ANNUAL REPORT

2023/2024

science & innovation
Department:
Science and Innovation
REPUBLIC OF SOUTH AFRICA

CSIR
Touching lives through innovation

30 YEARS OF FREEDOM
South Africa 1994 - 2024

Cover image: Noxolo Skhosana,
CSIR Communication Assistant

SECTION A
General information

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General information

The CSIR is a leading scientific and technology research organisation that researches, develops, localises and diffuses technologies to accelerate socioeconomic prosperity in South Africa.

The organisation's work contributes to industrial development and supports a capable state. The organisation plays a key role in supporting government's programmes through directed research that is aligned with the country's priorities, the organisation's mandate and its science, engineering and technology competencies.

General information

Registered name	Council for Scientific and Industrial Research
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Website address	www.csir.co.za
External auditors	Auditor-General South Africa
Bankers	ABSA

List of abbreviations/acronyms

Advanced Chemistry and Life Sciences	**ACLS**
Adjusted Estimates of National Expenditure	**AENE**
Advanced Agriculture and Food	**AAF**
African Female	**AF**
African Male	**AM**
Advanced Polymer Composites	**APC**
Aeronautical Society of South Africa	**AeSSA**
Audit and Risk Committee	**ARC**
Auditor-General of South Africa	**AGSA**
American Chemical Society	**ACS**
Anthropomorphic Test Device	**ATD**
Artificial Intelligence	**AI**
Audiovisual	**AV**
Broad-Based Black Economic Empowerment	**B-BBEE**
Building Management System	**BMS**
Capability Investment Development Programme	**CIDP**
Chartered Institute of Business Accountants	**CIBA**
Chief Executive Officer	**CEO**
Chief Financial Officer	**CFO**
Chief Information Officer	**CIO**
Centre for High Performance Computing	**CHPC**
Coloured Female	**CF**
Coloured Male	**CM**
Committee of Transport Officials	**COTO**
Content Management System	**CMS**
Corporate Social Investment	**CSI**
Council for Scientific and Industrial Research	**CSIR**
Coronavirus disease 2019	**Covid-19**
CSIR C-Cubed	**CSIR C^3**
CSIR International Convention Centre	**ICC**
Department of Forestry, Fisheries and Environment	**DFFE**
Department of Home Affairs	**DHA**
Department of Science and Innovation	**DSI**
Department of Trade Industry and Competition	**the dtic**
Doctor of Philosophy	**PhD**
Eskom Research, Testing and Development	**Eskom RT&D**
Excellence, People-Centredness, Integrity and Collaboration	**EPIC**
Executive Cluster Managers	**ECM**
Executive Committee	**Exco**
Executive Development Programme	**EDP**
Existing Air handling units	**AHUs**
Expected credit loss	**ECL**
Foreign Female	**FF**
Foreign Male	**FM**
Financial year	**FY**
Forensic Pathology Services	**FPS**
Fraud Prevention Plan	**FPP**
Gas leak detection system	**GasCAM**
Gel Permeation Chromatography	**GPC**
Geographic Information System	**GIS**
Global System for Mobile Communication	**GSM**
Graduates-In-Training	**GITs**
Health and Safety	**H&S**
Heating, ventilation and air conditioning	**HVAC**

List of abbreviations/acronyms

Higher education institutions	**HEIs**
Honours	**Hons**
Hot Isostatic Press	**HIP**
Human Resources and Social and Ethics Committee	**HRSEC**
Human Capital	**HC**
Human Sciences Research Council	**HSRC**
Indian Female	**IF**
Indian Male	**IM**
Inertial Navigation Systems	**INS**
Information and Communication Technology	**ICT**
Information Technology	**IT**
Integrated Port Operation Support System	**IPOSS**
Intellectual Property	**IP**
Inter-Bursary Support Programme	**IBS**
International Accounting Standards Board	**IASB**
International Accounting Standards	**IAS**
International Financial Reporting Interpretations Committee	**IFRIC**
International Financial Reporting Standards	**IFRS**
International Information System	**ISC**
International Organisation for Standardisation	**ISO**
Internet of things	**IoT**
Key Performance Indicators	**KPIs**
KwaZulu-Natal	**KZN**
Laboratory Information Management System	**LIMS**
Leadership and management development training programmes	**LMDP**
Mandela Mining Precinct	**MMP**
Manufacturing Engineering and Related Services	**MerSETA**
Master of Business Administration	**MBA**
Master of Science	**MSc**
Maximum Draught	**DMAX**
Member of the Executive Council	**MEC**
Memorandum of Understanding	**MoU**
Ministers and Members of Executive Council	**MINMEC**
National Cleaner Production Centre of South Africa	**NCPC-SA**
National Economically Active Population	**NEAP**
National Foundry Technology Network	**NFTN**
National Institute of Standards and Technology	**NIST**
National Integrated Cyber Infrastructure System	**NICIS**
National Science Week	**NSW**
National Skills Fund	**NSF**
National Treasury	**NT**
Nelson Mandela University	**NMU**
North-West University	**NWU**
Operational Effectiveness Systems	**OES**
Other Comprehensive Income	**OCI**
Parliamentary Grant	**PG**
Photovoltaics	**PV**
Portable Batch System	**PBS**
Portfolio Committee	**PC**
Programme Management Unit	**PMU**
Property, Plant and Equipment	**PPE**
Proprietary limited	**Pty Ltd**

List of abbreviations/acronyms

Provincial Disaster Management Centre	**PDMC**
Public Finance Management Act	**PFMA**
Polyurethane Dispensing Unit	**PUDU**
Rapid Product Development Association of South Africa	**RAPDASA**
Recordable Incident Rate	**RIR**
Regional Innovation Support Programme	**RISP**
Renewable Energy Development Zones	**REDZs**
Research, Development and Innovation Committee	**RDIC**
Research group	**RG**
Research, development and innovation	**RD&I**
Ribonucleic acid	**RNA**
Road Asset Management System	**RAMS**
Safety, Health, Environment and Quality	**SHEQ**
Safety, Health and Environment	**SHE**
Scanning Electron Microscopy	**SEM**
Science, Engineering and Technology	**SET**
Science, Technology and Innovation	**STI**
Science, Technology, Engineering, Mathematics and Innovation	**STEMI**
Sector Education Training Authority	**SETA**
Sefako Makgatho Health Sciences University	**SMU**
Short-term incentive	**STI**
Sea level pressure	**SLP**
Small, medium and micro enterprises	**SMMEs**
South Africa	**SA**
South African Local Government Association	**SALGA**
South African Maritime Safety Authority	**SAMSA**
South African Mining Extraction, Research, Development, and Innovation	**SAMERDI**
South African National Defence Force	**SANDF**
Spatial Light Modulators	**SLM**
State Information Technology Agency	**SITA**
State-owned enterprises	**SOEs**
Strategic Objective	**SO**
Technology Innovation Agency	**TIA**
Technology Readiness Levels	**TRLs**
Transnet National Ports Authority	**TNPA**
Ultra High-Performance Liquid Chromatography	**UHPLC**
Ultraviolet	**UV**
United Nations Development Programme	**UNDP**
University of Cape Town Graduate School of Business	**UCT GSB**
University of Pretoria	**UP**
University of South Africa	**UNISA**
University of the Witwatersrand	**Wits**
Virtual private network	**VPN**
White Female	**WF**
White Male	**WM**
Work integrated learning	**WIL**
Youth Employment Services	**YES**

FOREWORD BY THE CHAIRPERSON

Vuyani Jarana
Chairperson of the Board

2024 marks a momentous year for South Africa as we celebrate 30 years of democracy. On 27 April 1994, millions of South Africans cast their ballots in a democratic election, many for the first time in their lives. That historic day was the culmination of centuries of struggle to liberate South African people from poverty and inequality, among other challenges.

Celebrating 30 years of democracy

The CSIR plays a critical role in addressing issues that hinder our economic advancement, particularly the triple challenges of poverty, unemployment and inequality. This role is embedded in our mandate to foster scientific and industrial development to improve the quality of life for all South Africans, especially the youth, women and people with disabilities.

The CSIR is a schedule 3B national government business enterprise and we assess the organisation's effectiveness by how well we implement projects on behalf of government departments and state-owned enterprises in support of a capable state, our contribution to industrial development and the development of long-term strategic SET capabilities.

I can confidently say that the CSIR has performed admirably during this financial year (FY). The organisation has achieved or exceeded 87% of its key performance indicators for the 2023/24 reporting year. It is especially pleasing to note a 42% increase in projects implemented to increase the capacity of the state, reflecting our commitment to support government initiatives.

In the 2023/24 FY, the CSIR has implemented more initiatives for the government than in the past five years. Pages 70 to 74 provide illustrative examples of our support for the energy, mining, transport, logistics and health sectors. Additionally, we have contributed to decision support and improved

efficiencies in information and communication systems for national departments.

The organisation remains crucial for the government to realise the National Development Plan, Vision 2030 and other transformation agendas such as the Economic Reconstruction and Recovery Plan and the 2019 National Policy on Science, Technology and Innovation, among others. Our efforts also continue to support industrial development.

