

R&D and Innovation Capabilities in South African State-Owned Enterprises: The Case of Air Traffic & Navigation Services SOC Ltd



Centre for Science,
Technology and
Innovation Indicators,
Human Sciences
Research Council

WORKING PAPER SERIES
No. 2c | February 2022

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CeSTII, 2022. *R&D and Innovation Capabilities in South African State-Owned Enterprises: The Case of Air Traffic & Navigation Services SOC Ltd.*
Cape Town: Human Sciences Research Council.

Date of publication: February 2022
Copy editing: Katharine McKenzie
Design and layout: Tracey Watson

Unless otherwise specified, images courtesy of ATNS and used with thanks.

This report forms part of WORKING PAPER SERIES 2a-d (February 2022)

— 2a: Gearing for R&D and Innovation in South African State-Owned Enterprises – Findings from Case Studies of ATNS, SANEDI and SAFCOL.
Pretoria: Human Sciences Research Council.

— 2b: R&D and Innovation Capabilities in South African State-Owned Enterprises: The Case of the South African National Energy Development Institute (SANEDI).
Cape Town: Human Sciences Research Council.

— 2c: R&D and Innovation Capabilities in South African State-Owned Enterprises: The Case of Air Traffic & Navigation Services SOC Ltd.
Cape Town: Human Sciences Research Council.

— 2d: R&D and Innovation Capabilities in South African State-Owned Enterprises: The Case of South African Forestry Company SOC Ltd (SAFCOL).
Cape Town: Human Sciences Research Council.

All papers in the series can be downloaded from
<http://www.hsrc.ac.za/en/departments/CeSTii/reports-cestii>

EXECUTIVE SUMMARY

This case study research report, commissioned by the Department of Science and Innovation (DSI), analyses R&D and innovation capabilities in the South African state-owned enterprise, Air Traffic and Navigation Services SOC Ltd (ATNS). It situates ATNS within its unique innovation system, examining five key dimensions within the organisation: human capabilities, technological capabilities, networks, research infrastructure, and governance. The research also explores ATNS's plans and strategies to develop its R&D and innovation capabilities, including a new R&D Strategy and the less recent 2017 Amendment Bill to its founding legislation, to enable the entity to conduct business outside the borders of the Republic. Where possible, the analysis is punctuated with examples of ATNS's R&D and innovation outputs as well as unit-level R&D Survey data pertaining to ATNS.

The mandate of ATNS is to acquire, establish, develop, provide, maintain, manage, control or operate air navigation infrastructures, air traffic services or air navigation services. Almost all ATNS's revenue (90%) is generated through its regulated business, with its non-regulated business enabling revenue generation (10%) through training and technology consulting services.

As a key innovation activity, ATNS performs research and experimental development (R&D) to solve air traffic management and navigation-related problems, including the adaptation of internationally-manufactured equipment to local conditions and exigencies. The outcomes of R&D lead predominantly to new process development or process improvements (process innovation), with some new product development and improvement (product innovation). Notably, ATNS operates an extremely well-established training academy, where staff are capacitated for various roles within the ATNS business and suite of regulated services (product and process innovation).

The ATNS R&D and innovation team comprises researchers, engineers, and technicians in different parts of the organisation and includes technical, marketing, training, and strategy executives.

Technologically, ATNS makes use of advanced high-tech facilities, such as ground-based primary and secondary radar and navigation and surveillance systems, which are procured routinely as part of the entity's capital expenditure. Advances in satellite-based systems, and interoperability, will necessitate adjustments to ATNS's systems in the future. Global corporations, such as Thales, are among the principal original equipment manufacturers (OEMs) with which ATNS interacts on a regular basis. Senior executives at ATNS interviewed for this research expressed the view that relatively little has been done to leverage the skills and knowledge in South Africa to produce some of these facilities. R&D and innovation could lead to the development of new products for the country, but this is not necessarily a 'quick win'.

In terms of research infrastructure, defined by the South African Research Infrastructure Roadmap, the ATNS R&D team use predominantly desktop-based applications in relation to existing air traffic management infrastructure and systems, as opposed to dedicated laboratory or experimentation facilities. A key point of this case study is that the physical and digital infrastructure that ATNS implements in its core business represents, in effect, a type of research infrastructure that is—and can be used—as the basis for R&D and innovation activity.

Encouragingly, ATNS does not pursue R&D or innovation in isolation; it works with a number of partners, including South African and international universities, science councils, and other agencies. The National Aeronautical Centre (NAC), the Technology Innovation Agency

(TIA), and the Council for Scientific and Industrial Research (CSIR) are among the key South African partners that help it to fill critical capacity gaps. It also works with private sector actors, such as Aireon, on special projects. To deepen its networks, ATNS organises the annual Avi Afrique innovation summit to discuss key issues for air traffic navigation management and service provision, a gathering that helps ATNS to cement existing relationships, including and especially with African partners, and develop new ones.

Collaboration at ATNS, as this report shows, fulfils a number of purposes: sharing knowledge and ideas; promoting human capital development, in particular development of skills in the ICT field and addressing historical imbalances of high skilled engineers; remaining abreast of advancements at the technological frontier; as well as working with local and global industry regulatory actors to ensure air traffic is accident free. An openness and willingness to engage in collaboration with other role-players, such as the Square Kilometre Array (SKA), where there is a good business case to do so, or a key problem to be solved, was also a finding of this research.

At the level of governance, ATNS appears to have elevated the role of R&D in the past two years. It has elaborated a strategy for R&D, with the fourth industrial revolution as a key framing concept, and a dedicated steering committee. Both executive management and the board support the strategy. In this way, R&D is beginning to play a more prominent role within the ATNS business model.

The case study argues that ATNS is successfully fostering a culture of R&D and innovation within the organisation, in the context of its unique and favourable position as arguably the leader of air traffic and navigation services on the African continent and the southern Indian Ocean region more broadly. This culture of R&D and innovation is reinforced at the level of executive leadership and the board, but also reflected in increased expenditure on R&D over the past five years, and events such as the Avi Afrique innovation summit.

An important question addressed by this case study is which dimensions could be crucial in gearing ATNS to perform R&D and innovation effectively and efficiently in the future. Given its limited resources and the highly regulated nature of the aviation industry, attempting to outstrip global leaders in the development of air traffic and navigation management technology, predominantly supplied by a few large multinational companies, would be a high-risk option outside of the core mandate of the organisation. However, ATNS could deepen its R&D and innovation capabilities through strategic collaboration investments in areas with potential for long-term revenue growth. This includes training, for example, as well as greater focus on the IP protection of adaptive innovations that could yield commercial benefits or product development in the future. An example is the organisation's database of aeronautical information. An additional key challenge for ATNS in respect of its R&D and innovation capabilities is its capacity to respond to exponential technological changes and big data convergence within the air traffic and navigation global business environment, which anticipates a single globally-interoperable system in the future.

In summary, this report is a snapshot of the unique character of R&D and innovation at ATNS in terms of critical dimensions such as human and technological capabilities, collaboration, research infrastructure, and governance, highlighting challenges and opportunities for consideration by the entity and stakeholders within its innovation system.

SUMMARY FINDINGS AND RECOMMENDATIONS

| Findings | Recommendations |
|---|---|
| <p>ATNS appears to be committed to fostering a culture of R&D and innovation within its organisation.</p> | <p>A culture of R&D and innovation could be reinforced and strengthened through targeted organisational investments, incentives, and international learning exchanges, as well as the reinforcement of linkages across the national system of innovation.</p> |
| <p>ATNS appears to be paying greater attention to becoming an innovator ‘in its own right’, as opposed to pure reliance on OEM.</p> | <p>As part of its R&D strategy, ATNS could develop an in-depth assessment of its current technological capabilities, to identify potential niche areas for new technological development.</p> |
| <p>ATNS is well-positioned to innovate in a variety of areas, especially training, through service level agreements with other African countries.</p> | <p>The enactment of legislation enabling ATNS to operate as a fully-fledged business entity outside of South Africa could drive future R&D and innovation, and impact business revenue growth in the short term.</p> |
| <p>ATNS’s nascent R&D team and the partnerships it has cultivated are credited with the entity’s good R&D and innovation governance.</p> | <p>Continued emphasis, at the highest level of governance and executive management, should be placed on fostering collaboration and partnerships and building institutional networking skills.</p> |

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ACRONYMS

| | |
|----------------|--|
| ACSA | Airports Company South Africa |
| AFTM | Air Traffic Flow Management |
| AMDP | Aeronautical Management Development Programme |
| ANSP | Air Navigation Service Provider |
| ATA | Aviation Training Academy |
| ATS | Air Traffic Services |
| ATNS | Air Traffic and Navigation Services |
| CAA | Civil Aviation Authority |
| CAD | Central Aeronautical Database |
| CeSTII | Centre for Science, Technology and Innovation Indicators |
| CSIR | Council for Scientific and Industrial Research |
| DST | Department of Science and Technology |
| DSI | Department of Science and Innovation |
| DOT | Department of Transport |
| ENAC | Ecole Nationale de l'Aviation Civile |
| GNSS | Global Navigational Satellite System |
| HSRC | Human Sciences Research Council |
| IATA | International Air Transport Association |
| ICAO | International Civil Aviation Organisation |
| NAC | National Aerospace Centre |
| R&D | Research and Experimental Development |
| SAAATS | South African Advanced Traffic System |
| SAA | South African Airways |
| SANSA | South African National Space Agency |
| SADC | Southern African Development Community |
| SOE | State-owned enterprise |
| SARIR | South African Research Infrastructure Roadmap |
| OECD | Organisation for Economic Co-operation and Development |
| OEM | Original equipment management |
| WITS | University of the Witwatersrand |

1 | INTRODUCTION

'Celebrating 25 years of safer African skies' was, at the time of this report's preparation, a motto of the South African state-owned enterprise, the Air Traffic and Navigation Services SOC Ltd (ATNS thereafter). Founded pre-democracy in the early 1990s through the Air Traffic and Navigation Services Company Act (Act 45 of 1993), ATNS provides air traffic management services and infrastructure chiefly to the aviation industry in South Africa. Increasingly, ATNS also provides technical support to aviation actors in other African countries, though this remains a small proportion of total annual revenue. Flanked by sectoral SOEs such as the Airports Company South Africa (ACSA), the Civil Aviation Authority (CAA), and South African Airways (SAA), and in the policy context of a relatively new White Paper on National Civil Aviation (2017), ATNS is a pivotal actor within the South African—and by extension, the regional and global—air transport system. Indeed, it is responsible for about 10% of the world's airspace, which encompasses South Africa and significant portions of the Southern Indian and Atlantic Ocean.¹

This case study research report analyses ATNS's R&D and innovation capabilities. It situates ATNS within its unique innovation system, examining five key dimensions within the organisation: human capabilities, technological capabilities, networks, research infrastructure, and governance. The research also explores the plans and strategies that ATNS has set in place to develop its R&D and innovation capabilities, including a new R&D Strategy and a 2017 Amendment Bill enabling the entity to operate outside of the borders of the Republic.² Where possible, the analysis is punctuated with examples of ATNS R&D and innovation outputs, and some unit-level ATNS R&D Survey data covering the past five years.³



ATNS air traffic control tower at OR Tambo International Airport. [Source: ATNS]

The case study develops the argument that ATNS is succeeding in fostering a culture of R&D and innovation within the organisation, in the context of its unique and favourable position as a leader of air traffic and navigation services on the African continent and within the Indian Ocean more broadly. This is tangibly demonstrated in increased expenditure on R&D over the past five years. However, given its limited resources and the highly regulated nature of aviation, the research also argues that rather than attempting to outstrip global leaders in the development of air traffic and navigation management technology, predominantly supplied by a few large global manufacturers, ATNS could deepen its R&D and innovation capabilities through strategic investments in areas with potential for long-term revenue growth, such as training, as well as pay greater attention to the IP protection of adaptive innovations that could yield commercial benefits, or product development, in the future. A key challenge for ATNS in

respect of its R&D and innovation capabilities is its capacity to respond to exponential technological changes, and convergence, within the air traffic and navigation global business environment, which anticipates a single globally interoperable system in the future.

Section 2 describes the research methodology followed in the preparation of this case study; Section 3 describes the study's analytical framework; Section 4 presents and discusses research data in relation to the study's analytical framework; and Section 5 discusses challenges and opportunities for ATNS in respect of its R&D and innovation capabilities and plans.

