, UK.
[34] **Hubbard, G., Rice, J. & Galvin, P.** 2014. *Strategic management*. Pearson, London, UK.

[35] **Singh, S.K., Watson, H.J. & Watson, R.T.** 2002. EIS support for the strategic management process. *Decision Support Systems*, 33(1):71-85.
[36] **Hron, J.** 2006. Knowledge and strategic management. *Zemedelska Ekonomika-Praha-*, 52(3):101-106.
[37] **Tikkanen, J. & Halinen, A.** 2003. Network approach to strategic management–exploration to the emerging perspective. In *Proceedings of the 19th IMP International Conference, Lugano, Switzerland*, pp. 1-23.
[38] **Hill, C.W. & Jones, G.R.** 2011. *Essentials of strategic management*. 3rd Edition, Cengage Learning, Boston, United States.
[39] **Kraus, S. & Kauranen, I.** 2009. Strategic management and entrepreneurship: Friends or foes? *International Journal of Business Science & Applied Management (IJBSAM)*, 4(1):37-50.
[40] **Kazmi, A. & Kazmi, A.** 1992. *Strategic management*. McGraw-Hill Education, New York, United States.
[41] **Tricker, R.** 2014. *ISO 9001: 2008 for small businesses*. Abingdon: Routledge.
[42] **Magodi, Y., Daniyan, I.A. & Mpofu, K.** 2022. Application of Lean Six Sigma to a small enterprise in the Gauteng province: A case study. *South African Journal of Industrial Engineering*, 33(1):190-204.
[43] **Smart, P.A., Maddern, H. & Maull, R.S.** 2009. Understanding business process management: Implications for theory and practice. *British Journal of Management*, 20(4):491-507.
[44] **Daniyan, I. A., Adeodu, A.O., Mpofu, K., Maladhzi, R. & Kana-kana Katumba, M.G.** 2022. Application of Lean Six Sigma methodology using DMAIC approach for the improvement of bogie assembly process in the railcar industry. *Heliyon*, 8(2022), e09043:1-14.
[45] **Korenova, D. & Cepelova, A.** 2016. Factors influencing process management and effective operation of public administration organizations. *Actual Problems of Economics*, 3(177):80-88.
[46] **Mack, N.** 2005. *Qualitative research methods: A data collector's field guide*. [Online]. Available from: http://repository.umpwr.ac.id:8080/bitstream/handle/123456789/3721/ Qualitative%20Research%20Methods_Mack%20 et%20al_05.pdf?sequence=1 [Accessed: 05/04/2020].
[47] **Guest, G., Namey, E.E. & Mitchell, M.L.** 2013. Qualitative research: Defining and designing. In *Collecting qualitative data*. London: Sage, pp. 1-40.
[48] **Whitehead, D. & Whitehead, M.** 2016. Sampling data and data collection in qualitative research. Edited by Schneider, Z. & Whitehead, D. In *Nursing and midwifery research: Methods and appraisal for evidence-based practice*,pp. 111-123.
[49] **Maxwell, J.A.** 2012. *Qualitative research design: An interactive approach*. Thousand Oaks, CA: Sage.
[50] **Clarke, V. & Braun, V.** 2017. Thematic analysis. *The Journal of Positive Psychology*, 12(3):297-298.
[51] **Gavin, H.** 2008. *Understanding research methods and statistics in psychology*. Sage, Newcastle, UK.
[52] **Kim, H.W.** 2017. A study on application methods of drone technology. *The Journal of Korea Institute of Information, Electronics, and Communication Technology*, 10(6):601-608.
[53] **Ansoff, H.I., Kipley, D., Lewis, A.O., Helm-Stevens, R. & Ansoff, R.** 2018. *Implanting strategic management*. Springer, Germany.
[54] **Mithas, S., Krishnan, M.S. & Fornell, C.** 2005. Why do customer relationship management applications affect customer satisfaction? *Journal of Marketing*, 69(4):201-209.
[55] **Ivošević, B., Han, Y.G., Cho, Y. & Kwon, O.** 2015. The use of conservation drones in ecology and wildlife research. *Journal of Ecology and Environment*, 38(1):113-118.
[56] **Freeman, R.E. & McVea, J.** 2001. A stakeholder approach to strategic management: In *the Blackwell Handbook of Strategic Management*, edited by Hitt, M. A., Freeman, E. & Harrison, J. S. Wiley-Blackwell, New Jersey, United States, pp. 189-207.