Considering the critical role the CSIR plays, the ongoing decline in the parliamentary grant is a concern. Adequate support is essential for the organisation to fulfil its developmental mandate and maintain essential capabilities. It is vital for the state to continue funding research and development (R&D) and view it not as an expense but as an investment in the future. Many successful countries owe their success to continued investment in R&D.

This year marks five years of implementing the CSIR Strategy, which amplifies the 'I' in CSIR. The transition to the new strategy was not an easy endeavour, but our dedicated team ensured our success. I commend the leadership and employees for embracing this change and proactively making it work. In his message on pages 12 to 13, Dr Dlamini highlights the strides made in implementing the strategy and it is elaborated upon on pages *75* to *77*.

Exceeding 87% of our key performance indicators

Despite the challenges, I want to thank the executive leadership and staff of the CSIR for their dedication to touching lives through innovation.

On behalf of the CSIR Board, I also acknowledge the continuous support and guidance from the Minister of Science and Innovation, Prof. Blade Nzimande, and his department, as well as the dedication of my fellow Board members to the organisation's continued success.

Amazwi kaSihlalo weBhodi

Unyaka wezi-2024 uwunyaka oyingqophamlando eNingizimu Afrika njengoba sigubha iminyaka engama-30 entando yeningi. Mhla zingama-27 kuMbasa 1994, izigidi zabantu baseNingizimu Afrika zavota okhethweni lwentando yeningi, kwabaningi okwakungokokuqala ngqa empilweni yabo. Lolo suku oluyingqophamlando lwaba uvuthondaba emzabalazweni wamakhulu ngamakhulu eminyaka okukhululwa kwabantu baseNingizimu Afrika ebuphofwini nokuphathwa ngokungalingani, ukubala nje izinselele ezimbalwa.

I-CSIR idlala indima esemqoka kakhulu ekuzameni ukubhekana nezinkinga eziyizithiyo entuthukweni yethu yezomnotho, ikakhulukazi izinselele ezintathu zobuphofu, ukuntuleka kwemisebenzi kanye nokungaphathwa kwabantu ngokulingana. Le ndima ididiyelwe emgomweni wethu wokugqugquzela ukuthuthukiswa kwezesayensi nezimboni ukuze kwenziwe ngcono iqophelo lempilo yabo bonke abantu baseNingizimu Afrika, ikakhulukazi intsha, abesifazane nabantu abakhubazekile.

I-CSIR iyibhizinisi likahulumeni kazwelonke likasheduli 3B futhi sihlola ukusebenza kahle kwenhlangano ngokuthi iyenza kahle kanjani imiklamo egameni leminyango kahulumeni namaBhizinisi oMbuso ekwesekeni umbuso onamandla, igalelo lethu ekuthuthukisweni kwezimboni kanye nokuthuthukiswa kwezinhlelo zesikhathi eside. Ngamasu amakhono e-SET.

Ngingasho ngokuqinisekile ukuthi i-CSIR yenze kahle kakhulu kulo nyakamali (i-FY). Inhlangano ifinyelele noma ize yedlula ama-87% ezinkomba zayo ezisemqoka zokusebenza onyakeni wokubika wezi-2023/24. Kuyajabulisa kakhulu ukuqaphela ukwenyuka ngama-42% kwemiklamo eqaliswe ukusebenza ukuze kwenyuswe amandla ombuso, okubonisa ukuzibophezela kwethu ekwesekeni imizamo kahulumeni.

Ngonyaka wezi-2023/24, i-CSIR iqalise izinhlelo eziningi kuhulumeni kunakule minyaka emihlanu edlule. Ukusuka ekhasini 70 kuya kwele-74 sikhonjiswa izibonelo ezibonisa ukweseka kwethu imikhakha yezamandla, ezezimayini, ezokuthutha, ukuhlelwa kwezokuthutha kanye nezempilo. Ukwengeza kuloko, sibe nesandla ekwesekeni izinqumo kanye nokwenza ngcono ukusebenza kahle kwezinhlelo zezolwazi nezokuxhumana zeminyango kazwelonke.

Le nhlangano isalokhu ibalulekile kuhulumeni ukuze akwazi ukufeza uHlelo Lwentuthuko Kazwelonke, Umbono Wonyaka wezi-2030 kanye nezinye izinhlelo zezinguquko ezifana noHlelo loKwakhiwa kaBusha nokuVuselelwa koMnotho kanjalo neNqubomgomo kaZwelonke yowezi-2019 yeSayensi, ubuChwepheshe nokuSungula, phakathi kokunye. Imizamo yethu iyaqhubeka nokweseka ukuthuthukiswa kwezimboni.

Uma ubuka indima ebalulekile edlalwa yi-CSIR, ukulokhu kuqhubeka nokwehla kwesibonelelo sikahulumeni sasephalamende kuyinto ekhathazayo. Ukwesekwa okwanele kwenhlangano kubalulekile ukuze ikwazi ukufeza umgomo wayo wokuthuthukisa futhi igcine amakhono asemqoka. Kubaluleke kakhulu ukuthi umbuso uqhubeke nokuxhasa ngezimali ucwaningo nentuthuko (i-R&D) futhi ungakubuki loku njengezindleko kodwa njengotshalomali oluzoba yimpumelelo esikhathini esizayo. Amazwe amaningi asephumelele ayazi ukuthi impumelelo yawo ingenxa yotshalomali olwenziwe ku-R&D.

Kulo nyaka sigubha iminyaka emihlanu kwaqaliswa ukusebenza kweSu le-CSIR, eligqamisa kakhulu u 'I' ku-CSIR. Ukushintshela kuleli su elisha kwakungeyona neze into elula, kodwa ithimba lethu elizinikele laqinisekisa ukuthi siyaphumelela. Ngibethulela isigqoko abaholi nabasebenzi bethu ngokulwamukela ngezandla zombili lolu shintsho futhi benze isiqiniseko sokuthi luyasebenza. Emlayezweni wakhe osekhasini 12 kuya kwele-13, uDkt Dlamini ugcizelele wagqamisa amagxathu enziwe ekuqaliseni ukusebenza kwaleli su futhi kuchazwa kabanzi ekhasini 75 kuya kwele-77.

Naphezu kwezinselele ezikhona, ngifuna ukubonga ubuholi obuphezulu kanye nabasebenzi be-CSIR ngokuzinikela kwabo ekuthinteni izimpilo zabantu ngokusungula izinto ezintsha.

Egameni leBhodi le-CSIR, ngithanda ukuphinda ngibonge ukwesekwa okuqhubekayo nokuqondiswa okuvela kuNgqongqoshe wezeSayensi nokuSungula, uSolwazi Blade Nzimande, nomnyango wakhe, kanjalo nokuzinikela kwamalungu engikanye nawo kuBhodi ngempumelelo eqhubekayo yenhlangano.

Vuyani Jarana
USihlalo weBhodi

Kakaretšo ya modulasetulo wa Boto

2024 ke ngwaga o bohlokwa go Afrika Borwa ka ge re keteka mengwaga ye 30 ya temokrasi. Ka la 27 Moranang 1994, dimilione tša Maafrika Borwa di kgethile mo dikgethong tša temokrasi, ba bantši e le la mathomo mo maphelong a bona. Letšatši le la histori e bile mafelelo a ntwa ya go lokolla batho ba Afrika Borwa go tšwa go bohloki le go se lekalekane gare ga ditlhohlo tše dingwe.

CSIR e kgatha tema ye bohlokwa go šogana le ditaba tšeo di ditelago tšwelopele ya ekonomi ya rena, kudu ditlhohlo tše tharo tša bohloki, go hloka mešomo le go se lekalekane. Mošomo wo o ka gare ga taolelo go hlokomela tšweletšopele ya saense le intasteri go kaonafatša boleng bja bophelo bja Maafrika Borwa, kudu bafsa, basadi le batho bao ba phelago ka bogolofadi.

CSIR ke kgwebo ya mmušo ya setšhaba ya lenaneo la 3B gomme re lekola bokgoni bja mokgatlo ka gore re phethagatša diprotšeke tša rena bjang legatong la dikgoro tša mmušo le Dikgwebo tša Mmušo go thekga mmušo wa bokgoni, go kgatha tema ga rena go tšweletšopele ya intasteri le mabokgoni a SET tša peakanyo ya nako ye telele.

Nka bolela ka go ikgantšha gore CSIR e šomile gabotse kudu nakong ya ngwaga wo wa ditšhelete. Mokgatlo o fihleletše goba o fetile 87% ya ditlhahli tša phethagatšo tša motheo tša ngwaga wa go bega wa 2023/24. Go a thabiša go lemoga koketšego ya 42% mo diprotšekeng tšeo di phethagaditšwego go oketša bokgoni bja mmušo, re bontšha boikgafo bja rena go thekga mananeo a mmušo.

Ka ngwaga wa ditšhelete wa 2023/24, CSIR o phethagatša mananeo a mantši a mmušo go feta mo mengwageng ye mehlano ya go feta. Matlakala a 70 go ya go 74 a fa mehlala ya mohola ya thekgo ya rena go makala a enetši, meepo, dinamelwa, lotšistiki le maphelo. Go tlaleletša, re kgathile tema go thekgo ya diphetho le bokgoni bjo bo kaonafaditšwego ka go mananeo a tshedimošo le kgokagano a dikgoro tša setšhaba.