1 ATNS Product Brochure.

2 ATNS Company Amendment Bill, Government Gazette 41120, September 2017.

3 The South African National Survey on Research and Experimental Development (R&D Survey) is conducted annually by the Centre for Science, Technology and Innovation Indicators on behalf of the Department of Science and Innovation. For more information, go to <http://www.hsrc.ac.za/en/departments/cestii>

2 | RESEARCH METHODOLOGY, IN BRIEF

Research questions

The research methodology adopted in the preparation of this case study is an exploratory, qualitative mixed methods approach, applied in the context of a larger three-case study project, of which this report is one output.⁴ This research aimed to answer the following question and sub-questions: **To what extent and how are South African SOEs geared—in terms of their human and technological capabilities, networks, research infrastructure and governance—to perform R&D and innovation?** Two sub-questions emphasise a present and future orientation studied in this research:

- **Sub-question #1:** What are the current human and technological capabilities, networks, research infrastructure and governance of SOEs to perform R&D and innovation?
- **Sub-question #2:** What strategies or plans do SOEs have in place to develop these dimensions?

Definitions of R&D and innovation

Research and experimental development (R&D) is defined, in this study, according to the OECD's Frascati Manual (2015), and innovation is defined according to the OECD's Oslo Manual (2018). These definitions are given as:

- **Research and experimental development (R&D)** comprise creative and systematic work undertaken in order to increase the stock of knowledge—including knowledge of humankind, culture and society—and to devise new applications of available knowledge.⁵
- **Innovation** is defined as a new or improved product or process (or combination thereof) that differs significantly from the unit's previous products and processes and that has been made available to potential users (product) or brought into use by the unit (process).⁶

It is important to note that, in studies of innovation, R&D is considered one 'innovation activity' among others.

Data collection and preparation

To develop an in-depth understanding of ATNS, the study team engaged primary sources, notably ATNS's 2016, 2017 and 2018 integrated annual reports and corporate plans, as well as corporate brochures and grey literature sources, such as presentations, magazine and news articles. Some of these materials were shared with the research team by ATNS, while some were located through keyword web searches. In addition, the study team attended the eighth Avi Afrique conference themed 'breaking barriers in the aviation industry through innovation', held at the CSIR International Convention Centre, Pretoria, from 23-24 October 2018, to collect data and source additional information about the entity.

To supplement these information sources, semi-structured interviews administered with key informants from ATNS were conducted in 2018 and 2019.⁷ Key informants included two ATNS executives and one senior engineer involved in R&D.⁸ Attempts were made to interview an executive in charge of training as well as the chief operations officer, but scheduling challenges prevented these from materialising. Interviews were semi-structured, with a clear list of questions (see *Synthesis Report* for full interview schedule), and the expectation

4 A more detailed account of the research methodology is included in the annexures of the *Synthesis Report*, accompanying this report.

5 Organisation for Economic Co-operation and Development (OECD), *Frascati Manual: Guidelines for Collecting and Reporting Data on Research and Experimental Development*. OECD Publishing: Paris, 2015.

6 Organisation for Economic Co-operation and Development (OECD), *Oslo Manual Guidelines for Collecting, Reporting and Using Data on Innovation, 4th Edition*. OECD Publishing: Paris, 2018.

7 In-person interviews took place on 16 March 2018, 23 October 2018 (two interviews), and 14 February 2019. Follow-up email correspondence took place on 23 July 2019.

8 Cited in this report respectively as **INTERVIEW.ROLE DESCRIPTION. CASE STUDY NUMBER, DATE:** ITV.ENG.CS2, 16 March 2018; ITV.EXEC1.CS2, 23 October 2018; ITV.EXEC2.CS2, 23 October 2018; ITV.ENG.CS2, 14 February 2019; ITV.ENG.CS2, 23 July 2019.

of some flexibility around the sequence in which questions were asked. Respondents were invited to elaborate more broadly on question topics, and to follow up with the research team telephonically, in-person, or via email subsequently.

In terms of data preparation, interviews were transcribed verbatim from the audio recordings. Transcript data was descriptively coded by grouping and categorising transcribed statements into the study's five dimensions.⁹ Due to the limited number of key informant exchanges, no specialist coding software was required. Report writing, critical review, and improvement took place concurrently, commencing in April 2019 and concluding in final draft form in November 2019.

Ethical considerations and dissemination

The study's researchers produced and explained informed consent forms to key informants before each interview. In line with consent forms, key informants remain anonymous in the draft written reports and access to the original recordings and transcriptions is restricted to CeSTII researchers. It was expressly agreed with key informants at the time of the interviews that draft reports would be shared with ATNS key informants first, to correct inaccuracies, and, as part of the validation of the research. This took place during 2020 and 2021. The validated reports will be shared widely with the relevant government departments, other researchers, and the general public, for further validation and to enhance the dissemination and uptake of the research findings.

⁹ R. Tesch, *Qualitative Research, Types and Software Tools*. Falmer Press: New York, 1990. Also: J. Saldana, 2016. *The Coding Manual for Qualitative Researchers*. Sage: London.

3 | ANALYTICAL FRAMEWORK

The concept of gearing

Unlike the concept of gearing in financial accounting, which reflects the proportion of debt to equity, the concept of 'gearing' from an automotive perspective refers to the capacity of the engine and gears, working together, to alter a vehicle's rate of acceleration. The study team chose this as a useful organising concept for the research—to help shape our assessment of the extent to which SOEs are prepared, ready and capacitated, for R&D and innovation. The study team hypothesised that if an SOE is *gearing*—or indeed, *geared*—appropriately, then it is in a position to leverage R&D and innovation to achieve its mandate efficiently and effectively. If not, then a set of questions could be invited as to what investment or organisational change is required to facilitate the development of R&D and innovation capabilities in the future.

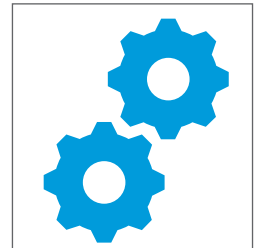


Figure 1: Gearing reflects the capacity of SOEs to utilise R&D & innovation activities to achieve their mandates efficiently and effectively.

A caveat is in order. While there are indicators against which SOEs can report on their R&D and innovation activities to their shareholders, for example within integrated annual reports, this case study research is not generalisable to the extent that it can provide a normative framework for 'gearing' (that is if a given SOE meets certain pre-defined criterion, then it is geared 'correctly', and vice versa). Rather, it aims to develop a set of qualitative suggestions, based on the individual case study's research findings, for consideration by national policy-makers and SOE organisational leaders in determining future plans for R&D and innovation within the specific SOEs studied. Indeed, more case study research could in the future contribute empirical evidence to allow for generalisability of findings, which could further enhance indicator development and evidence-based policymaking within this domain.

Systems approach

State-owned enterprises, like non-state firms, are actors within particular national policy and industrial systems that span a range of boundaries, both commercial, technological, political and geographical.¹⁰ When it comes to R&D and innovation, SOEs are also nested within particular knowledge and technical systems (innovation systems) that can enable or circumscribe their capacity. The systemic nature of R&D and innovation, therefore, represents a conceptual starting point for this research. **Figure 2** illustrates the position of an SOE (black box) in relation to its regulatory forces, market demand (brown oval), global value chains, national and international framework conditions, as well as the knowledge flows (black lines) and interactive relationships (green lines).

¹⁰ B.Å. Lundvall, *Product Innovation and User-Producer Interaction, Industrial Development*, Research Series 31, Aalborg University Press: Aalborg, 1985.

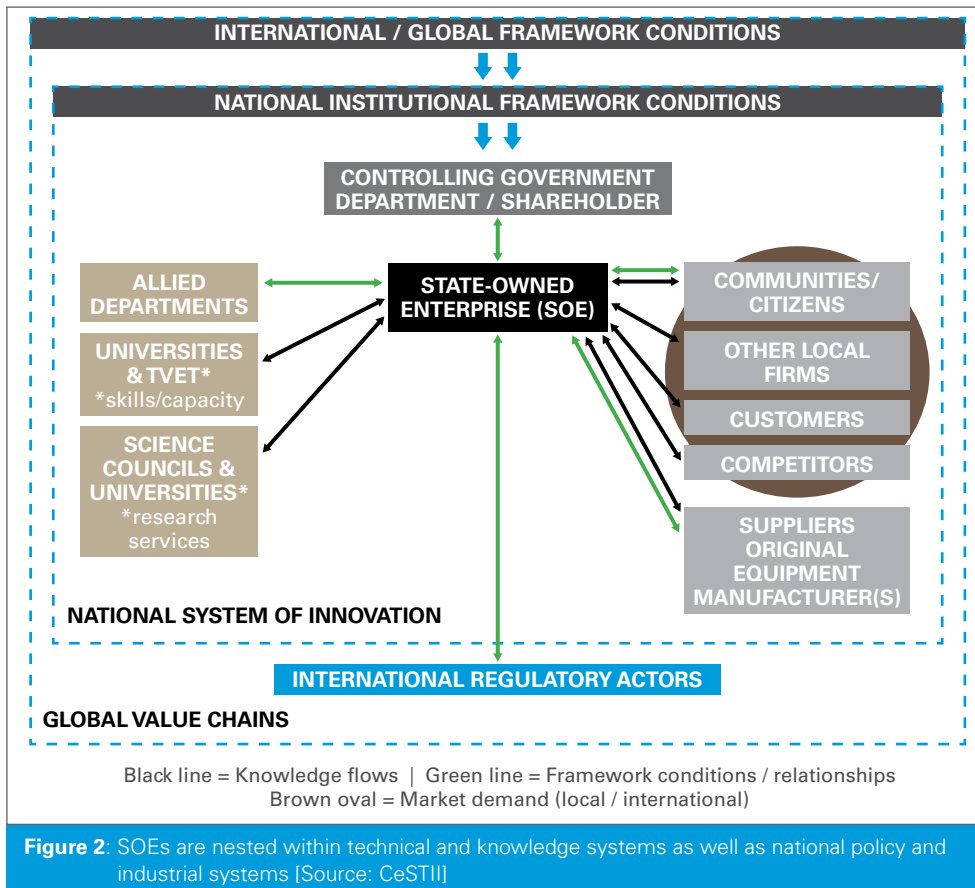


Figure 2: SOEs are nested within technical and knowledge systems as well as national policy and industrial systems [Source: CeSTII]

R&D and innovation capabilities of the SOE: Five study dimensions

Within this systems context, the case study focuses on five dimensions within the organisation—the unit of analysis—to assess ATNS preparedness or gearedness to perform R&D and innovation. These dimensions, defined in more detail below, are human capabilities; technological capabilities; networks; research infrastructure; and governance. These dimensions were prioritised during stakeholder consultations in 2017, with SOEs and government departments, which identified areas for investigation through case study research.¹¹ A critical assumption the study team made is that how these dimensions are established can affect the way the organisation operates and therefore its ability to deliver goods and services to customers within its resource-base constraints.

Human capabilities

The ability of people as a whole or as individuals to perform and manage their affairs successfully is how the OECD defined human capabilities in 2006.¹² In the specific context of this research, human capabilities refer to the abilities of R&D and innovation personnel within a given state-owned enterprise to generate R&D and innovation outputs and outcomes in line with their organisational mandates.

¹¹ See Key Outcome 7.4 and 7.5 in ANNEXURE A: KEY OUTCOMES FROM THE CLUSTER WORKSHOP ON PUBLIC RESEARCH AND DEVELOPMENT (R&D) INVESTMENT TRENDS AND POLICY IMPLICATIONS DATE: 13 APRIL 2018, UNION BUILDINGS.

¹² Organisation for Economic Co-operation and Development, Development Assistance Committee (OECD-DAC), *The Challenge of Capacity Development: Working Towards Good Practice*. OECD DAC, DAC Network on Governance (GOVNET), 2006.

Technological capabilities

In this study, technological capabilities refers to the entity's ability, based on its accumulated knowledge, to perform R&D and innovation, which results in new technological knowledge development to achieve positive results.¹³ Similarly, technological capabilities, as defined by Guerra and Carmago in 2016, refer to the ability of a firm to execute a technical function.¹⁴ Following these definitions, technological capabilities within this research includes technologies and knowledge of technologies.

Networks

Networks, as defined in this research incorporates relationships enacted by and through SOE personnel and institutional processes, and the form of formal partnership agreements or informal collaborative work undertaken in the conduct of R&D and innovation activities.¹⁵ Partners or collaborators can be private firms, professional bodies, other SOEs, universities, or other actors. Networks have the potential to increase R&D and innovation productivity and performance, by transferring skills and expertise through inter-organisational knowledge flows.¹⁶

Research infrastructure

The 2016 *South African Research Infrastructure Roadmap* (SARIR) defines research infrastructure as facilities, resources and services used by the scientific community across all disciplines to conduct cutting-edge research for the generation, exchange and preservation of knowledge.¹⁷ According to the SARIR definition, this includes major facilities, equipment or sets of instruments, collaborative networks and knowledge-containing resources such as collections, archives, databanks and biobanks. Research infrastructures may be single-sited, distributed, or virtual. SOEs require access to research infrastructure to conduct cutting-edge research, which in turn nurtures and sustains the SOE's R&D and innovation capabilities.