[57] **Rosemann, M. & Vom Brocke, J.** 2015. The six core elements of business process management. In Vom Brocke, J. & Rosemann, M. (eds), *Handbook on business process management, 1. I**ntroduction, methods, and information systems, 2nd edition***. Berlin, Heidelberg: Springer, pp. 105-122.
[58] **Duelli, C., Keller, R., Manderscheid, J., Manntz, A., Röglinger, M. & Schmidt, M.** 2018. Enabling flexible laboratory processes: Designing the laboratory information system of the future. In Vom Brocke, J. & Mendling, J. (eds), *Business process management cases*. Cham: Springer, pp. 361-379.
[59] **African Union.** 2019. *Drones on the horizon transforming Africa's agriculture*. [Online]. Available from: https://www.nepad.org/publication/drones-horizon-transforming-africas-agriculture [Accessed: 15/05/2021].
[60] **Papademetriou, T.** 2016. Regulation of drones: European Union. In *The Law Library of Congress, Global Legal Research Center*, pp. 122-132.
[61] **Von Rosing, M., Foldager, U., Hove, M., Von Scheel, J. & Bogebjerg, A.F.** 2015. *Working with the business process management (BPM) life cycle*. [Online]. Available from: https://0-www-sciencedirect-com.tkplib01.tut.ac.za/science/ article/pii/ B9780127999593000148 269-345 [Accessed: 16/09/2020].

[62] **Zur Muehlen, M. & Ho, D.T.Y.** 2005. Risk management in the BPM lifecycle. In *International Conference on Business Process Management*. Berlin, Heidelberg: Springer, pp. 454-466.
[63] **Russack, T. & Menges, S.** 2018. Supporting process implementation with the help of tangible process models. In Vom Brocke, J. & Mendling, J. (eds), *Business process management cases*. Cham: Springer, pp. 541-555.
[64] **Melão N. & Pidd, M.** 2000. A conceptual framework for understanding business processes and business process modelling. *Information Systems Journal*, 10(2):105-129.
[65] **Magodi, Y., Daniyan, I.A. & Mpofu, K.** 2022. An investigation of the effect of the ISO 9001 quality management system on small and medium enterprises in Gauteng, South Africa. *South African Journal of Industrial Engineering*, 33(1):126-138.
[66] **Foster, S.T.** 2013. *Managing quality: Integrating the supply chain*. Harlow: Pearson Education Limited.
[67] **Vom Brocke, J. & Mendling, J. (eds).** 2017. *Business process management cases: Digital innovation and business transformation in practice*. Cham, Switzerland: Springer.
[68] **Martin, D.P.** 1993. Key factors in designing a manufacturing line to maximize tool utilization and minimize turnaround time. In *IEEE/SEMI International Semiconductor Manufacturing Science Symposium*, IEEE, pp. 48-53.
[69] **Bolger, J.** 2000. Capacity development: Why, what and how. *Capacity Development Occasional Series*, 1(1):1-8.
[70] **Preston, B.L. & Stafford-Smith, M.** 2009. *Framing vulnerability and adaptive capacity assessment: Discussion paper*. CSIRO Climate Adaptation Flagship Working Paper No. 2. [Online]. Available from: http://www.csiro.au/org/ClimateAdaptationFlagship.html [Accessed: 06/04/2020].
[71] **Blokland, M., Alaerts, G., Kaspersma, J. & Hare, M.** 2009. *Capacity development for improved water management*. Delft: CRC Press.
[72] **Zelt, S., Recker, J., Schmiedel, T. & Vom Brocke, J.** 2019. A theory of contingent business process management. *Business Process Management Journal*, 25(6):1291-1316.
[73] **De Feo, J.A.** 2015. *Juran's quality Management and analysis*. New York: McGraw-Hill Education.
[74] **Epstein, R.M. & Hundert, E.M.** 2002. Defining and assessing professional competence. *Jama*, 287(2):226-235.
[75] **Sujova, A. & Marcinekova, K.** 2015. Modern methods of process management used in Slovak enterprises. *Procedia Economics and Finance*, 23:889-893.
[76] **Mokoena, Q., Daniyan, I. A., Mpofu, K. and Abisuga, O.** 2022. Development of a framework for improving the turnaround time of the application process at the South African Civil Aviation Authority. *Heliyon*, 8 (e10075): 1-9.