Mokgatlo o dula o le bohlokwa go mmušo go lemoga Leano la Tšweletšopele la Setšhaba, Pono ya 2030 le mananeo a mangwe a phetogp go swana le Leano la Mpshafatšo le Kagolefsa la Ekonomi le Pholisi ya Setšhaba ya Saense, Theknolotši le Boithomelo ya 2019, gare ga tše dingwe. Maitapišo a rena le wona a thekga tšweletšopele ya intasteri.

Go lebeletšwe mošomo wa bohlokwa woo CSIR e e kgathago, phokotšego ye e tšwelago pele go thekgo ya ditšhelete ya palemente ke tlhobaboroko. Thekgo ye e amogelegago e bohlokwa go mokgatlo go kgotsofatša taolelo ya yona ya tšweletšopele le go swara mabokgoni a bohlokwa. Go bohlokwa go mmušo go tšwela pele ka go thekga ka ditšhelete dinyakišišo le tšweletšopele (R&D) gomme o se e bone bjalo ka ditshenyagelo eupša ka peeletšo ya ka moso. Dinaga tše dintši tšeo di atlegilego di beeletša dikatlego tša tšona go peeletšo ye e tšwelago pele go R&D.

Se se dira mengwaga ye mehlano ya phethagatšo ya Peakanyo ya CSIR, ye e matlafatšago "Nna" ka go CSIR. Phetogo go ya go peakanyo ye mpsha ga se ya ba leeto le bonolo, eupša sehlopha se seo se ikgafilego se kgonthiša katlego ya gago. Ke reta boetapele le bašomi ka go amogela phetogelo gomme ba e dira gore e šome. Mo molaetšeng wa gagwe matlakaleng a 12 go fihla go 13, Ngaka Dlamini o gateletše ditšwelopele tšeo di dirilwego go phethagatša peakanyo gomme e boletšwe go išwa pele matlakaleng a 75 go fihla go 77.

Le ge go na le ditlhohlo, ke rata go leboga boloadiphethiši le bašomi ba CSIR ka boikgafo bja bona go kgwatha maphelo ka boithomelo.

Legatong la Boto ya CSIR, ke amogela thekgo ye e tšwelago pele le tlhahlo go tšwa go Tona ya Saense le Boithomelo, Prof. Blade Nzimande, le kgoro ya gagwe, gammogo le boikgafo bja badirišani ba maloko a Boto go katlego ye e tšwelago pele tša mokgatlo.

Vuyani Jarana
Modulasetulo wa Boto

MESSAGE FROM THE CEO

Dr Thulani Dlamini
CSIR Chief Executive Officer

I am pleased to present the Annual Report of the Council for Scientific and Industrial Research (CSIR) for the 2023/24 financial year (FY). This report details our efforts in advancing the CSIR's mandate, five years after our strategy was implemented.

The CSIR Strategy, launched in the 2019/20 FY, aims to amplify the "I" in CSIR through research, development and innovation activities that support re-industrialisation whilst ensuring that we continue to support the development of a capable state. It also introduces a business model that increases the relevance of the CSIR's products and services to sectors of the South African economy with the most potential for transformation through innovation and economic impact.

The strategy focuses on growth, sustainability, impact and relevance. Guided by these principles and our strategic objectives, we have established key performance indicators (KPIs) to direct and guide the organisation's actions and decisions. Reflecting on our performance over the past FY and the last five years, we are very pleased with the progress we have made in implementing the strategy.

In the past five years, we have collaborated with state-owned enterprises and government, deepened our partnerships with industry and higher education institutions, created a balanced innovation portfolio, increased our focus on innovation and commercialisation, transformed our staff, invested in infrastructure, diversified our income and improved our governance. You can read more about these achievements and the impact of our work on pages 70 to 74.

For the 2023/24 FY, we exceeded several of our KPI targets and achieved 27 out of 31 KPI targets. Here are some highlights in comparison to the 2022/23 FY:

- A 14% increase in the number of joint technology development projects with industry partners;
- A 47% increase in the number of small and medium-sized enterprises (SMMEs) supported;
- A 50% increase in the number of standards delivered or contributed to in support of the state; and
- A 42% increase in projects implemented to increase the capacity of the state.

This performance demonstrates the CSIR's commitment to enable re-industrialisation and the creation of a capable state.

Recognising the importance of skilled human resources to deliver on the CSIR's mandate and national strategic objectives, we prioritise the development of colleagues in leadership roles, science, engineering and technology (SET) fields and support functions. This strategic investment cultivates a diverse and innovative talent pool dedicated to addressing South Africa's socioeconomic challenges through research and technological advancements. By

empowering our human resources to actively contribute to national imperatives, the CSIR strengthens its role in driving a sustainable and prosperous future for the country.

Significant progress has been achieved in recent years in terms of demographic transformation and strengthening our SET base. There has been notable advancement in the transformation of senior and middle management levels, along with an increase in the representation of females.

For the reporting year, there has been a 3% increase in the SET base compared to 2022/23, now comprising 71% of the total staff base. The proportion of black SET staff has increased by 2%; the proportion of principal researchers who are black has increased by 3%; the number of exchange programmes with industry has increased by 12%, in line with our intention to work more closely with the industry; and investment in property, plant and equipment has increased by 63% compared to the previous FY.

Through strategic partnerships with relevant external stakeholders in the National Systems of Innovation, the CSIR has leveraged support for skills development, innovation, youth unemployment and Corporate Social Investment. With the assistance of these partners, 184 internships have been facilitated for unemployed youth in South Africa through various programmes. The CSIR's self-funded flagship Youth Employment Services (YES) programme continues to offer unemployed youth opportunities to work in the organisation and its partnering SMMEs, with a particular focus on female candidates and people living with disabilities. In 2023/24, the CSIR invested R6.2 million to appoint 66 new YES recipients.

Financially, the organisation achieved a net profit of R36.47 million, surpassing the targeted loss of R38.07 million by R74.57 million. While this represents a decrease of R7.1 million compared to the net profit for the same period in the previous year, it still demonstrates a significant improvement in financial performance, especially considering the reduction in the baseline CSIR parliamentary grant of R34.69 million (R30.16 million excluding VAT). The South African public sector income stream contribution to total income is 59%, which is 2% above the target of 57%. The contribution of R238.48 million from the South African private sector to total income accounts for 8%, falling short of the budget contribution target of 11% by 3%.

The CSIR remains resolute in diversifying its income to reduce the financial risk associated with significant reliance on a single sector and improve the organisation's operational profitability. During the FY under review, the CSIR officially launched its commercialisation enterprise, named CSIR C^3, to accelerate the pace and increase the scale of the commercialisation of the organisation's technologies and intellectual property (IP). The standalone enterprise holds all the CSIR's intellectual property and acts as the main point of engagement with investors and entrepreneurs to commercialise CSIR intellectual property.

Our performance in terms of good governance remains exceptional. In the year under review, the CSIR achieved its target to secure a recordable incident rate (RIR) of less than 0.6, achieving an RIR of 0.09. Despite this achievement, the CSIR continuously monitors its health and safety risks and implements appropriate response measures to address undesirable trends as they are identified, aligning with our zero-harm target. Once again, the CSIR maintained a B-BBEE rating of one and maintained a clean audit opinion from the Auditor-General of South Africa.

All these achievements wouldn't be possible without the organisation's engine – the EPIC leadership and employees who continue to embody and live up to our values of excellence, people-centred, integrity and collaboration. I thank you for your contribution and commitment to our pursuit of touching lives through innovation.

We are also very grateful for the guidance and support of the CSIR Board and the shareholder.

Umyalezo Ovela KuMphathi Oyinhloko (i-CEO)

Nginentokozo enkulu yokwethula Umbiko Wonyaka WoMkhandlu Wezesayensi Nocwaningo Ezimbonini, i-Council for Scientific and Industrial Research, (i-CSIR) wonyakamali we-2023/24 (i-FY). Lo mbiko uchaza kabanzi imizamo yethu yokwenza ngcono umgomo we-CSIR, eminyakeni emihlanu emva kokuqaliswa kokusebenza kwesu lethu.

Isu le-CSIR, elethulwa ngonyakamali we-2019/20, lihlose ukukhulisa u-"I" ku-CSIR ngocwaningo, imisebenzi yentuthuko nokusungulwa kwezinto ezintsha ezeseka ukuthuthukiswa kabusha kwezimboni ngenkathi kuqinisekiswa ukuthi siyaqhubeka nokweseka intuthuko yombuso okwaziyo ukuzimela. Liphinde lethule imodeli yebhizinisi elenyusa ukubaluleka kwemikhiqizo ye-CSIR nezinsizakalo emikhakheni yomnotho weNingizimu Afrika esethubeni eliphakeme kakhulu wokuba noshintsho ngokwakhiwa kwemikhiqizo emisha nokuba nomthelela emnothweni.

Isu ligxile ekuletheni ukuthuthuka, uzinzo, umthelela nokubaluleka. Ngokulawula yile migomo nezinjongo zethu, sisungule izinkomba zokusebenza ezisemqoka (ama-KPI) ukuqondisa ukusebenza nezinqumo zenhlangano. Ngokubuka indlela esisebenze ngayo kulo nyakamali odlule neminyaka emihlanu edlule, sinentokozo enkulu ngenqubekela phambili esesiyenzile ngokuqalisa ukusebenza kwesu.