Governance

Governance, read in a corporate context as opposed to a national or international context, according to Camay and Gordon refers to systems, processes, policies and structures available to direct, manage and control an organisation.¹⁸ Governance also involves the effective and equitable allocation and management of resources for the common good.¹⁹ Following these definitions, this research interprets governance of the SOE broadly, focussing on actors within the SOE (as opposed to external governance actors) and focussing specifically on R&D and innovation activities.

13 P.A. Zawislak & F.M. Reichert, Technological Capability and Firm Performance. *Journal of Technology Management and Innovation*, 9 (4), 2006, p. 21.

14 D. A. Guston & D. Sarewitz, *Shaping Science and Technology Policy: The Next Generation of Research*. The University of Wisconsin Press: Madison, 2014.

15 R. Hamann & F. Boulogne, Partnerships and Cross-sector Collaboration. In: R. Hamann, S. Woolman, and C. Sprague, eds., *The Business of Sustainable Development in Africa: Human Rights, Partnerships, Alternative Business Models*. Pretoria: Unisa Press, 2008, pp. 54-82.

16 G. Kruss, *Creating Knowledge Networks: Working Partnerships in Higher Education, Industry and Innovation*, HSRC Press: Cape Town, 2006.

17 South African Research Infrastructure Roadmap (SARIR), 1st edition, Department of Science & Technology, 2016.

18 P. Camay & A.J. Gordon, *Evolving Democratic Governance in South Africa*. The Co-operative for Research and Education (CORE): Johannesburg, 2004.

19 Ibid., p. 17.

4 | ANALYSIS: IS ATNS GEARED TO PERFORM R&D AND INNOVATION?

ATNS's mandate, business model and operating context

An important starting point for this case study's analysis is a description of the ATNS mandate, business model, and operating context. This sets the scene for a review of the ATNS innovation system, and thereafter more in-depth discussions on the case study's key dimensions.

Mandate

A state-owned company established in 1993, the year before South Africa become a constitutional democracy, the ATNS Company Act (Act 45 of 1993), mandates the organisation to acquire, establish, develop, provide, maintain, manage, control or operate air navigation infrastructures, air traffic services or air navigation services.²⁰ One executive interviewed explained to the study team that the ATNS mandate is to ensure total aircraft and passenger safety: "we need to make sure that aircrafts are safely separated and do not collide with each other."²¹

Reporting to the South African transport minister, ATNS provides this vital service within a set of global and national frameworks, established by bodies such as the International Civil Aviation Organisation (ICAO), the International Air Transport Association (IATA), and the South African Civil Aviation Authority (CAA), with accompanying technical norms and standards. In addition, ATNS must comply with South African legislation and administrative frameworks, critically, the Civil Aviation Act (Act 13 of 2009) and, at the administrative level, the Public Finance Management Act (Act 1 of 1999) and the Companies Act (Act 71 of 2008).

In terms of its mandate, a major development ATNS is pursuing is an amendment to its founding legislation,²² to enable it to develop a subsidiary company that can operate outside the country.²³ Since revenue growth in its South African business is restricted by tariff regulation, future ATNS growth is expected to be generated outside of the Republic, where there is unmet demand.²⁴ The Bill also proposes scope for objections to decisions by the entity's economic regulator.

Business model

A business model expresses the rationale of how an organisation delivers value to its customers.²⁵ ATNS describes itself as a "'commercialized' air navigation services provider (ANSP) operating on the 'User Pays' principle that relies on current revenues and debt funding for its operational and capital expenditure requirements."²⁶ Specific services it provides range from billings and collections management; Air Traffic Flow Management (AFTM); WGS-84 Surveying and Obstacle Evaluation; airspace design; Central Aeronautical Database (CAD); flight procedure design and cartography; and the ATNS Aviation Training Academy (ATA).²⁷ As noted, the ATNS customer base includes South African and other African aviation entities, notably international and national airports operators.

Approximately 90 percent of the company's revenue is generated through its regulated business, what it describes as "en route and approach fees" with the remaining revenue derived from service provision outside the remit of its Regulating Committee, including, for

20 Air Traffic and Navigation Services Company Act, No. 45 of 1993, p. 3.

21 ITV.EXEC1.CS2, 23 October 2018

22 ATNS Company Amendment Bill, p. 2. According to a discussion between a member of the study team and Valerie Carelse at Parliament on 23 October 2019, the Bill, while open for comment, had not yet been debated by the House.

23 ATNS Corporate Plan 2016/17 – 2018/19, p. 4.

24 ITV.EXEC2.CS2, 23 October 2018. An article by Aurette Bouwers, shared with CeSTII by this executive, refers to a feasibility study with 10-year growth projections of air traffic management opportunities on the African continent and surrounding islands. "The study has enabled us to define the business context, and the Commercial Services team is now driving its implementation through a series of identified projects," the article says.

25 J. Magretta, Why Business Models Matter, *Harvard Business Review* (May 2002). Available at: <https://hbr.org/2002/05/why-business-models-matter>, last accessed 4 March 2019.

26 ATNS Corporate Plan 2016/17 – 2018/19, p. 7.

27 ATNS Product Brochure.

example, satellite communication networks.²⁸ Executive 1 provided a compelling reason for the evolution of the ATNS business and revenue model:

If we look at the likes of ACSA, 75 percent of its revenue comes from a non-mandate, a business. In other words, it comes from retail, it comes from parking, it doesn't actually come from aircraft that are using the airport. So only 25% comes from that. And if you look at ATNS, 90% of our revenue comes from the regulated business and only ten percent comes from the non-regulated business and we want to turn this around. Because if we can achieve the reverse, in other words 90% of our revenue coming from the non-regulated business, then we'll ease the burden/baggage of the flying public member.²⁹

In 2017/18, ATNS generated a net profit of R190.1 million, with revenue of R1.557 billion exceeding operating costs of R1.382 billion.³⁰ Capital expenditure decreased by 0.7% from R307 million to R305 million in 2017/18, though a CAPEX Delivery Framework has been identified as a key organisational priority.³¹

Operating context

With headquarters in Johannesburg, Gauteng, ATNS provides services in all nine provinces in South Africa—to nine ACSA airports as well as a small number of regional ones (see **Figure 3**).³² Although the ATNS mandate principally concerns air traffic management within South Africa, as noted, the SOE's scope of service provision is growing to extend beyond the country's borders to the rest of Africa, including the southern Indian Ocean region (**Figures 4 and 5**). The ATNS Integrated Report 2018 provides a clear statement with respect to the company's future growth potential:

Increased air traffic movement on the continent will be the backbone of our long-term financial sustainability as there is little room left in the local market to improve our bottom line.³³

Other notable developments within the ATNS national operating context include a relatively new White Paper on Civil Aviation (2017); as well as, perhaps more acutely, the politicised discourse on the future of SOEs in the wake of state capture. Globally, changes taking place at the technological frontier of air traffic management, as well as within air traffic management regulatory bodies, suggest far greater interoperability between national and regional systems, to improve safety and enhance cybersecurity.³⁴

28 ATNS Integrated Report 2018, p. 21.

29 ITVE.CS2, 23 October 2018

30 Ibid., p. 4.

31 ATNS Integrated Report 2018, p. 116.

32 ATNS Integrated Report 2018.

33 Ibid., p. 31.

34 T. Peege, 'Aviation and Cyberthreats are Becoming a Reality', Presentation Avi Afrique 2018, 23-24 October 2019. Peege is the South African representative on the Council of International Civil Aviation Organization.

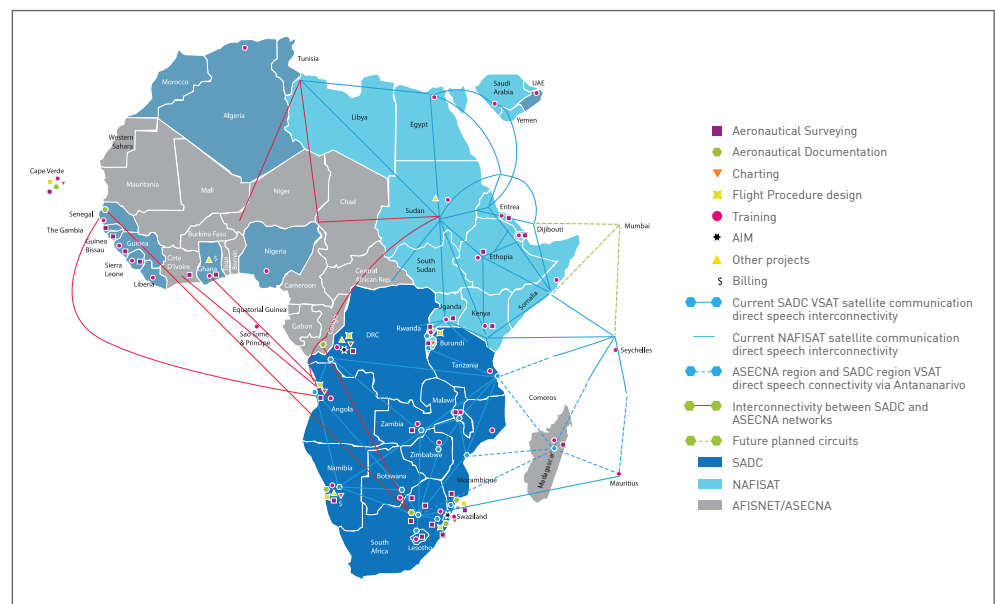


Figure 3: ATNS operations outside South Africa [Source: ATNS Integrated Report 2018]

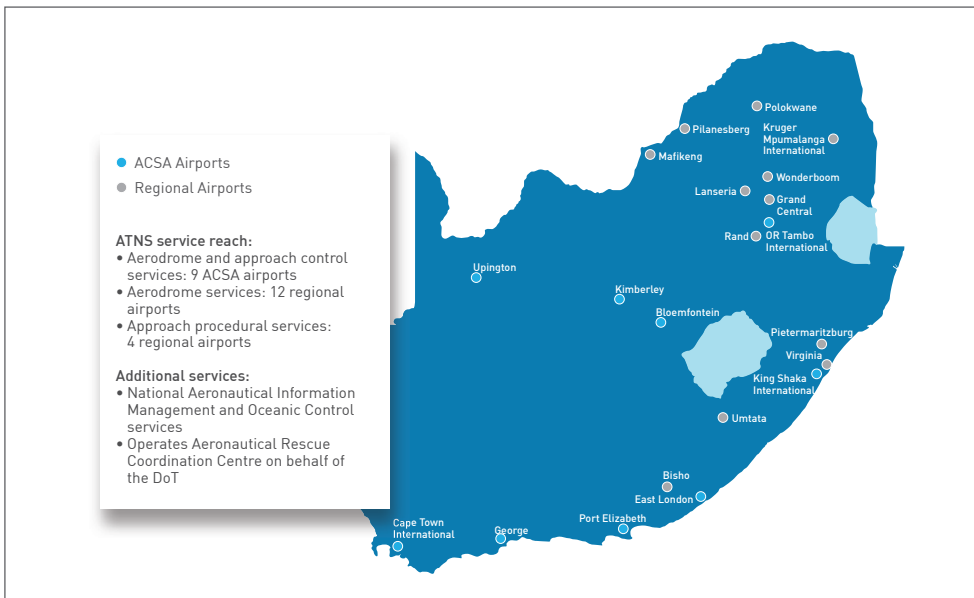


Figure 4: ATNS operates at over 20 South African ACSA and regional airports
 [Source: ATNS Integrated Report 2018]

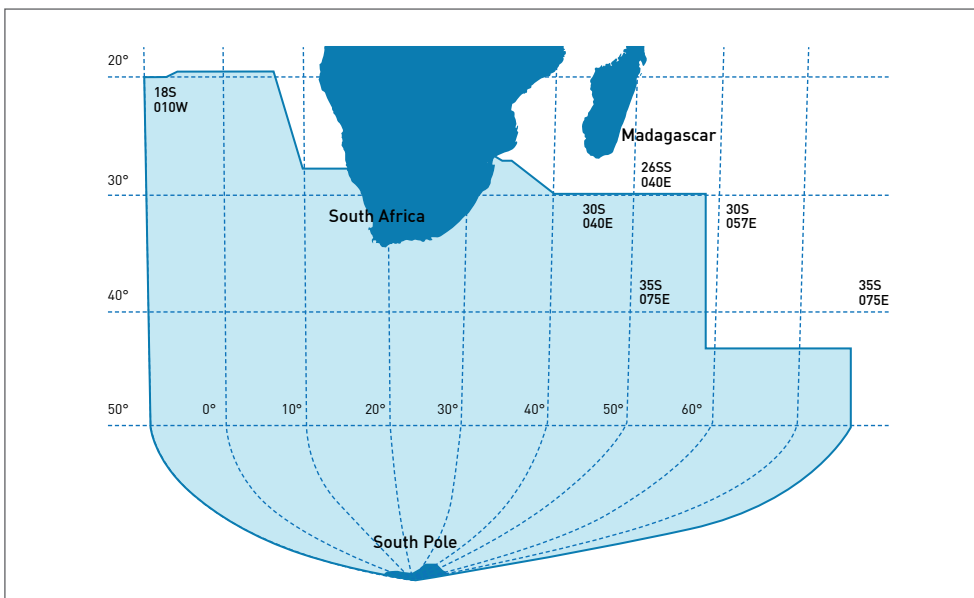


Figure 5: ATNS's current and projected future operation in African Indian Ocean airspace
 [Source: ATNS Integrated Report 2018]

Situating ATNS within an R&D and innovation systems context

A secondary starting point for this case study's analysis is a description of the ATNS R&D and innovation system. An illustrative mapping of the ATNS R&D and innovation system is provided in **Figure 6**. There are at least five features of the system that are noteworthy:

- first, owing understandably to stringent safety requirements, the mapping reflects the highly regulated nature of the system, present in the number of national and international regulatory authorities, associations and conventions, including the Civil Aviation Authority, International Air Transport Association, and the Chicago Convention (which established the International Civil Aviation Organisation of the UN);
- second, the presence of a new policy framework for civil aviation in South Africa in the form of the White Paper on National Civil Aviation Policy (2017), which aims to bring

in greater private sector involvement and coherence to the aviation industry in South Africa, including its 135 licensed airports;³⁵

35 K. Gernetzky, More private funding envisaged for local airports, *Business Day*, 23 February 2017. Available at: <https://www.businesslive.co.za/bd/companies/transport-and-tourism/2017-02-23-more-private-funding-envisaged-for-local-airports/>, last accessed 8 November 2019.

- third, the presence of large multinationals, such as Thales, a key original equipment manufacturer (OEM), and supplier of significant infrastructure to ATNS;
- fourth, collaborations with local universities and science councils, including notably the CSIR, the National Aerospace Centre at Wits University, University of Pretoria, and Durban University of Technology;
- fifth, the absence of competitors, given its positioning as a South African entity, within an African continental and southern Indian Ocean economy context.

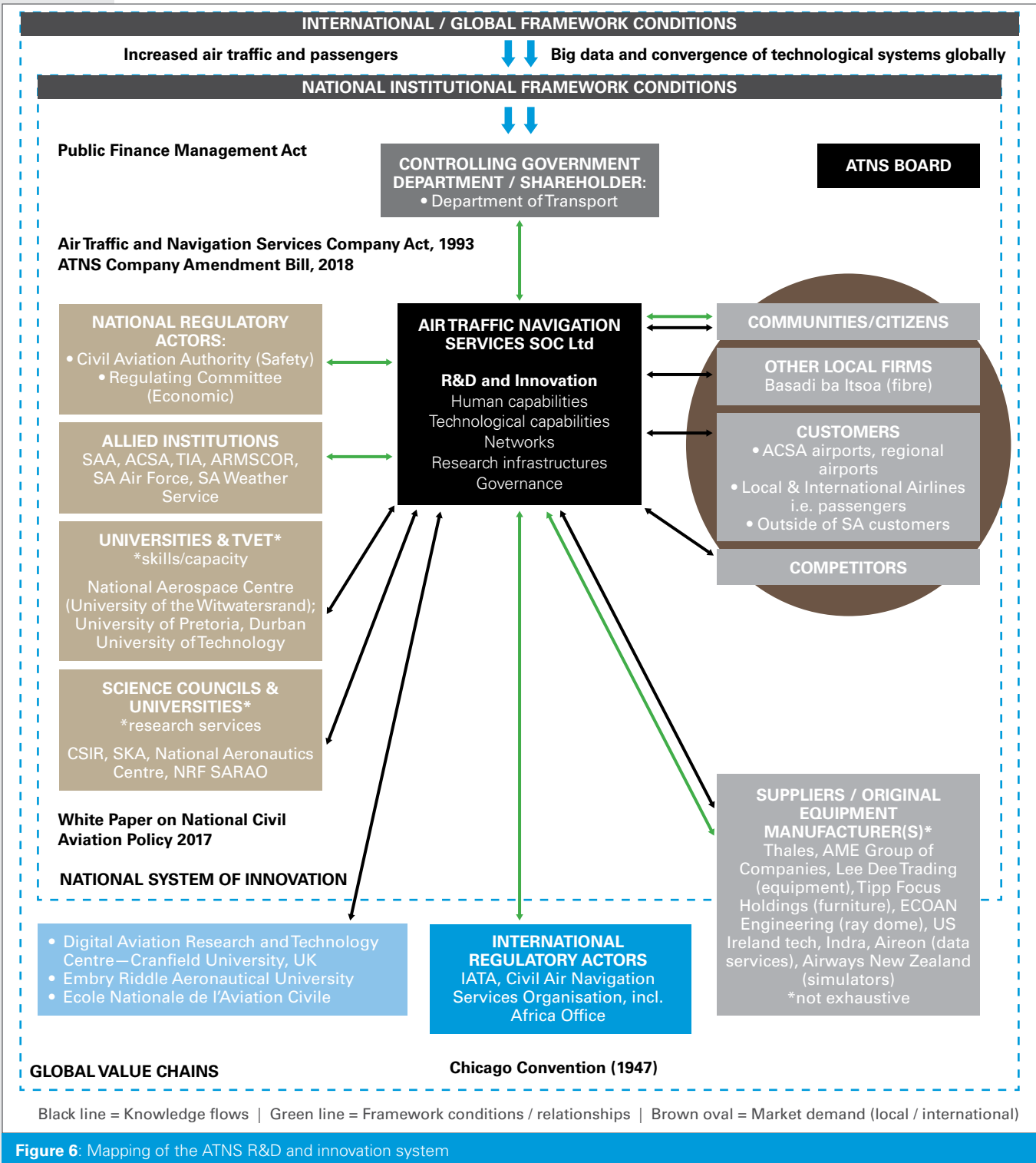
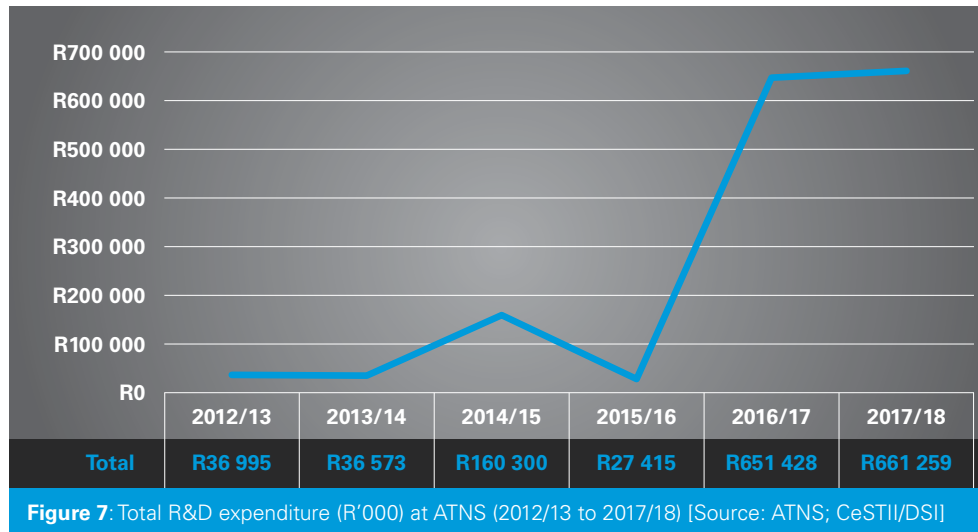


Figure 6: Mapping of the ATNS R&D and innovation system

These key aspects of the ATNS R&D and innovation system permeate the analysis of key informant data, presented below.

R&D expenditure (2012/13 – 2017/18)

A third starting point for the analysis is to examine unit-level data from the SA R&D Survey, as provided to CeSTII by ATNS. Total R&D expenditure is calculated as the sum of expenditure on R&D-relevant vehicles, plant, machinery and equipment; land, buildings and other structures; labour; and other current expenditure. **Figure 7** shows total expenditure to have grown substantially between 2015/16 and 2016/17, after three years of relatively low but not insignificant R&D expenditure.



When benchmarked against total R&D expenditure in the SOE sector for the years where comparative data is available, the entity's expenditure rises virtually on trend with the sector as a whole, increasing, notably from 2.45% of the total sector spend in 2012/13 to 26.07% in 2017/18.³⁶ This suggests that ATNS is amongst the largest investors in R&D in South African SOEs participating in the R&D Survey.

Table 1: Comparison of ATNS R&D expenditure with SOE total R&D expenditure (2012/13 to 2017/18)

| Year | Number of R&D performing SOEs | R&D expenditure (R'000) | ATNS R&D expenditure (R'000) | Proportion of ATNS to SOEs |
|---------|-------------------------------|-------------------------|------------------------------|----------------------------|
| 2012/13 | 19 | R1,512,021 | R36,995 | 2.45% |
| 2013/14 | 19 | R1,609,771 | R36,573 | 2.27% |
| 2014/15 | 19 | R2,019,919 | R160,300 | 7.94% |
| 2015/16 | 18 | R1,973,416 | R27,415 | 1.39% |
| 2016/17 | 16 | R2,621,883 | R651,428 | 24.85% |
| 2017/18 | 16 | R2,536,374 | R661,259 | 26.07% |

³⁶ Data source is the South African National Survey of Research and Experimental Development (R&D Survey) Statistical Report 2017/18, produced by CeSTII for DSI.

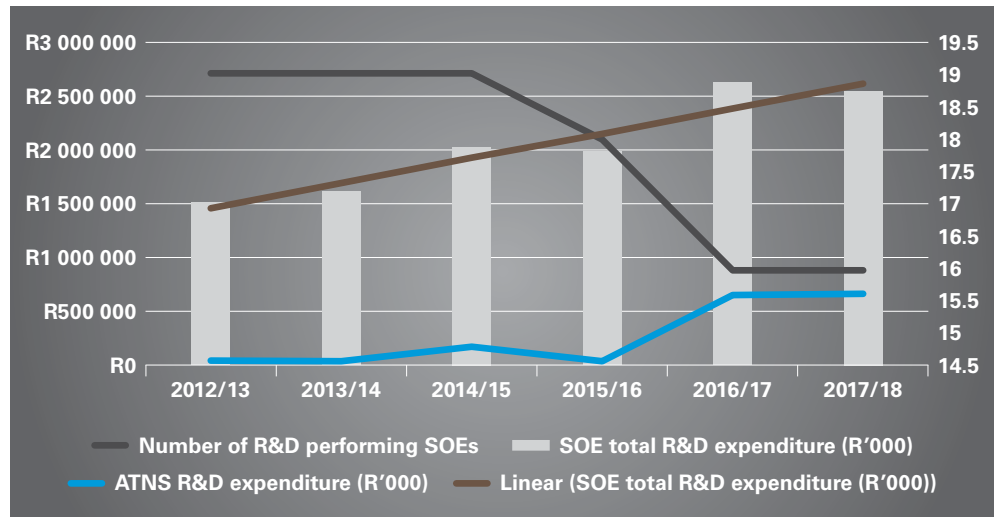


Figure 8: ATNS benchmark against SOE R&D expenditure, including number of R&D performers (2012/13 to 2017/18) [Source: ATNS; CeSTII/DSI]

In terms of its R&D performance, ATNS conducts applied research focusing on aviation and non-aviation technology; and 85% of all R&D conducted by ATNS is applied research (Figure 9).³⁷ Through R&D, ATNS is able to modify the existing equipment to suit the entity's special requirements, operational and environmental conditions. Methodologically, the senior engineer interviewed explained the ATNS approach more specifically:

*ATNS's R&D emphasises the adoption of the Applied Business Research method, where research activities undertaken are with the purpose to innovate, develop, enhance and/or validate technology solutions that have potential to be operationalised or commercialised for primary use in the Air Traffic Management operational environment. The outcomes of the applied research may lead to product development, process development and/or improvement.*³⁸

R&D performers at ATNS do not pursue publications in peer-reviewed journals, the engineer said, but rather focus on the practical challenges and problems presented.