Kule minyaka emihlanu edlule, sibambisene siye sasebenzisana nezinkampani zikahulumeni kanye nohulumeni, saqinisa ubudlelwane bethu nezimboni nezikhungo zemfundo ephakeme, sazakhela iphothifoliyo ebhalansile yokusungula izinto ezintsha, saqinisa ukugxila kwethu ekusungulweni kwezinto ezintsha nasekuhwebeni, sathuthukisa abasebenzi bethu, satshala izimali kungqalasizinda, sakha imithombo eyahlukahlukene yokungenisa imali futhi sathuthukisa nokubusa kwethu. Ungafunda kabanzi mayelana nalezi zimpumelelo kanye nomthelela womsebenzi wethu ekhasini 70 kuya ku- 74.

Ngonyakamali wezi-2023/24, seqe imigomo eminingana yama-KPI ebesizibekele yona futhi safinyelela imigomo yama-KPI engama-27 kwengama-31 ebeyibekiwe. Nanka amanye amaphuzu avelele uma kuqhathaniswa nonyakamali wezi-2022/23:

- Ukwenyuka ngo-14% kwenani lemiklamo yokuthuthukisa ubuchwepheshe ngokubambisana nabalingani bemboni;
- Ukwenyuka ngama-47% enanini lamabhizinisi amancane naphakathi nendawo (ama-SMME) asekiwe;
- Ukwenyuka ngama-50% enanini lamazinga alethiwe noma anikelelwe ukweseka umbuso; kanye
- Nokwenyuka ngama-42% emiklamweni eqaliwe ukuze kukhuliswe amandla ombuso.

Ukusebenza okunje kubonisa ukuzibophezela kwe-CSIR ekwakhiweni kwezimboni nokusungulwa kombuso onamandla okwenza izinto.

Ngenxa yokubona ukubaluleka kwabasebenzi abahlonyiswe ngamakhono ukuze kufezwe umgomo we-CSIR kanye nezinjongo zamasu zikazwelonke, sibeka eqhulwini ukuthuthukiswa kozakwethu emisebenzini yobuholi, emikhakheni yesayensi, yobunjiniyela kanye nobuchwepheshe (i-SET) kanjalo nemisebenzi yokweseka. Lolu tshalomali lobuhlakani lukhuthaza ukuba kube neqoqo lamathalente ahlukahlukene okuhloswe ngalo ukubhekana nezinselele zenhlalo-mnotho yaseNingizimu Afrika ngocwaningo kanye nokuthuthuka kwezobuchwepheshe. Ngokuhlomisa abasebenzi bethu ukuze babambe iqhaza labo ngenkuthalo ezimisweni zikazwelonke, i-CSIR iqinisa indima yayo ekuholeni ikusasa elisimeme neliphumelelayo ezweni.

Inqubekelaphambili ebonakalayo ifezekile eminyakeni yakamuva mayelana nokuguqulwa kwezibalo zabantu kanye nokuqinisa isisekelo sethu se-SET. Kube nenqubekelaphambili egqamile ekuguqulweni kwamazinga obuholi obuphezulu naphakathi nendawo, kanye nokwenyuka kokumeleleka kwabesifazane.

Kulo nyaka esibika ngawo, kube nokwenyuka ngo-3% esisekelweni se-SET uma kuqhathaniswa nowezi-2022/23, manje esihlanganisa u-71% wenani eliphelele labasebenzi. Isibalo sabasebenzi abamnyama be-SET senyuke ngo-2%; ingxenye yabacwaningi abayinhloko abamnyama senyuke ngo-3%; inani lezinhlelo zokushintshisana nezimboni likhule ngamaphesenti ayi-12, okuhambisanayo nenhloso yethu yokusebenzisana kakhulu nezimboni; kanye nokwenziwa kotshalomali kwezezindlu, ezimbonini izitshalo nemishini yokusebenza kwenyuke ngo-63% uma kuqhathaniswa nonyakamali wangaphambilini.

Ngosizo lobudlelwane obunobuhlakani nababambiqhaza bangaphandle abafanelekile oHlelweni Lukazwelonke Lwezokusungula, i-CSIR izuze ukwesekwa kwezokuthuthukiswa kwamakhono, ukusungulwa kwezinto ezintsha, ukuntula kwentsha imisebenzi kanye Notshalomali Kumabhizinisi Omphakathi. Ngosizo lwalaba balingani, sekuhlinzekwe ama-internship ayi-184 entsheni engasebenzi eNingizimu Afrika ngezinhlelo ezahlukene. Uhlelo lwe-CSIR oluzimele oluzixhasayo ngezimali lwe-Youth Employment Services (i-YES) lusaqhubeka nokuhlinzeka intsha engasebenzi ngamathuba okusebenza enhlanganweni kanye nama-SMME ababambisene nawo, lapho kugxilwe ikakhulukazi kwabesifazane kanye nabantu abaphila nokukhubazeka. Ngonyaka wezi-2023/24, i-CSIR yenze utshalomali lwezigidi eziyisi-R6.2 ukuze iqashe abantu abasha abangama-66 ngaphansi kohlelo lwe-YES.

Ngokwezimali, le nhlangano izuze inzuzo eyizigidi ezingama-R36.47, idlula ukulahlekelwa obekuhlosiwe kwezigidi ezingama-R38.07 ngezigidi ezingama-R74.57. Nakuba lokhu kumele ukwehla ngezigidi eziyi-R7.1 uma kuqhathaniswa nenzuzo yangemva kwentela yesikhathi esifanayo ngonyaka odlule, kusakhombisa ukuthuthuka okukhulu ekusebenzeni kwezimali, ikakhulukazi uma kubhekwa ukwehliswa kwesabelomali esiyinhloko esinikwa i-CSIR yiPhalamende sezigidi ezingama-R34.69. (R30.16 million ngaphandle kwe-VAT). Imali engenayo yomkhakha kahulumeni eNingizimu Afrika emalini engenayo isiphelele ngama-59%, okungama-2% ngaphezu komgomo wama-57%. Isamba sezigidi ezingama-R238.48 esivela embonini ezimele yaseNingizimu Afrika emalini engenayo ufinyelela ku-8%, okungaphansi kwesabelo sesabiwomali esiwumgomo ka-11% ngama-3%.

I-CSIR isalokhu izimisele ngokuba nemithombo eyahlukahlukene engenisa imali ukuze kuncishiswe ubungozi bezezimali obuhambisana nokuthembela kakhulu emkhakheni owodwa kanye nokwenza ngcono inzuzo yokusebenza kwenhlangano. Ngesikhathi sonyakamali obukezwayo, i-CSIR yethule ngokusemthethweni ibhizinisi layo lezentengiselwano, elibizwa nge-CSIR C3, ukuze kusheshiswe ijubane futhi kukhushulwe izinga lokudayiswa kobuchwepheshe benhlangano kanye nempahla yobuciko bengqondo (i-IP). Ibhizinisi elizimele liphethe wonke ama-IP e-CSIR futhi lisebenza njengephuzu eliyinhloko lokuxoxisana nabatshalizimali kanye nosomabhizinisi ukuze bahwebe nge-CSIR IP.

Indlela esisebenza ngayo mayelana nokuphatha okuhle kusalokhu kuyingqayizivele. Kulo nyaka obukezwayo, i-CSIR ifinyelele umgomo wayo wokuqinisekisa izinga lezehlakalo elirekhodikayo (i-RIR) elingaphansi kuka-0.6, yazuza i-RIR engu-0.09. Naphezu kwale mpumelelo, i-CSIR iyaqhubeka nokuqapha ubungozi bayo bezempilo nokuphepha futhi isebenzisa izinyathelo ezifanele zokubhekana nemikhuba engathandeki njengoba ihlonzwa, okuhambisana nomgomo wethu wokungabikhona nokukodwa ukulimala. Nakulokhu, i-CSIR iqhubeke nezinga le-B-BBEE lokukodwa futhi yagcina umlando wayo wombiko wocwaningomabhuku ovela kuMcwaningimabhuku Jikelele waseNingizimu Afrika.

Zonke lezi zimpumelelo bezingeke zenzeke ngaphandle kwenjini yenhlangano – ubuholi BEKHETHELO nabasebenzi abaqhubeka nokuyiphila futhi baphile ngayo le migomo yokusebenza ngokuncomekayo, ukugxila kubantu, ubuqotho nokusebenzisana. Ngiyabonga ngeqhaza lenu nokuzibophezela emizamweni yethu yokuthinta izimpilo ngokusungula izinto ezintsha.

Sibonga kakhulu futhi ngesiqondiso nokwesekwa yiBhodi le-CSIR kanye nomninimasheya.

Dkt Thulani Dlamini
UMphathi Oyinhloko e-CSIR (i-CEO)

Molaetša go tšwa go CEO

Ke thabela go le abela Pego ya Ngwaga le Ngwaga ya Khansele ya Saense le Dinyakišišo tša Intasteri (CSIR) ya ngwaga wa ditšhelete wa 2023/2024. Pego ye e hlaloša ka botlalo maitapišo a rena a go tšwetšapele taolelo ya CSIR, mengwaga ye mehlano ka morago ga ge peakanyo ya rena e phethagaditšwe.