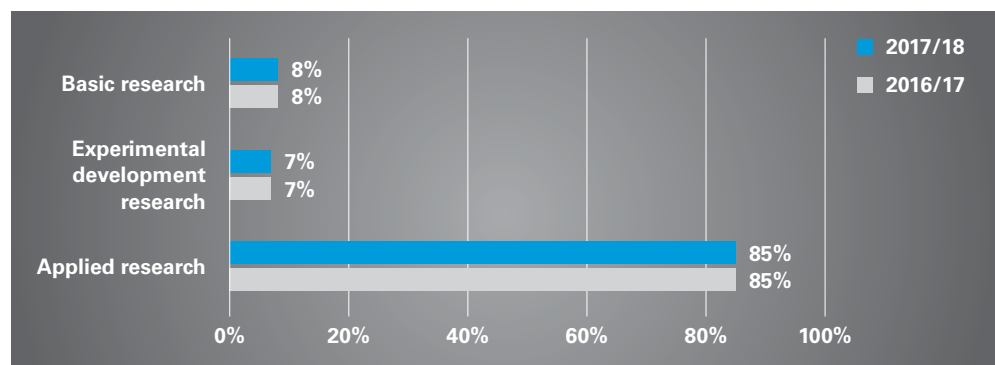


Figure 9: Breakdown of ATNS R&D expenditure by type of research (2016/17 to 2017/18), no data was available for years prior to 2016/17. [Source: ATNS; CeSTII/DSI]

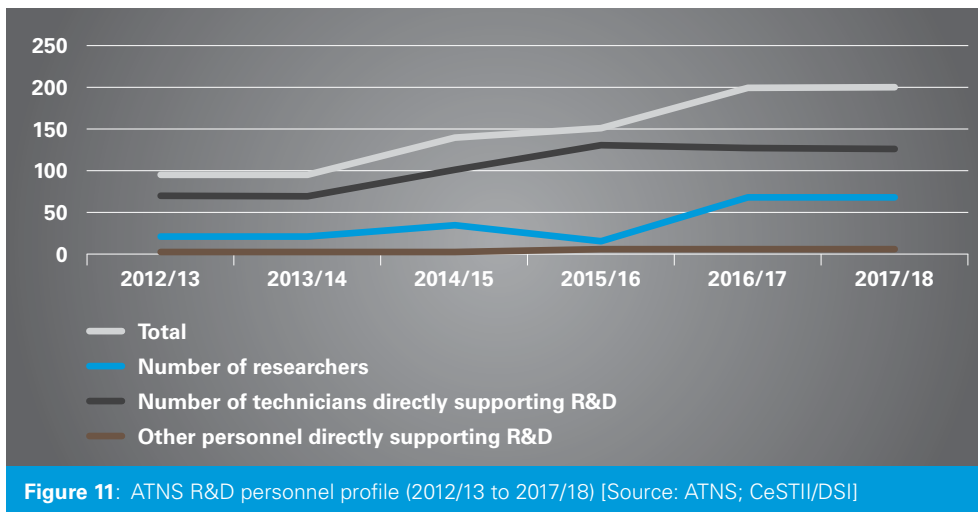
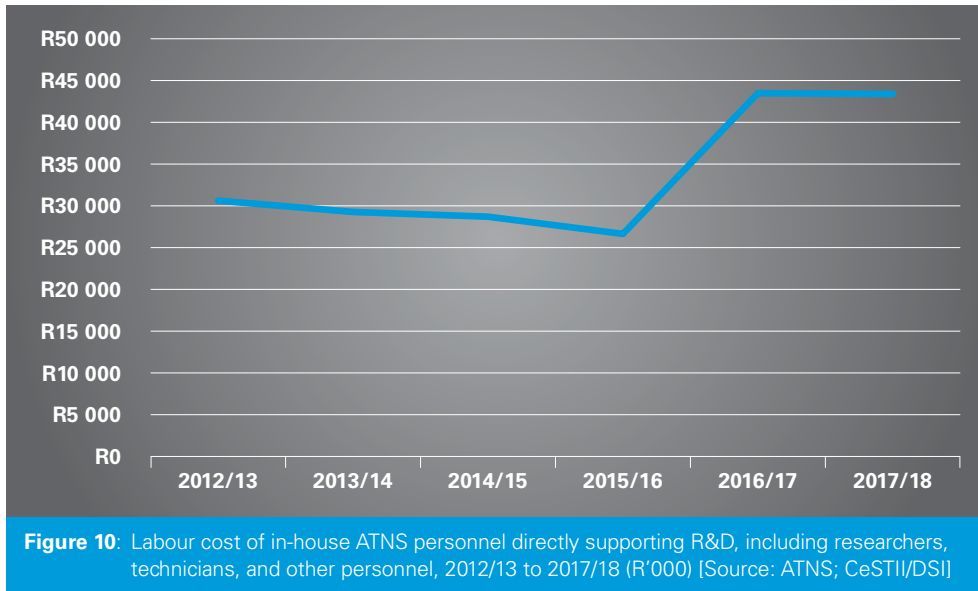
Analysis of five dimensions of R&D and innovation capability

Based on the previous discussion, this section of the case study analyses data collected concerning each dimension outlined in the conceptual framework. By studying key informant interview data, information derived from desktop research, and R&D Survey unit-level data for ATNS, this section provides an empirical basis to discuss challenges and opportunities for R&D and innovation capability building at ATNS.

³⁷ ITV.ENG.CS2, 23 July 2019

³⁸ ITV.ENG.CS2, 16 March 2018

As a performer of R&D and innovation, ATNS's human capabilities are a key dimension for analysis of the entity's overall capability. The unit-level R&D Survey dataset records trends in the ATNS R&D workforce for the period 2012/13 to 2017/18. **Figure 9** reflects some fluctuation in the researcher workforce, in particular a quadrupling in the number of researchers between 2015/16 and 2016/17, as well as a stabilising of the ratio between technicians and researchers after 2016/17.



Both are positive developments, reflecting an increase in research capacity. As the engineer interviewed for this research stated:

There is now a unit that has been created for R&D after the recent realignment to lift the profile of R&D, there is now a structure for R&D. They are recruiting senior engineers and R&D managers, as well as junior engineers to be absorbed from universities.³⁹

39 ITV.ENG.CS2, 16 March 2018

It is important to note that the majority of ATNS staff do not focus on R&D activities, as R&D is not a direct mandate of the organisation in terms of its legislation. As the engineer interviewed pointed out:

If you look at the ATNS survey completed in the 2016/17 financial year, majority of ATNS staff spend less time (20 percent) on R&D as per their job description. Only a few spend 60 to 80 percent of their time on R&D activities as per their job description.⁴⁰

Executive 1 echoed this concern when asked whether ATNS had sufficient skills in-house to innovate:

We definitely do not have capacity. And I was saying to my team that should be the first thing that as soon we can accept that we don't have capacity, don't try to be smart, ... don't try to say you clever what what, if we can, the sooner we accept that we don't have capacity the sooner we'll be able to capacitate ourselves. So, and the only way to capacitate ourselves is through partnerships. Because we are relatively new in terms of research and we need someone to hold our hands and run with us.⁴¹

The example in **Box 1**, showcasing collaboration between ATNS and the University of Pretoria, reflects ATNS's response to a dearth of internal capacity. Analysis of the areas for collaboration point to skills-related challenges but also technological needs.

Box 1: ATNS-University of Pretoria partnership: Human Capital Through R&D

Areas for collaboration:

- ATNS related technology projects for the future
- Investigating future technologies and proof of concept
- Developing high level skills to innovate in the SA and African aviation industry
- Provide continuous professional development to engineers and technicians
- Develop industry specific training and postgraduate modules
- Collaborate with ATNS's international partners for research and skills development

Examples:

- Transponder Position Monitoring Using Multilateration
- Audio To Text Conversion: Translation System for an Air Traffic Control Centre

Source: Prof. Sunil Maharaj (2013)

In terms of its human capabilities within innovation more broadly, the example of the ATNS training is worth exploring in some detail.⁴² ATNS has established the Aviation Training Academy (ATA) as a division within the company. The ATA offers a variety of air traffic services, technical support and related trainings in the fields of engineering, air traffic services and management. Most engineering graduates ATNS employs participate in a structured training programme that includes attending ATA aviation-related courses. Executive 2 reflected at length on the potential for training in the context of ATNS innovation.

Training is a key part of our business. I mean, we train air traffic controllers ... to a Principal Air Traffic Controller, that's a very experienced controller, who sits in an aerial control centre or tower in Johannesburg that controls some of the most complex airspaces in the world. But that training starts from our academy.

We've developed a system, of course guided by the regulatory framework globally and locally, to the standard that we are sought after in terms of training of other

⁴⁰ ITV.ENG.CS2, 16 March 2018

⁴¹ ITV.EXEC1.CS2, 23 October 2018

⁴² Scheduling difficulties prevented an in-person interview with the executive in charge of training.

institutions, for other institutions on the continent, and dare I say even other countries beyond the continent that have approached [us]. We trained in the continent [from] Ghana to Guinea to Kenya, Tanzania, Zambia, and so it's a big part of our strategy. Talk of our commercial strategy, a big part of our strategy is hinged on training. How do you then innovate? For now, most of our training is based in South Africa, they come sit at the college and spend the year, or more, depending on what we train them on ... Very few of those courses are offered in those regions by the nature of ... the type of training that ... has to take place. I'm just talking air traffic control. We also train in other disciplines as well. Our technical staff ... is also trained at the academy. So we've got a serious capability. How do we project that into the continent beyond what we are doing, again, innovation, technology, learning systems, e-learning, we are at the forefront of trying to bring in systems that can enable us to project.⁴³

A source of revenue, and a potential area for innovation, the Air Traffic Academy is a key pillar of the ATNS value proposition. The academy was founded in 1995 and has won a number of accolades, including IATA Worldwide Top Regional Training Partner five times consecutively (since 2011), joining the IATA Premier Circle in 2016; as well as being designated a Regional Centre of Excellence by the International Civil Aviation Organisation (ICAO).⁴⁴ The ATA is also an ISO 9001:2008 accredited institution and has international cooperation agreements with partners such as the Embry Riddle Aeronautical University, Ecole Nationale de l'Aviation Civile (ENAC) and the University of the Witwatersrand. These mutually beneficial partnerships support the presentation and accreditation of international courses in Air Traffic Services.⁴⁵ As reflected in the statement below from the 2017 Integrated Report, ATNS has a strong vision for the future of the academy:

We are particularly proud of our expanding in-house training facility, the Air Traffic Academy (ATA), which is ISO 9001:2008 accredited and growing in strength to provide new educational offerings. During the year, the ATA explored ways to transition from the conventional face-to-face training approach to a more interactive e-learning methodology. Our current training content will be converted to an e-learning platform to offer ATA clients more flexible learning avenues. From the perspective of our international strategy, the new e-learning format offers exponentially increased opportunities for distance learning. The benefits of training through the ATA will become all the more attractive as we register as an academic institute with the Council of Higher Education to provide certified academic qualifications.⁴⁶

Finally, ATNS has a track record of implementing programmes to support the development of staff. In 2013 ATNS launched the Aeronautical Management Development Programme (AMDP) with the University of the Witwatersrand. ATNS also runs a Women's Development Programme⁴⁷ and has been named as among the country's top employers.⁴⁸

Summary of human capability dimension



The trend data shows an increase in R&D personnel and an improved ratio of technicians-to-researchers, though in-house capacity to perform R&D remains a challenge that ATNS overcomes through collaboration. The development of the ATNS Training Academy provides an excellent example of non-R&D innovation delivered by ATNS.

⁴³ ITV.EXEC2.CS2, 23 October 2018

⁴⁴ ATNS online, <https://www.atns.com/about.php?id=104>, last accessed 18 September 2018.

⁴⁵ ATNS Integrated Report 2016, p. 10-11.

⁴⁶ Integrated Report 2017, p. 33.

⁴⁷ <http://www.polity.org.za/article/atns-statement-by-the-air-traffic-and-navigation-services-on-the-inaugural-aviation-qualification-in-africa-for-atns-women-24032013-2013-03-24>

⁴⁸ ATNS has been recognised by the Top Employer's Institute, which measures workplace satisfaction. The Institute's most recent research on the entity states: "Our comprehensive independent research revealed that Air Traffic and Navigation Services provides exceptional employee conditions, nurtures and develops talent throughout all levels of the organisation and has demonstrated its leadership status in the HR environment, always striving to optimise its employment practices and to develop its employees." Top Employers online. Available at: <https://www.top-employers.com/en-ZA/companyprofiles/za/air-traffic-and-navigation-services/>, last accessed 23 December 2018.

Technological capabilities

The development of national technological capabilities within South African air traffic management can be traced to 1936, “when Air Traffic Control was transferred to the National Department of Transport”.⁴⁹ However it was only after the Second World War, and the construction of what is now OR Tambo International Airport, that air traffic control was institutionalised in earnest.