Peakanyo ya CSIR, yeo e thakgotšwego ka ngwaga wa ditšhelete wa 2019/20, e ikemišeditše go oketša "Nna" mo CSIR ka mešongwana ya dinyakišišo, tšwelotšopele le boithomelo tšeo di thekgago mpshafatšo mola ka go le lengwe e kgonthiša gore re tšwela pele go thekga tšweletšopele ya mmušo wa go se fetogefetoge. E tsenya gape mmotlolo wa kgwebo woo o oketšago go ba maleba ga ditšweletšwa le ditirelo tša CSIR go makala a ekonomi ya Afrika Borwa ka bokgoni bjo bogolo bja phetogo ka boithomelo le khuetšo ya ekonomi.

Peakanyo e nepiša go kgolo, tshwarelelo, khuetšo le go ba maleba. E laolwa ke dikgopolo tše le dinepo tša rena tšeo di beakantšwego, re lemogile ditlhahli tša phethagatšo tša motheo (KPIs) go laetša le go hlahla magato le diphetho tša mokgatlo. Ge re naganišiša ka phethagatšo ya rena mo ngwageng wa go feta wa ditšhelete le mengwaga ye mehlano ya go feta, re thabela kudu tšwelopele yeo re e dirilego mo go phethagatšeng peakanyo.

Mo mengwageng ye mehlano ya go feta, re šomišane le dikgwebo tša mmušo le mmušo, ra matlafatša tšhomišano ya rena le diintasteri le diinstitušene tša thuto ya godimo, ra hlola tekano go potfolio ya boithomelo, ra oketša nepišo ya rena go boithomelo le go tšweletša ditšweletšwa tše difsa tša kgwebo, go fetola bašomi ba rena, go beeletša go infrastraktšha, go fapantšha letseno la rena le go kaonafatša pušo ya rena. O ka bala tše dintši ka diphihlelelo tše le khuetšo ya mošomo wa rena go matlakala 70 go fihla go 74.

Go ngwaga wa ditšhelete wa 2023/2024, re fetile tše mmalwa tša dilebanywa tša KPI tša rena gomme ra fihlelela dilebanywa tša KPI tše 27 go tše 31. Dintlha tše dingwe ke tše ge o bapetša le 2022/23:

- Koketšego ya 14% go palo ya diprotšeke tša tšwelotšopele ya theknolotši ye e kopantšwego le badirišani ba diintasteri.
- Koketšego ya 47% go palo ya dikgwebopotlana le dikgwebo tša magareng (diSMME) tšeo di thekgwago;
- Koketšego ya 50% mo palong ya maemo ao a abilwego goba a kgathilego tema go thekga mmušo; le
- Koketšego ya 42% go diprotšeke tše di phethagaditšwego go oketša bokgoni bj ammušo.

Phethagatšo ye e bontšha boikgafo bja CSIR go kgontšha mpshafatšo le tlholo ya mmušo wa bokgoni.

Go lemoga bohlokwa bja methopo ya batho yeo e nago le mabokgoni go aba dinepo tša peakanyo ya setšhaba le taolelo tša CSIR, re bea pele tšweletšopele ya badirišani mo dikarolong tša mešomo ya boetapele, saense, boentšenere le theknolotši (SET) le mešomo ya thekgo. Peeletšo ye ya peakanyo e thekga sehlopha sa talente ya boithomelo seo seo ikgafilego go šogana le diekonomi tša leago ka Afrika Borwa ka ditšwelopele tša dinyakišišo le theknolotši. Ka go matlafatša methopo ya batho go kgatha tema ka mafolofolo go dinyakwa tša setšhaba, CSIR e matlafatša mošomo wa yona ka go sepetša naga ya ka moso ya go swarelela gape ya katlego.

Go fihleletšwe tšwelopele ye kgolo mo mengwageng ya gonabjale go ya ka phetogo ya temokrafi le matlafatšo tšeo di theilwego go SET. Go bile le kaonafalo ye kgolo go phetogo ya magato a taolo ya godimo le ya magareng, gammogo le koketšego go kemedi ya basadi.

Go ngwaga wa ditšhelete wa go bega, go bile koketšego ya 3% go tšeo di theilwego go SET ge go bapetšwa le 2022/23, bjale go na le 71% ya palomoka ya bašomi. Palo ya bašomi ba SET ba bathobaso e oketšegile ka 2%; palo ya banyakišišibagolo bao e lego bathobaso e oketšegile ka 3%; palo ya mananeo a kgwebišano le diintasteri e oketšegile ka 12%, go sepelelana le maikemišetšo a rena a go šoma kgauswi le intasteri; peeletšo ya thoto, semela le sediriša e oketšegile ka 63% ge go bapetšwa le ngwaga wa ditšhelete.

Ka ditirišano tša peakanyo le bakgathatema ba ka ntle ba maleba ka go Mananeo a Setšhaba a Boithomelo, CSIR e hueditše thekgo ya mabokgoni a tšweletšopele, boithomelo, tšweletšopele ya bafsa le Peeletšo ya Leago ya Kgwebo. Ka thušo ya badirišani ba, dibaka tša go ithutela mošomo tše 184 di filwe bafsa bao ba sa šomego ka Afrika Borwa ka mananeo a go fapana. Lenaneo la Ditirelo tša Thwalo ya Bafsa (YES) la sekhwana sa go ithekga sa CSIR le tšwela pele go fa bafsa dibaka tša mošomo go šoma mokgatlong gomme le dirišana le diSMM, gomme le nepiša basadi le batho bao ba phelago ka bogolofadi. Ka 2023/24, CSIR e beeleditše R6.2 milione go thwala baomogedi ba bafsa ba YES ba 66.

Ka ditšhelete, mokgatlo o fihleletše poelo ya R36.47 milione, go feta selebanywa sa tahlegelo ye e lebantšwego ya R38.07 milione ka R74.57 milione. Mola se se emela phokotšego ya R7.1 milione ge go bapetšwa le poelo ya nako yona yeo mo ngwageng wa go feta, e sa tšweletša kaonafalo ye kgolo go phethagatšo ya ditšhelete, kudu ge go lebeletšwe phokotšego go magomo a thekgo ya go tšwa palamenteng yeo e fiwago CSIR ya R34.69 milione (R30.16 milione ge go sa akaretšwe VAT). Thekgo ya moela wa letseno la lekala la setšhaba la Afrika Borwa go ya go palomoka ya letseno la 59%, leo e lego 2% ka godimo ga selebanywa sa 57%. Kabo ya R238.48 milione go tšwa go lekala la praebete la Afrika Borwa go ya go diakhaonthe tša letseno la palomoka la 8%, la go se lekane selebanywa sa kabo ya tekanyetšo sa 11% ka 3%.

CSIR e dula e sa šikinyege ka go fapanatša letseno go fokotša kotsi ya ditšhelete ye e amanago le thekgo ye bohlokwa mo go lekala le tee gomme e kaonafatša poelo ya tirišo ya mokgatlo. Nakong ya ngwaga wa ditšhelete wa tshekatsheko, CSIR e thakgotše semmušo kgwebo ya yona ya go tšweletša ditšweletšwa tše difsa tša kgwebo, yeo e bitšwago CSIR C3, go potlakiša lebelo le go oketša sekala sa tšweletšo ya ditšweletšwa tše difsa tša kgwebo tša ditheknolotši tša mokgatlo le thoto ya bohlale (IP). Kgwebo ye e ikemego e swere diIP ka moka tša CSIR gomme e šoma bjalo ka lefelo la motheo la kgokagano le babeeletši le borakgwebo go tšweletša tše difsa tša kgwebo tša IP ya CSIR .

Phethagatšo ya rena go ya ka pušo ye botse e dula e retega. Mo ngwageng wo wa tshekatsheko, CSIR e fihleletše selebanywa sa yona go šireletša tekanyo ya tiragalo ya go retega (RIR) ya ka fase ga 0.6, go fihlelela RIR ya 0.09. Ntle le phihlelelo ye, CSIR e tšwela pele go lekola maphelo a yona le dikotsi tša tšhireletšo gomme ya phethagatša ditekanyo tša dikarabo tša maleba go šogana le ditšweletšopele tše di sa nyakegego ge di lemogwa, di sepelelana le selebanywa sa go hloka dikgobalo. Gape, CSIR e swere tekanyetšo ya B-BBEE ya pele gomme e swere kgopolo ya tlhakišo ya go hlweka go tšwa go Motlhakišimogolo wa Afrika Borwa.

Diphihlelelo tše ka moka nkabe di se a kgonagala ntle ga entšene ya mokgatlo – Boetapele bja EPIC le bašomi bao ba tšwelago pele go ba mohlala gomme ba phela go ya ka maitshwaro a rena a bokgoni, ao a hlokomelago batho, ka go tshepagala le go dirišana. Ke a le leboga ka go kgatha tema ga lena le boikgafo ga lena go mošomo wa rena wa go kgwatha maphelo ka boithomelo.

Re leboga gape tlhahlo le thekgo ya Boto ya CSIR le bengdišere.