*In 1948, Air Traffic Control comprised ex-wartime operators such as navigators and pilots. Radio operators and gunners formed the backbone of the communications network using Morse code and high frequency direction finding. Operations were conducted from a wooden hut behind the current control tower at Germiston in the East Rand of Gauteng.*⁵⁰

There is now a recognition at the executive level of the changing nature of the key technology that enables ATNS, with the move from terrestrial to satellite-based systems. As the ATNS Corporate Plan 2016/17 – 2018/19 states:

*The Air Navigation Services Providers are also looking to Technology and new operational structures that will change the way air navigation service providers interact with the flights they are guiding through the skies.*⁵¹

Table 2 provides a snapshot of ATNS’s milestones, as recorded in a publication celebrating its twenty-first anniversary.

| Year | Milestone |
|------|--|
| 1993 | The founding of ATNS |
| 1994 | Setting up ATNS |
| 1995 | Establishment of ATNS college |
| | Commencement of Project Pronav |
| | JASRAD |
| 1997 | MSSR and Radar Display System (MADRAD) project |
| | Project Speakeasy |
| | Global Navigation Satellite System (GNSS) |
| | Civil Air Navigation Services Organisation (CANSO) |
| 1998 | Communication Navigation Surveillance/Air Traffic Management (CNS/ATM) plan |
| | Relocation of Bloemfontein area control centre to Johannesburg |
| | South African Radar Replacement and Improvement Programme (SARRIP) |
| | Voice Communication and Control System (VCCS) project |
| | Future Airspace Management Efficiency (FAME) project |
| 1999 | ISO 9001 certification |
| | Automatic Dependent Surveillance/Controller Pilot Data Link Communication (ADS/CPDLC) installation for Indian Ocean area |
| 2000 | New high frequency radio system installed |
| | Contract for aeronautical surveying awarded to ATNS by the Federal Aviation Administration (FAA) |
| 2001 | Upgrading of systems at the Johannesburg Air Traffic Control centre |
| | Flexible use of airspace (FUA) (part of FAME) |
| | Area Navigation (RNAV) routes |
| | Phase 1 and 2 of Project Motseta |

Continues overleaf...

⁴⁹ ATNS, 21 Years of Excellence in Air Traffic Management, https://atns.co.za/PDF/Performance/Annual%20Reports/2014/ATNS_21st_Coffee_Table_Book.pdf, last accessed 21 November 2019.

⁵⁰ Ibid.

⁵¹ ATNS Corporate Plan 2016/17, p. 13.

⁵² Ibid.

| Year | Milestone |
|------|--|
| | Signing/final upgrade of South African Advanced Air Traffic System (SAAATS) contract |
| | Installation of 3D Air Traffic Control simulator at ATNS's Aviation Training Academy (ATA) |
| 2002 | South African Radar Replacement and Improvement Programme (SARRIP) |
| | Construction begins on the South African Advanced Air Traffic System (SAAATS) |
| 2003 | Acceptance of main system at Johannesburg control centre (SAAATS project) |
| | Central Airspace Management Unit (CAMU) |
| 2004 | Completion of SAAATS |
| 2005 | Global Navigational Satellite System (GNSS) |
| | Proposed SADC VSAT satellite communication upgrade |
| 2006 | International Civil Aviation Organization (ICAO) Laurel Award |
| | Southern African Development Community (SADC) Upper Airspace Control Centre (UACC) |
| 2007 | ATNS's Safety Management System (SMS) |
| 2008 | ATNS Safety Week and CISM training course |
| | Implementation of a new North East African Indian Ocean VSAT network (NAFISAT) |
| | Reduced Vertical Separation Minima (RVSM) |
| | Multilateration trials |
| 2009 | Control tower construction at King Shaka International Airport |
| 2010 | The Central Airspace Management Unit (CAMU) Air Traffic Flow Management (ATFM) tool |
| 2011 | Launch of a 3D simulator for the ATNS Aviation Training Academy (ATA) |
| | International Air Transport Association (IATA) Worldwide Top Regional Training Partner (RTP) Award |
| 2012 | Inauguration of NAFISAT Master Back-up Terminal in Uganda |
| | ATNS Avi Afrique Innovation Summit |
| | Civil Air Navigation Services Organisation (CANSO) Global Air Traffic Management Safety Conference |
| | International Air Transport Association (IATA) Worldwide Top Regional Training Partner (RTP) Award |
| 2013 | Aviation Management Development Programme (AMDP) |
| | International Air Transport Association (IATA) Worldwide Top Regional Training Partner (RTP) Award |
| 2014 | Best Service Provider Award at Jane's annual ATC Awards ceremony |
| | South African Aviation Collaborative Decision Making (CDM) Conference |

As **Table 2** illustrates, technological capability building at ATNS has been characterised by capital investments in new air navigation infrastructure sites (for example, the control tower at King Shaka International Airport); technology acquisitions (high frequency radio); systems for information and communication (NAFISAT); training programmes (AMDP); new certifications (ISO 9001); and collaborative networks (Avi Afrique). Together, these investments, alongside the human capabilities developed to operationalise these technologies, represent a substantial track record of technological capability within the organisation.



Figure 12: Radar technology is pivotal to ATNS's service provision [Image credit: ATNS]

Despite this progress, however, there remains a perceived dependency on original equipment manufacturers (OEM). As Executive 1 remarked:

All those equipment we buy them from overseas. But if you look at South Africa, you cannot tell me that we don't have capacity to design and manufacture those things. Yes, as ATNS it is not our line of business ... we have the likes of Denel, we have the likes of Armscor, we have got the likes of CSIR ... in terms of innovation, we have the likes of TIA [Technology Innovation Agency] which they can assist in terms of funding, and be able to be innovative, and come up with those equipment that we are buying overseas with a lot of money. We could, jointly, manufacture those facilities and sell them into Africa, not only for our use but for the African continent as well. There is a market for them. And one of the reasons why probably there is poor infrastructure in Africa it's mainly because of the cost [...] you buy a radar for R30 million... In Dollars it's nothing but for us in Rands and in African currencies it's quite a lot of money. I mean the industry has to pay for that and the industry they just take that cost and pass it on to the passenger.⁵³

Executive 1 also said:

One of the mistakes ... after 1994, is to not leverage on the skills we had. You know, the Denel have built the Rooivalk, a [military] helicopter, they are building your seekers, your drones, the RS so that to me is indicative of a wealth of knowledge and skills in this country. And we're not using it, and that's where I'm coming from. Yes, I acknowledge that at ATNS we don't have the capacity and it's not really our business, but we need to assist the likes of Denel: please realise your potential and you've got the market, consider this, we'll buy it from you, because you are a South African company, you are a government-owned company.⁵⁴

The ATNS Corporate Plan for 2019/20 to 2023/2024 presents a refinement of the sentiments expressed by Executive 1 in terms of the relationship between ATNS and OEMs.

In keeping with our strategic objective to expand the ATNS footprint into the wider continental market, we have a strong imperative for securing future growth and revenue. Our regulatory environment restricts our revenue growth potential within the South African market by strictly applying tariff adjustments. It is in this context that ATNS's new Corporate Strategy, commencing in 2019/20 to 2023/24, should be

⁵³ ITV.EXEC1.CS2, 23 October 2018

⁵⁴ ITV.EXEC1.CS2, 23 October 2018

determined in its focus towards growing and expanding our continental footprint. As part of our renewed focus, our desire and intent is to create business linkages between local manufacturing enterprises and global original equipment manufacturers (OEMs).



Summary of technological capability dimension

Technological capability building is characterised by wide-ranging capital investments in new physical infrastructures, systems, technologies for information and communication, training programmes and collaborative networks. An ongoing challenge for ATNS concerns its symbiotic relationships with OEM, which has ramifications for the cost of doing business.

R&D and innovation networks

While internal collaboration between technicians (air traffic controllers, for example) and R&D-performers is promoted for problem-solving, external networks include less formalised collaborations and formalised partnerships.

On a more formal level, ATNS engages networks for the purposes of adhering to industry standards and best practices—for example, through its membership of the International Civil Aviation Organization, as well as the Civil Air Navigation Services Organisation (CANSO). These networks represent vital sources of information, as well as promote information flows between the larger aviation system and the ATNS innovation system.

As the discussion on human capabilities has shown, partnerships are of central importance to the ATNS outlook for filling R&D and innovation skills gaps. As Executive 1 stated:

For me, the key, it's capacitating people, our own people to be able to innovate, to be able to be researchers ... part of that [is the] ability to network, ability to identify your partners. Because if you have partners you can share amongst yourselves.⁵⁵

Box 1 showed that ATNS's collaborations to fill capacity gaps traverse research, human development, particularly development of skills in the ICT field, as well as addressing historical imbalances of highly skilled engineers. Collaboration is also about dealing with the technical challenges that need to be addressed because the entity lacks internal resources. As Executive 1 explained:

We've got a memorandum of understanding with TIA on the issue of funding. We've got a MOU with CSIR on the issue of partnering on research, certain research activities. One classic example is the passive radar ... And then we have the memorandum of understanding with the National Aeronautical Centre (NAC) in terms of identifying the students.

In 2017, ATNS and the Council for Scientific and Industrial Research concluded an MOU to "collaborate on a national multi-static passive radar facility."⁵⁶ This is one of a number of examples of collaboration for technical capacity development. Another key partner for ATNS is the National Aerospace Centre, based at Wits University. Its website says:

Recognising the need for greater innovation and skills development in line with the needs of the South African aerospace industry, the NAC was launched in 2006. The centre engages with government, industry, academia and research institutions, locally as well as internationally, in promoting sector competitiveness and developing human capital.⁵⁷

⁵⁵ ITV.EXEC1.CS2, 23 October 2018

⁵⁶ ATNS online, <https://www.atns.com/about.php?id=104>, last accessed 18/9/2018.

⁵⁷ National Aerospace Centre online, <https://www.wits.ac.za/nac/>, last accessed 12 December 2018.

There is a recognition within ATNS of the value of linkages with the centre, in the view of Executive 1:

They look after the interests of students, to get students into contracts with funders. If you like the material, you could absorb the student into your operations.⁵⁸

An important component of its networking strategy has been the Avi Afrique Summit, launched in 2012, which promotes both formal and informal collaboration. With reference to the Summit, Executive 2 explained its utility as providing a space for sharing across the industry:

*The whole idea was to say to ... network and ... begin to meet different players in different [continental] spaces *... who may not [be] in air traffic management or in the aviation space who you can collaborate with, who you can share ideas, to develop different technologies. This is a perfect example of that. And by all means, there are so many other areas that one can talk to beyond this where you have that type of collaboration.⁵⁹*

Box 2: Avi Afrique Innovation Summit

The 2018 Avi Afrique Innovation Summit took place on 23 and 24 October at the Council for Scientific and Industrial Research's International Convention Centre. Themed 'Breaking barriers in the aviation industry through innovation', the 2018 event was the seventh such summit. The goal of the 2018 event was to "explore how the industry deals with the emergence of incidental and/or real-life barriers that may lead to a need for realignment and restructuring—from an Air Navigation Services Provider or Civil Aviation Authority perspective." To lead in the area of innovation, ATNS founded the Avi Afrique Aviation Innovation Summit, which was inaugurated in November 2012. The forum is aimed at integrated research and innovation, to ensure that solutions on the continent are relevant to the African market and address needs that may not be met by research programmes in the US (NEXTGEN) and Europe (SESAR).

Summary of networks dimension



The typology of partnerships that ATNS engages includes a wide range of forms of interaction. Communication networks: These operationalise multinational agreements such as the Chicago Convention (i.e. South Africa assigns a representative to the International Civil Aviation Organization to report back on global industry developments) and ensure ATNS remains abreast of regional and global standards. Skills partnerships: ATNS works collaboratively with universities such as the University of Pretoria and the University of the Witwatersrand, among others, to leverage expertise and to create a pipeline of engineers, researchers, executives and technicians. Technology partnerships: ATNS collaborates with state actors, such as the Technology Innovation Agency, CSIR, and other non-state actors, on technology development projects.

Research infrastructure

This case study explores whether SOEs are sufficiently resourced in terms of research infrastructure to achieve their R&D and innovation goals. In terms of infrastructure, ATNS requires physical infrastructure (e.g. control towers), information and communications infrastructure (e.g. high frequency radio), navigation infrastructure (e.g. mapping systems),

⁵⁸ ITV.EXEC1.CS2, 23 October 2018

⁵⁹ ITV.EXEC2.CS2, 23 October 2018

and surveillance infrastructure (e.g. radar). Auxiliary aviation services, such as aeronautical information publications, flight procedure design and aeronautical surveys are also required.