Ngaka Thulani Dlamini
Mohlankedimogolophethiši (CEO) wa CSIR

Statement of responsibility for and confirmation of accuracy of the annual report

To the best of our knowledge and belief, we confirm the following:

All information and amounts disclosed in the annual report are consistent with the annual financial statements audited by the Auditor-General.

The annual report is complete, accurate and free from any omissions.

The annual report has been prepared in accordance with the guidelines on the annual report as issued by the National Treasury.

The annual financial statements (Section G) have been prepared in accordance with the International Financial Reporting Standards applicable to the CSIR.

The Accounting Authority is responsible for the preparation of the annual financial statements and the judgements made in this information.

The Accounting Authority is responsible for establishing and implementing a system of internal control that has been designed to provide reasonable assurance as to the integrity and reliability of the performance information, the human resources information and the annual financial statements.

The external auditors are engaged to express an independent opinion on the annual financial statements.

In our opinion, the annual report fairly reflects the operations, performance information, human resources information and financial affairs of the CSIR for the financial year ended 31 March 2024.

Yours faithfully

Chief Executive Officer
Dr Thulani Dlamini
23 August 2024

Chairperson of the Board
Vuyani Jarana
23 August 2024

Legislative and other mandates

The CSIR is listed as a Schedule 3B public entity in terms of the Public Finance Management Act (PFMA), 1999 (Act 1 of 1999) (as amended). The CSIR is constituted under the Scientific Research Council Act, 1988 (Act 46 of 1988), as amended. South Africa's legislative framework for entities applies to the CSIR, with the PFMA superseding all other legislation apart from the South African Constitution. The CSIR aligns with the government's transformation agenda and ensures compliance with the Public Preferential Procurement Frameworks Act (as amended) and the Broad-Based Black Economic Empowerment Act, 2003 (Act 53 of 2003) (as amended). As a research-generating entity, the CSIR adheres to all requirements of South Africa's intellectual property legislation.

Strategic overview

VISION

We are accelerators of socioeconomic prosperity in South Africa through leading innovation.

MISSION

Collaboratively innovating and localising technologies, while providing knowledge solutions for the inclusive and sustainable advancement of industry and society.

VALUES

Our beliefs, principles and the impact we wish to make to improve the quality of life of South Africans are EPIC. Team CSIR pursues excellence, celebrates people, personifies integrity and welcomes collaboration.

EXCELLENCE

We strive for excellence and quality in everything that we do. We always strive to deliver solutions that surpass the expectations of our stakeholders. We hold each other to the highest possible standard in RD&I, as well as all other facets of CSIR business. We believe that excellence is a product of investing in the continuous development of our people, processes and ways of doing business.

PEOPLE - CENTRED

Our business is about touching the lives of people — our employees and business partners. We care about people. We respect each other's diversity and conduct ourselves in a manner that upholds the dignity of every person. We believe in continuous personal development and encourage one another to seize opportunities for personal growth. We treat our stakeholders the way we like to be treated.

INTEGRITY

We act with integrity. We are honest and fair when dealing with one another and our business partners. We respect the trust that our colleagues and stakeholders place in us, and commit to ethical decision-making, delivery and governance.

COLLABORATION

We are keen to learn from one another, and collaborate across the organisation and with external partners to ensure that our work has the best chance of innovating a better future for South Africans. We actively share our knowledge and expertise by design, formally and informally, so that we can realise largescale impact.

The CSIR Board

April 2023 to March 2024

Vuyani Jarana
CEO,
Ilitha Telecommunications

Dr Thulani Dlamini
CEO,
CSIR

Maleke Matolong
Chairperson of Finance Committee,
North West Cricket Board

Mahesh Fakir
Independent Consultant

Jules Newton
Executive Director, Innovation
Green Business Value Chain Portfolio

Dr Vuyo Mthethwa
Deputy Vice Chancellor: People and Operations,
Durban University of Technology

Prof. Arnold van Zyl
Retired President,
Baden-Wuerttemberg Cooperative State University

Dr Christine Render
Independent Consultant

Michelle Govender
CEO
Octarity

Prof. Yunus Ballim
Retired Emeritus Professor,
University of the Witwatersrand

Mike Mulcahy
CEO, GreenCape
Chairman of the International Cleantech Network

Organisational structure

science & innovation
Department:
Science and Innovation
REPUBLIC OF SOUTH AFRICA

Vuyani Jarana
Chairperson of the Board

Dr Thulani Dlamini
CSIR Chief Executive Officer

Dr Kaven Naidoo
Group Executive:
Business Excellence and Integration

Andile Mabindisa
Group Executive:
Human Capital and Communication

Esteé Opperman
Chief Financial Officer

Adv. Esmé Kennedy
Group Executive:
Legal, Compliance and Business

Dr Rachel Chikwamba
Group Executive:
Advanced Chemistry and Life Sciences

Dr Sandile Malinga
Group Executive:
Smart Society

Dr Motodi Maserumule
Group Executive:
Advanced Production and Security

SECTION B

Organisational highlights

SECTION B

Organisational highlights

The CSIR's strategic objectives guide the organisation's research, development and innovation investments and activities. This section highlights a small sample of the organisation's work against these objectives.

01 Conduct research, development and innovation of transformative technologies and accelerate their diffusion

CSIR develops a platform for screening of effective cancer drugs

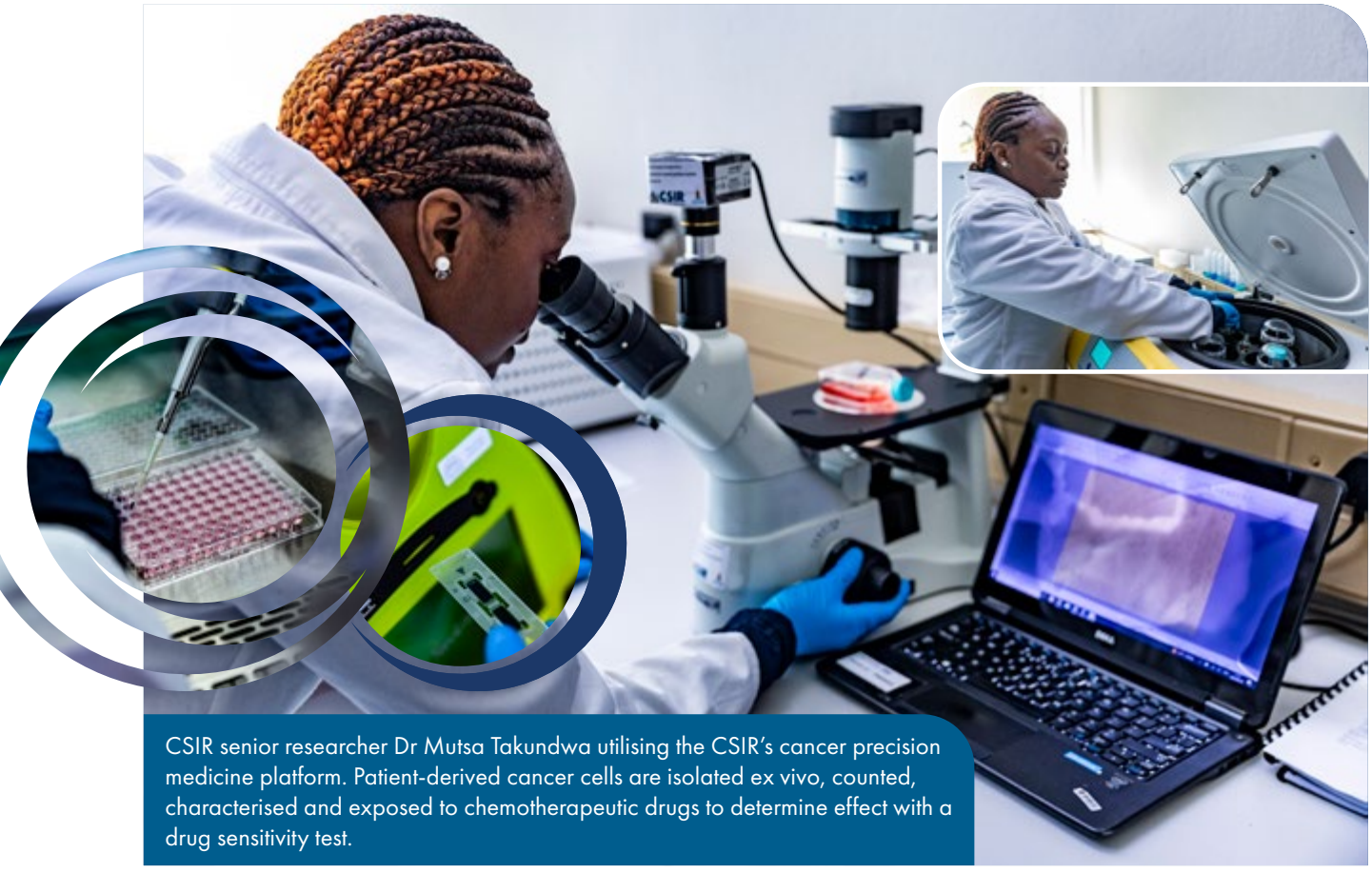
A new testing platform for drug sensitivity offers clinicians improved cancer treatment options for their patients. The CSIR played a crucial role in developing this improved precision medicine platform with Steve Biko Academic Hospital, Chris Hani Baragwanath Hospital and Wits Donald Gordon Medical Centre.