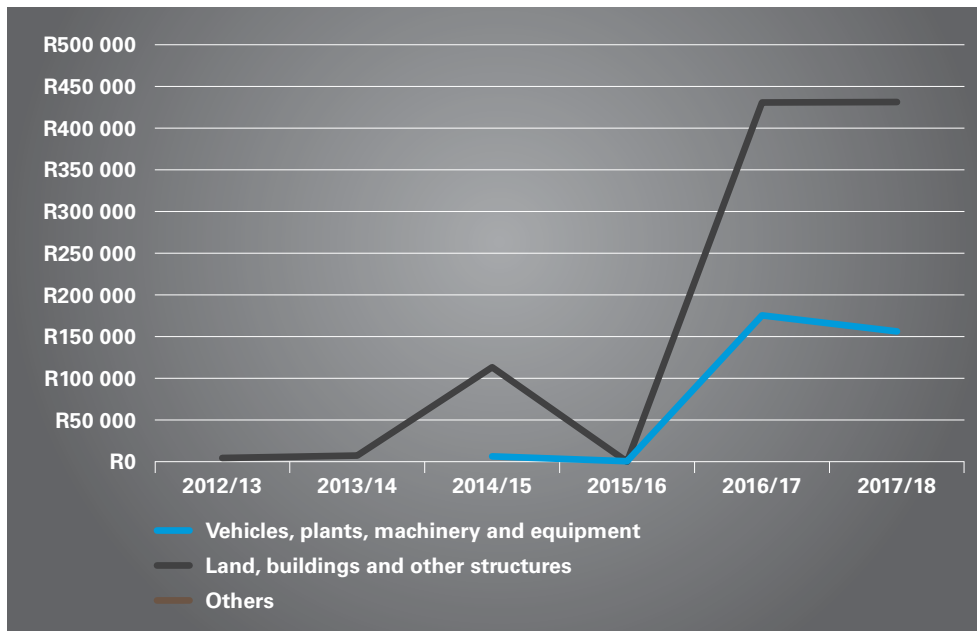


Figure 13: ATNS's R&D expenditure on research infrastructures, 2012/13 – 2016/17 (R'000)
[Source: ATNS; CeSTII/DSI]

While these infrastructure categories are not necessarily aligned to the South African Research Infrastructure Roadmap in the strictest sense, these are arguably the test-beds for ATNS's R&D and innovation capabilities. The breakdown of R&D Survey expenditure data below is useful, showing some investments in vehicles, plant, machinery and equipment as well as land, buildings and other structures in 2016/17. To perform R&D, a senior engineer explained, has necessitated investment in computing and software, including software for simulation. The engineer noted that the organisation does not have dedicated laboratories at present, but that there were proposals in the pipeline. When asked about whether there were plans for research infrastructure investment specifically, Executive 1 was not aware of specific details.

Summary of research infrastructures dimension



While ATNS has a rich tapestry of physical and digital infrastructures, it does not have substantial dedicated facilities for the performance of R&D.

Governance

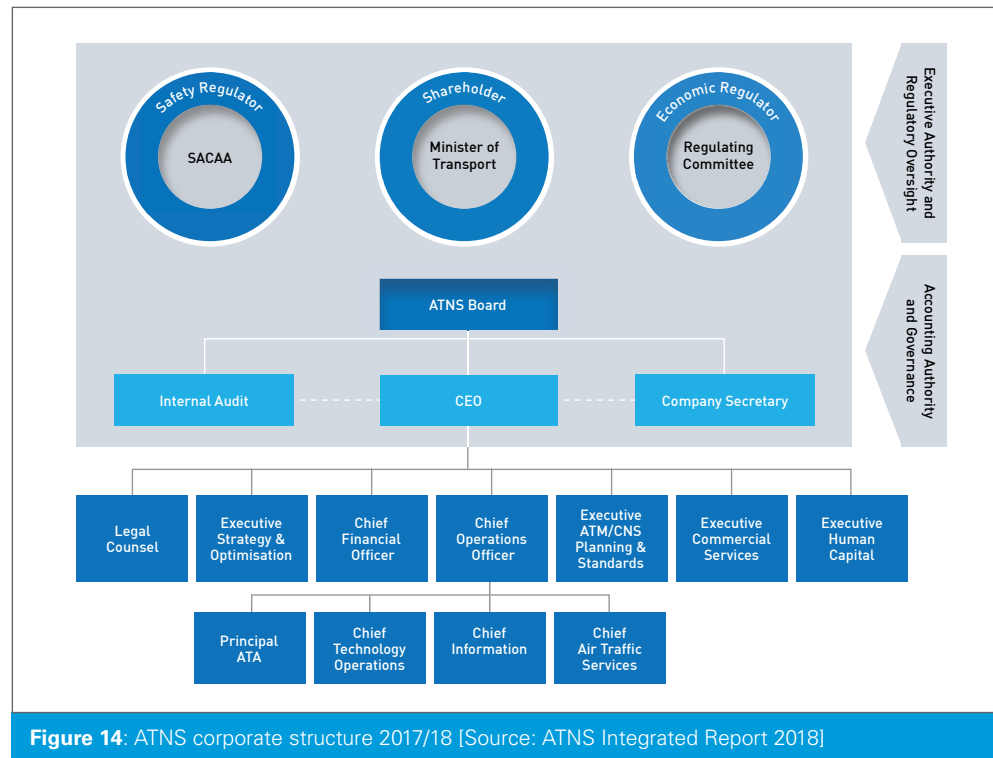
Governance is an increasingly critical concern for SOEs globally, and the OECD has published numerous guidelines on aspects thereof in recent decades.⁶⁰ In the South African context, the King Report on Corporate Governance and its subsequent iterations in 1994 (I), 2002 (II), 2009 (III) and 2016 (IV), set important standards for the governance of SOEs, together with the Public Finance Management Act (Act 1 of 1999) and the Companies Act (Act 71 of 2008). In this context, South African SOEs face a crisis of public confidence, in the wake of developments in entities such as Eskom, SAA and the SABC, to name a few. ATNS has not escaped unscathed.⁶¹ But what is the state of governance at ATNS, in so far as R&D and innovation are concerned?

⁶⁰ Since the early 2000s, the OECD has homed in on SOE governance and governance reform. For example: *Corporate Governance of State-Owned Enterprises: A Survey of OECD Countries, 2005*; *State-Owned Enterprise Governance Reform: An Inventory of Recent Change, 2011*; *Boards of Directors of State-Owned Enterprises: An Overview of National Practices, 2013*; *OECD Guidelines on Corporate Governance of State-Owned Enterprises, 2015*; *Broadening the Ownership of State-Owned Enterprises: A Comparison of Governance Practices, 2016*; *State-Owned Enterprises as Global Competitors: A Challenge or an Opportunity?*, 2016.

⁶¹ M. Reddy, Zuma-linked spies 'capture' key airports service, amaBhungane Centre for Investigative Journalism, 29 March 2018. Available at: <http://ht.ly/xrpV30jdlie>, last accessed 8 November 2019.

In terms of the governance of R&D and innovation, this report is interested in the systems, processes, policies and structures available to direct, manage and control the organisation's R&D and innovation activities internally. Principally, this concerns the role of executive management but also the board.

The ATNS corporate structure (**Figure 14**) includes both the economic and safety regulators (top left and right circles), and the entity's shareholder, which frames the governance structure. This institutional governance structure supports the SOE with funding allocations and other mechanisms so that new and improved ideas can flow through the organisation.



In the ATNS 2018 Corporate Plan, R&D is given prominence within a core programme entitled “Management of Research and Development initiatives, guided by an R&D framework, strategy and implementation plan.” This aims to:

... conduct critical R&D with a quest to develop and deploy innovative aviation technologies and concepts addressing security, efficiencies (QoS, cost-effectiveness, safety, productivity, financial) including environmental compatibility and security that are embodied in ATM and CNS Roadmaps.

It continues:

In line with the vision of the South African government to move the country towards a knowledge-based economy, ATNS is shifting from merely being a user of the acquired technologies to contributing to the value chain of technology innovation and the development of domestically consumed technologies. ATNS exhibits greater possibilities for innovation. As a result, ATNS AR emphasises a methodology where research activities are undertaken with the purpose to innovate, develop, enhance and/or validate technology solutions. This initiative has the potential to be commercialised or operationalised for primary use in the ATM operational environment. The outcomes of the applied research may lead to product development, process development and/or improvement. To achieve this, ATNS AR will be strategically partnering with both the Original Equipment Manufacturer (OEM), research agencies and institutions for

technology research and development. This will enable ATNS's AR department to deliver on the following ATNS strategic imperatives:

- To provide efficient air traffic management solutions and associated services which meet the needs and expectations of the ATM community.
- To play a leading role in the development of air traffic management in Africa and selected international markets.
- To deploy and use leading technologies to the benefit of the ATM community.⁶²

These passages are quoted at length as they reflect the organisation's documented strategic thinking and plans for R&D. This change in strategic thinking arose at ATNS in the late 2000s. Executive 2 explained the genesis of this shift and its implications for the organisation's capacity to innovate:

The corporate strategy of ATNS actually, the last 10 years, from the time we moved from being rather insulated ...[and] sticking to our mandate, somewhere around 2010 the CEO at the time felt that ATNS needed to leap forward and move beyond its ... current comfort zone of strictly, you know, providing services in the regulated business and we adopted what we call a 'market-based approach', which then said how do we leverage on ATNS's capabilities to move into the continent.⁶³

He continued:

Part of that ... was to develop a big marketing strategy and business intelligence capability to develop the stakeholder management capability but also to leverage off our existing infrastructure and human resources So those pillars are what drives us and, clearly, ... innovation becomes a big part then, of how we achieve that. Whether you talk of the business intelligence, market intelligence, that I talked about, because you need a strategy, you need a system, you need processes to be able to ... build those capabilities. Whether we are talking about business intelligence, which ... in most cases you would assume an inward-looking ability to have business intelligence systems, or whether we are talking market intelligence capabilities to be able to see what the opportunities ... [are]. So again, the ability to innovate in doing that became critical and part of, some of the strategies that we have put in place in achieving that, some of them even system-related, some of them ... have been driven by innovation.

As far as the mechanics of governance of R&D and innovation is concerned, ATNS presented its R&D Strategy to its board in December 2018, which was formulated by the entity's Operations Technology Department. According to a manager close to the strategy's implementation, who was conducting a national roadshow about it at the time of being interviewed, it has a very strong focus on the impacts of the fourth industrial revolution as these pertain to the aviation industry in general and air traffic navigation in particular.⁶⁴ Attempts were made to learn more about the strategy's detail, but this information was not available to CeSTII at the time of preparing this report. Executive 1 did, however, provide some insight into the strategy's key tenets:

First of all, you cannot be an excellent company whereas you've got thousands of problems within your company. So you need to get your house in order first. So most of our research strategy will be focussing on innovative solutions towards our problems and in the course of that, in the course of that, you identify an opportunity to commercialise that particular idea, and that process will run in parallel. But we want to reach a point where the main focus, the bulk of our focus will be for the commercial aspect of it but without neglecting our core responsibility. We don't want to, we don't want to sell innovative products into Africa, whereas our safety performance it's going down the drain. I mean that won't make sense because we'll be neglecting our core business and our core business is exactly that: it's to ensure [that] aircraft operate in Africa, in South Africa, safely.⁶⁵

⁶² ATNS Corporate Plan 2018, pp. 52-53.

⁶³ ITV.EXEC2.CS2, 23 October 2018

⁶⁴ ITV.ENG.CS2, 14 February 2019.

⁶⁵ ITV.EXEC2.CS2, 23 October 2018

To oversee the implementation of the strategy, ATNS established an R&D Steering Committee, consisting of senior executives and chaired by the Chief Operations Officer, Dr Sandile Malinga, formerly of the South African National Space Agency (SANSA). Members of the committee were “carefully chosen depending on their areas of responsibilities and the disciplines they are involved in,” Executive 1 reported.⁶⁶ The strategy’s purpose is outlined in its Integrated Report 2017:

*The strategy will shift ATNS from being a user of acquired technologies to contributing to the local technology value chain. Similarly, through our Aviation Innovation Laboratory ATNS will develop, test and validate future technology solutions with the potential to be commercialised or operationalised in the ATM environment. Accordingly, we look forward to positioning ATNS as an African leader in the 21st-century innovation economy.*⁶⁷

In an interview with a senior engineer in early 2019, the engineer reported that the strategy was being rolled out across the country in a roadshow, with presentations to staff about contributing to the achievement of the strategy.⁶⁸

On the side of innovation strategy, Executive 1 emphasised the importance of fostering a ‘culture’ of innovation, and of recognition:

When you talk about innovation, when you talk about creative thinking, new ideas and the likes, thinking outside of the box, you tend to go outside and engage people and see how they can help you. But you forget your own people. So what we have done is we have created a platform where our internal employees can come up with innovative ideas and actually recognise those. So whoever wins obviously gets the prize ... Most companies they go wrong when it comes to IP... so our legal department is seriously looking at our IP, not only to protect the company but to protect our own employees as well.

Executive 1 also reflected on the role of the ATNS Board to support innovation, through financing, as well as the role of partnerships:

You know the ATNS Board is very clear on innovation, they say you need to give us our strategy we’ll give you money. But you know that ATNS money alone won’t be enough for, for innovation. So hence we’re partnering with TIA and TIA is willing to put money into this ... but we [are] not going to limit our funding options to TIA. I mentioned the SKA now, they obviously have funding, we can leverage on that. The Department of Transport has identified research as one of the opportunities that they want to tap into. They say they want to create an innovative hub for the transport sector, where they bring all the government agencies in the transport sector into one roof, and they say how can we innovate together. And I can see obviously that expanding to other sectors. So you will end up having one big innovative hub for all the sectors.

So we need to have capacity to be able to identify those kind of opportunities. You know somebody was telling me that the likes of Boeing, the likes of Airbus, in terms of research they are spending billions, a lot of money, they are putting into research and they will get a hundred ideas from their own employees, because they’ve got a lab of researchers ... but probably only one will be used, and be commercialised, or will be used to improve or enhance the efficiency in terms of building their airframes. And it’s something that we need to recognise and acknowledge as ATNS as early as possible, for us to be innovative, we need to be bold and spend money and do not expect returns in the next two, three years.

⁶⁶ ITV.EXEC2.CS2, 23 October 2018

⁶⁷ ATNS Integrated Report 2017, p. 33.

⁶⁸ ITV.ENG.CS2, 14 February 2019

Summary of governance dimension



It is clear that ATNS has made substantial efforts to articulate a strategy to drive business revenue growth, and efficiencies. In the past decade it has positioned innovation, and more recently R&D, as a key driver of growth. A R&D Strategy, which draws in key executives as well as staff across the organisation, focuses on positioning ATNS in relation to the challenges presented to aviation by the fourth industrial revolution. Perhaps more than ever, innovation and R&D are within the crosshairs of ATNS's governance actors.

5 | DISCUSSION: CHALLENGES AND OPPORTUNITIES FOR R&D AND INNOVATION CAPABILITY BUILDING

The case study data presented here is useful to the extent that it contributes to a quantitative and qualitative, albeit incomplete, snapshot of R&D and innovation in the ATNS entity. What can we glean from this data about opportunities and challenges for capacity building in R&D and innovation at ATNS? The brief discussion that follows weaves together threads from the data described and analysed and sets out the challenges and opportunities for ATNS.

Challenges arising from convergences of global and local conditions

The dramatic increase in both aircraft and passenger numbers locally⁶⁹ and around the world, as well as the global trend toward digital aviation, necessitate that ATNS adapt its infrastructure and systems to align with fast-evolving industry norms and standards. Domestically, public and political pressure on state-owned enterprises in general to demonstrate their utility, viability and strategy is immediate. In the context of these contextual and strategic drivers, the capabilities of ATNS to conduct R&D, and to innovate, are essential. This research reveals a snapshot of ATNS's R&D and innovation capabilities, on the one hand, and its R&D and innovation plans, on the other. It paints a picture of an entity aware of changes in its external environment and its organisational capacity.

Challenges in defining the scope of R&D and innovation ambition

The R&D performed is almost exclusively R&D geared to the servicing or adaptation—calibration and optimisation—of equipment produced internationally to local contexts. Innovation comprises a broader set of activities, including training. In many developing countries, air traffic management service providers rely on technology imports from OEMs based in the Global North to perform their core functions efficiently and effectively. In this context, R&D or innovation is typically undertaken with a view to adapt equipment to local contexts or to upskill human resources to manage OEM technology effectively. ATNS has stated its ambition to balance reliance on imported technology with contributions to local technology value chains. This ambition is backed, in practice, by an R&D Strategy and a governance structure, the R&D Strategy Board. It is not altogether clear, however, where investment will be targeted.

Opportunities to develop South Africa's comparative advantage in air traffic navigation capacity development

An opportunity to expand revenues through exporting technical service provision to other African countries, also necessitates that ATNS take the necessary steps to position itself as a competitive and strategic 'consulting' player within the global air traffic management market. World-class air traffic management is essential to South Africa's aviation industry performance and indeed the country's economic development. In this context maintenance of stringent safety standards remains the key urgency for ATNS. Like many other industries, air traffic management in developing countries is transitioning between legacy systems, reflecting older technologies, and newer digital aviation, representing emergent technologies.

⁶⁹ ITVE.CS2, 23 October 2018

Opportunities to collaborate nationally and internationally

ATNS has developed strong collaborations with higher education institutions and science councils in South Africa, and this is evident in a number of seemingly productive higher education-industry and science council-industry type relationships. As early as 2006, Kruss identified challenges in research partnerships between higher education institutions and industry in South Africa.⁷⁰ These include: “policy coherence between organisational levels within an institution”; “the importance of seeking a balance between financial and intellectual research imperatives”; “the necessity of promoting a strategic balance between the forms of partnership that are allowed and encouraged to develop within an institution, and to the need for flexible regulation within institutions to provide levers and incentives without being heavy-handed or constricting.”⁷¹ In the case of ATNS, there is a distinct opportunity to leverage collaboration to fill capacity gaps within both R&D and innovation domains.

⁷⁰ G. Kruss, 2006. Tensions in Facilitating Higher Education-Industry Research partnerships in High Technology Fields in South Africa. *Journal of Higher Education Policy and Management*, 28 (1), pp.31-44

⁷¹ *Ibid.*, p. 43.

CONCLUSION

“Innovation for us means we have to be able to accept that we need to do things differently, that we have to do things in a manner that helps serve the interests of the users ultimately, who want a safe and efficient service provided in the most cost-effective manner, and they will do anything and everything to lobby for those.”

ATNS Executive 1

This case study research paints an overwhelmingly encouraging picture of an entity geared—and increasingly gearing itself—to perform R&D and innovation.

While ATNS, a profitable SOE in 2017/18, relies, in the main, on equipment from multinational corporations to execute its mandate, it also occupies a favourable and unique position within the South African, African and Indian Ocean market for air traffic management and navigation services, including satellite communication technology and training. ATNS recognises this position as a strength, while also recognising that the potential for revenue growth in South Africa is limited, owing to current economies of scale. In the case of South African SOEs, dynamic approaches are required if SOEs are to remain industrially competitive while serving the needs of a rapidly changing market characterised by increasingly global flows of big data, technology, and digital platforms. To these ends, R&D and innovation play a critical, though not the only, role in firm competitiveness.

ACKNOWLEDGEMENTS

The research leading to this case study report was undertaken by the Centre for Science, Technology and Innovation Indicators (CeSTII) within the Human Sciences Research Council (HSRC). Desktop research and key informant interviews were conducted by a team comprising Jerry Mathekga, who also managed the overall project, Dr Nazeem Mustapha, who conceptualised the project, and Gerard Ralphs who analysed the data.

We acknowledge any errors contained in this report as our own.

The research team wish to acknowledge the support of CeSTII's Executive Head, Dr Glenda Kruss, in guiding project progress, research design and instrumentation, as well as for valuable contributions to data analysis.

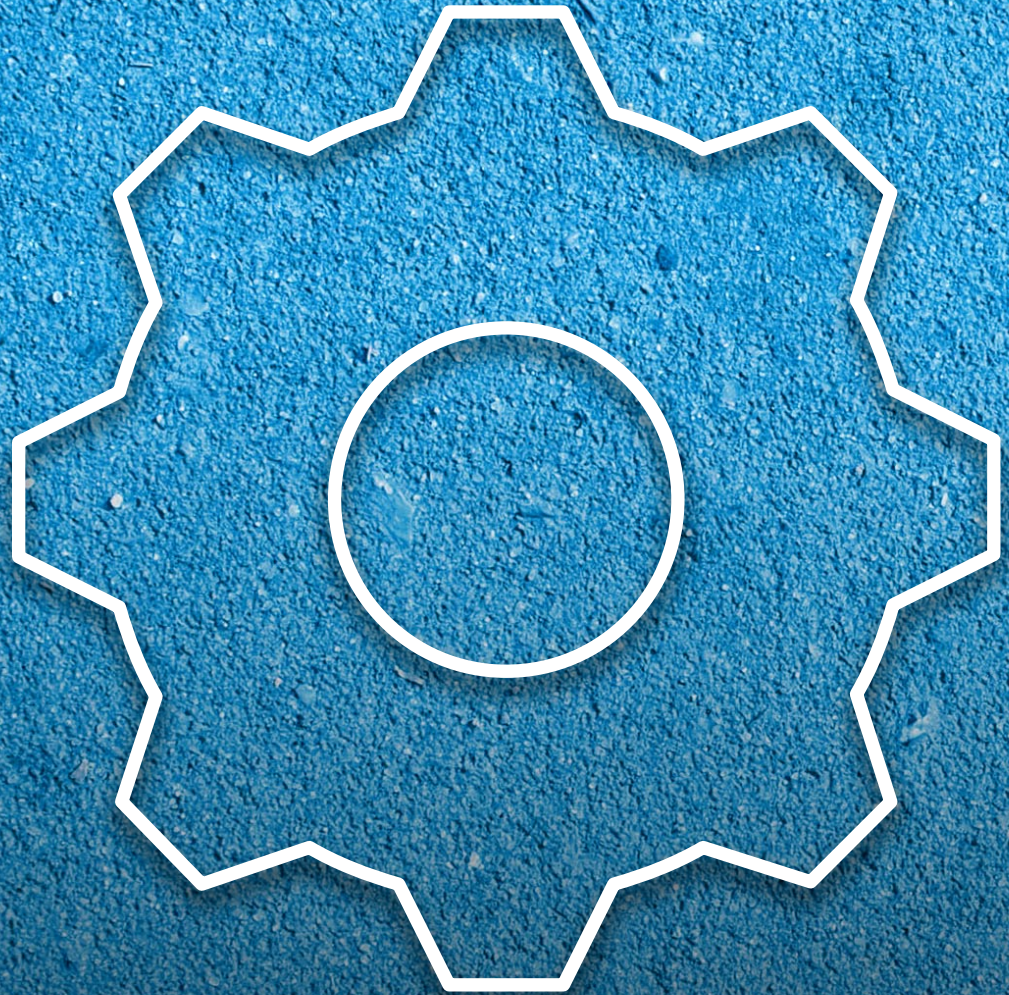
We also wish to acknowledge the ATNS organisation and the officials who participated in the research: notably, for their time, expertise and for valuable insights into the R&D and innovation capabilities of the organisation. We are especially grateful to the ATNS officials that supplied relevant research materials, photographs, and arranged research interview logistics.

Funding for this research was facilitated by CeSTII, which is supported by the Department of Science and Innovation. The DSI's Godfrey Mashamba, Tshidi Lekala, Kgomotso Matlapeng-Matjila, and Thabo Manyaka are thanked for their contributions to the leadership of this research.

We are grateful to Katharine McKenzie for the copy editing of earlier drafts of this report and Tracey Watson for design and layout.

To cite this report:

Centre for Science, Technology and Innovation Indicators. 2021. R&D and Innovation Capabilities in South African State-Owned Enterprises: The Case of Air Traffic & Navigation Services SOC Ltd. Working Paper, 2c (February 2022). Human Sciences Research Council: Cape Town.



Working Paper Series on R&D and Innovation Capabilities in South African State-Owned Enterprises

State-owned enterprises (SOEs) are important national assets with a mandate to contribute to sustainable economic growth and South Africa's broad developmental goals. In March 2019, the Department of Science and Innovation (DSI), published the White Paper on Science, Technology and Innovation. This recognised the importance of SOEs in the South African economy and the need to revitalise them to play a meaningful role in South Africa's science, technology, innovation and economic development. As key institutions for human capital development and international and national knowledge sharing, the White Paper also aimed to position SOEs as innovation-driven for the knowledge economy. But to what extent and how are South African state-owned enterprises geared to perform R&D and innovation? Based on in-depth case study research with three SOEs—SANEDI, ATNS and SAFCOL—as well as analysis of the academic literature, the Human Sciences Research Council's Centre for Science Technology and Innovation Indicators (CeSTII) identified dimensions key to effective R&D and innovation 'gearing' by these SOEs, including: human capabilities; technological capabilities; networks; research infrastructure; and governance. Out of this research, indicators on R&D and innovation are also proposed to guide national policy discussion on the future of SOEs in South Africa.



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