The gold standard in cancer treatment comprises standard chemotherapeutic agents that cause cell death. However, drug resistance frequently causes patients to relapse. The CSIR developed a drug sensitivity test for the identification of drugs and drug combinations capable of overcoming drug resistance.

The development process relied on 100 samples from patients with various types of cancer, including acute myeloid leukaemia, chronic lymphocytic leukaemia, chronic myeloid leukaemia, multiple myeloma, ovarian cancer and uterine cancer, along with samples from healthy donors.

Culture settings for all patient-derived tumor cells were established through 2D cancer cell culturing in 96 well plates. Researchers performed functional drug sensitivity testing using a panel of Food and Drug Administration-approved chemotherapy drugs. The average turnaround time from biopsy to drug sensitivity test results was 14 days. Preliminary drug sensitivity screening studies on patient samples show a good response to drug inhibitors against cancer signaling pathways.

The research was presented at the 24th American Association for Cancer Research (AACR) annual meeting in San Diego, California, the United States of America and will be published in the AACR 2024 *Cancer Research* journal, edition 84(6) S1.



CSIR senior researcher Dr Mutsa Takundwa utilising the CSIR's cancer precision medicine platform. Patient-derived cancer cells are isolated ex vivo, counted, characterised and exposed to chemotherapeutic drugs to determine effect with a drug sensitivity test.

01 Conduct research, development and innovation of transformative technologies and accelerate their diffusion

CSIR develops a green, safe process to produce pharmaceutical precursor

The CSIR has assisted Linuset, a small, medium and micro enterprise, to develop a greener and safer process for the commercial production of racemic phenibut as a precursor for a broad range of pharmaceuticals. Globally, it is used to treat, among others, anxiety and insomnia.

Racemic phenibut is best known globally for its use as a central nervous system depressant, enhancing the effects of sleeping pills, narcotics, antipsychotic and antiparkinsonian drugs. Linuset will produce racemic phenibut as an intermediate in the production of other drugs to meet the growing demand in the United States of America (USA), which has resulted from a decline in the quality of material provided by other countries.

The company had expressed interest through the CSIR-hosted Industrial Biocatalysis Hub for assistance with an alternative production technology for phenibut. Classical chemical methods for converting the nitro precursor substrate to the amine-containing phenibut pose a risk of dangerous explosive reactions.

Efforts to develop a biocatalytic process using a microorganism to convert the nitro precursor to the amine product were successful at laboratory scale. However, during attempts to scale up the process, it was established that the substrate broke down in the aqueous reaction mixture, dramatically decreasing yields. CSIR chemists and biochemists then developed a scaled-up process for green chemical synthesis technology that eliminated the risks of explosive conditions.

All necessary steps for producing the final product, including the downstream process, were completed and a market sample was produced for testing by clients in the USA. A licence agreement was signed with Linuset for the commercialisation of the technology and the product for domestic and international markets.

The CSIR has developed a green catalysis route to racemic phenibut.

01 Conduct research, development and innovation of transformative technologies and accelerate their diffusion

CSIR study finds that dual-fuel trackless mobile machines could help decarbonise the mining sector

Hydrogen internal combustion engine dual-fuel technology presents an alternative fuel option to support the 2050 net-zero decarbonisation targets set by the mining industry. The technology is compatible with the load requirements of locally used mining vehicles and can reduce carbon emissions by up to 60%. This finding comes from a pre-feasibility study conducted by the CSIR on dual-fuel internal combustion engine applications for trackless mobile machines, of which there are approximately 14 500 in underground mines and 68 000 in open-pit mines.

Dual-fuel technology enables a diesel engine to partially replace diesel with an alternative fuel. This can be achieved for existing equipment through retro fitment, which includes the addition of a hydrogen injection mechanism, additional controller and hydrogen storage system.

The mining industry is energy-intensive, relying heavily on diesel and fossil fuel-generated electricity, which drives significant carbon emissions. Consequently, the sector is compelled to seek innovative, cost-effective alternatives. Globally, the mining community has identified hydrogen technology as a suitable option over existing energy technologies in use in the industry.

The CSIR study found that because the propulsion system of hydrogen dual-fuel retro fitted vehicles largely remain unchanged, it could allow the mining sector to gradually transition to hydrogen technologies, compared to battery electric or fuel cell alternatives where conventional engines are completely replaced.

The findings of the study were presented at various hydrogen forums and generated interest in the private sector. Early in 2024, a large international original equipment manufacturer (OEM), in collaboration with two local OEMs, started the development of a dual-fuel solution for heavy mining equipment.

This study on the viability of implementing dual-fuel technologies in mining operations is part of a broader investigation into hydrogen technologies and their applications in mining, in response to the global goal of decarbonising the mining sector by 2050.

Blockchain-as-a-service platform to de-risk and de-skill blockchain adoption in South African industries

The CSIR is developing a blockchain-as-a-service platform tailored for South African industries to mitigate risks and reduce the complexity associated with adopting blockchain technology. Blockchain is increasingly vital for creating trust in digital technology ecosystems, enhancing security and transparency in applications ranging from supply chain management to internet of things networks. The technology secures transactions and data, reducing fraud and data tampering risks by integrating trust directly into digital infrastructure.

Integrating blockchain into solutions faces significant challenges, including a shortage of skilled professionals and difficulties with existing information and technology systems. The blockchain-as-a-service platform addresses these issues by providing shared infrastructure that simplifies blockchain usage, making it more accessible. It allows developers to engage with blockchain technology through an application programming interface, facilitating easy data transactions and enhancing the integration process.

The platform is being utilised in applications such as a farm-to-fork system for emerging farmers and in tracking greenhouse gas emissions in the foundry sector for compliance and verification. In the future, the platform will also provide a sandbox environment for real-world experimentation with blockchain applications, helping industries explore the potential without the usual risks or heavy investments.

A farm-to-fork system for emerging farmers.

01 Conduct research, development and innovation of transformative technologies and accelerate their diffusion

Learning from the data on microalgae biodiversity in South Africa's drinking water dams

To support the ecosystem health of South Africa's drinking water dams, CSIR researchers deployed a hyperspectral radiometric buoy in the Theewaterskloof dam, one of the country's largest reservoirs. The research team combined data from the buoy's instruments with in-water physical measurements and satellite data to assess microalgal diversity. This enables the detection of potential overgrowth of toxic algal species, which could negatively impact water quality and ecosystem stability.

While the buoy continuously measured the in-water light field (water colour), routine water sampling was conducted for laboratory analysis to identify the types and concentrations of algae, sediment and dissolved substances. These measurements were then correlated with water colour measurements captured by the buoy. Satellites also capture water colour, but from a birds-eye view. Understanding the relationship between data from all these platforms is crucial for confidently utilising satellite data.

The vast data set collected by the buoy will not only contribute to national water quality objectives but also to the global understanding of algal biodiversity and its interaction with light and nutrients, as the data set was shared with the NASA BioSCape airborne campaign, an international collaborative research project between South Africa and the United States of America. The project assesses biodiversity, including microalgae biodiversity, within the Greater Cape Floristic Region. The dataset is expected to be of particular interest because the dam was highly sediment loaded after severe rainfall in the Western Cape during September 2023.

A buoy, equipped with a series of instruments for continuous data collection, in the Theewaterskloof Dam in the Western Cape. (Left) CSIR researchers deploy the buoy.

02 Improve the competitiveness of high-impact industries to support South Africa's re-industrialisation by collaboratively developing, localising and implementing technology

CSIR develops protein for commercial fishing industry

The CSIR assisted Ziziba (Pty) Ltd, a small, medium and micro enterprise (SMME), with a scalable biobased technology to produce single-cell protein that is used as an ingredient in fish feed.

The CSIR's single-cell protein prototype is produced using a fungal-based biorefinery process that exploits industrial food waste streams as essential feedstocks during the synthesis of single-cell protein. The final product comes in dried biomass and pellet form. Internal and external tests confirmed that it is nutritionally comparable to the protein-rich ingredients used in commercial fish diets.

The CSIR and Ziziba (Pty) Ltd have agreed on the technology transfer, with the CSIR performing a contract manufacturing role while the SMME establishes its own manufacturing facility in Coega, Eastern Cape.

The single-cell protein produced at the CSIR will be sold to the SMME's industrial partner in Egypt, which has a demand for 10 000 tons of single-cell protein per annum.

The technology offers a sustainable and economically viable approach for commercial protein-rich ingredients that are currently used in fish diets.

CSIR senior researcher Yrielle Roets-Dlamini with fish feed pellets formulated using single-cell protein technology. (Left) Products generated from all the product stages.

02 Improve the competitiveness of high-impact industries to support South Africa's re-industrialisation by collaboratively developing, localising and implementing technology

Turning food waste into biocompost for agricultural beneficiation

The CSIR has trained eight agri-businesses on the use of a biocompost technique to process food waste into highly nutritious biocompost that can be used to replace expensive chemical fertilisers.

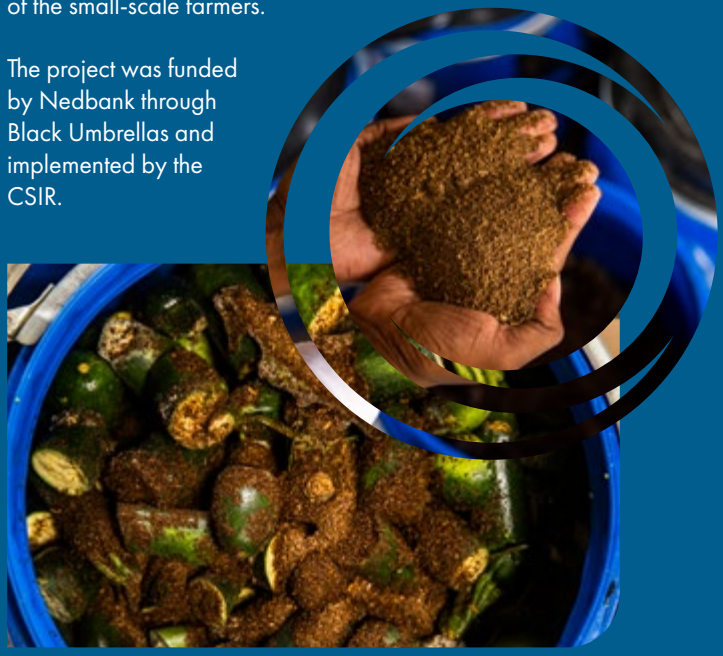
The enterprises that completed the training include Khepri Innovations, Mathibe, Kenokatha Farms, Mabinane Poultry Farmers and Zeakhu Group, all from Gauteng; Smartroots from the Eastern Cape; NDN Agri from North West and Luke Trading from Mpumalanga. They have been trained on biocompost approaches to combat food waste through valorisation.

Collectively, 13.5 tons of food waste has been processed into biocompost to fertilise crops. Food waste from households, commercial kitchens and vegetable markets can be used to generate the biocompost.

Following the training, farmers were provided with Bokashi Bran microorganisms, various gardening tools, an assortment of seeds for cultivation and the basic equipment required for the fermentation of the food waste and processing of the biocompost.

The next stage of the programme aims to include more small-scale farmers, with the goal of converting an additional 50 tons of food waste into biocompost. This will create employment opportunities and enhance the income generation capabilities of the small-scale farmers.

The project was funded by Nedbank through Black Umbrellas and implemented by the CSIR.



Quinty Rabophala of Kenokatha Farms in Midrand, Gauteng with the first harvest of baby marrows that had been cultivated using the farm's own biocompost. (Right) Food waste is converted into high-quality compost using the Bokashi process, during which microorganisms are added to food waste, fermented for six weeks and applied as compost two weeks before planting.

CSIR senior technologist Ndumiso Ndlovu with Quinty Rabophala.

02 Improve the competitiveness of high-impact industries to support South Africa's re-industrialisation by collaboratively developing, localising and implementing technology

CSIR optimises process to produce orris butter locally for fragrance industry

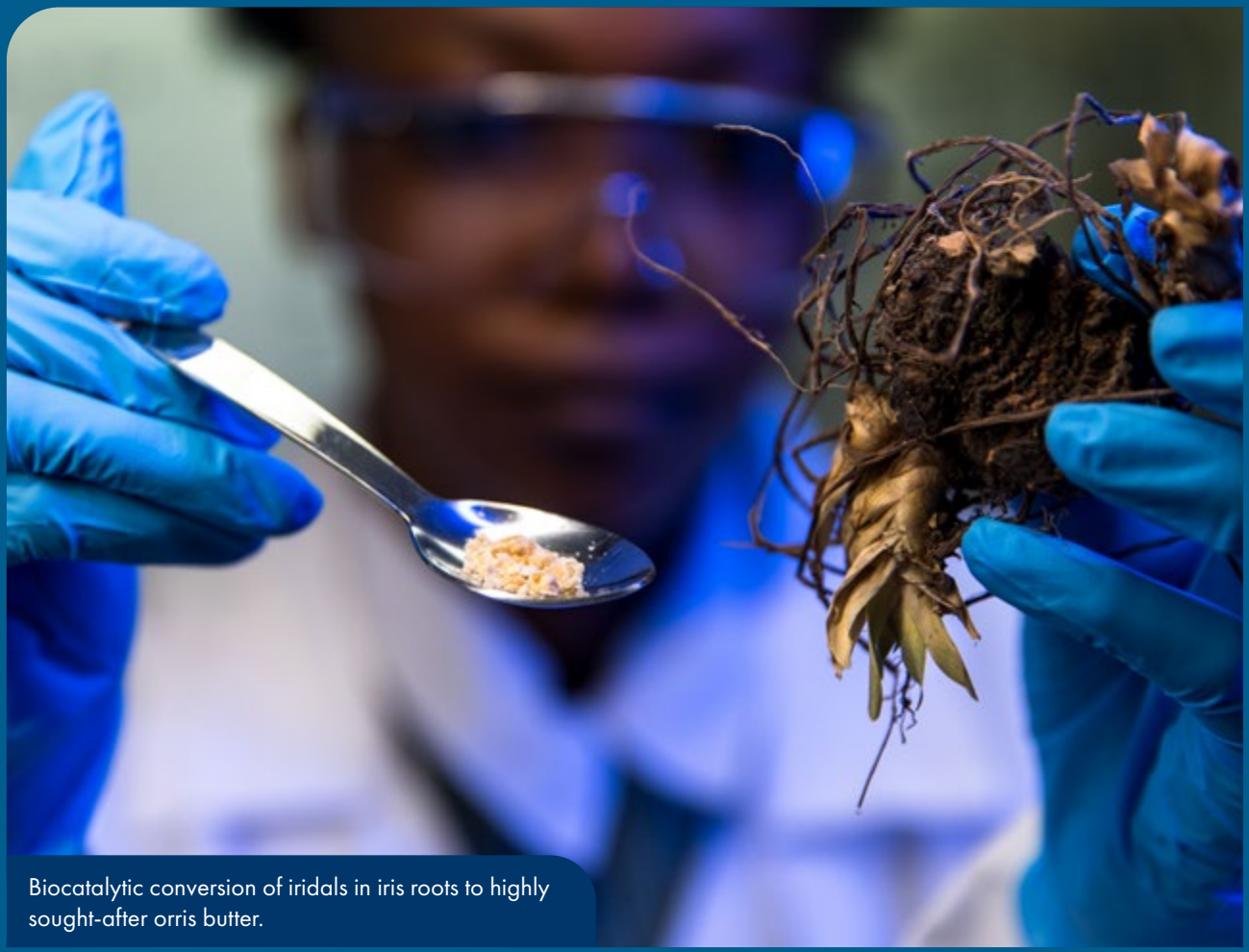
The CSIR assisted Puris (Pty) Ltd, a small, medium and micro enterprise, in developing a biocatalytic process to accelerate orris butter production. Orris butter, an essential oil with a powdery aroma derived from iris bulbs, is used in the flavour and fragrance industry, but is not currently produced locally.

The CSIR's green method uses fresh orris root, in contrast to the current methods that involve either maturing the orris root for two to five years or extracting the iridals (the natural product in oris root) by boiling in alcohol for extended periods. The CSIR approach offers benefits such as increased production yields, higher concentrations of the required irones and the use of cost-effective green chemicals.

The technology's full functionality was demonstrated from laboratory to bench scale using a 16 L reactor at maximum reaction volume, resulting in improved quality compared to commercial orris butter from leading international suppliers.

Puris (Pty) Ltd will use the green manufacturing technology demonstrated and scaled up by the CSIR to produce natural orris butter from orris roots.

This product will be sold to international fragrance formulators, catering to end-user consumers who prefer green or natural products.



Biocatalytic conversion of iridals in iris roots to highly sought-after orris butter.

02 Improve the competitiveness of high-impact industries to support South Africa's re-industrialisation by collaboratively developing, localising and implementing technology

CSIR sensor technology for fire detection licensed to a commercial partner

The CSIR has licensed its optical sensor technology for early fire detection and warning during a fire disaster, to a commercial partner, Autonosky.

Autonosky is a small, medium, and micro enterprise (SMME) based in the Western Cape. The SMME supports the Western Cape Fire Emergency Services with drone technology solutions for fighting fires. It has identified the CSIR's K-line camera as a cost-effective surveillance solution to be integrated into its drone for early fire detection and warning, especially in hard-to-reach places. The K-line camera is more precise and timely than conventional cameras in measuring fire flame location and spread dynamics due to its small pixel size, high pixel sensitivity and fast pixel response.

The CSIR's K-line technology is an optical imaging system that uses remote sensing techniques to detect potassium light energy emitted from burning vegetation during the combustion phase of fires. Potassium, a chemical element with the periodic symbol K, is released as light energy from fires and can be easily isolated using silicon-based detectors with peak sensitivity within the near-infrared spectrum. This technique has proven valuable for developing compact, affordable remote sensing systems for ground and airborne fire detection.

The rise in global temperatures and associated climate changes has triggered an increase in the frequency and severity of wildfires worldwide. Addressing the wildfire problem demands innovative solutions to mitigate catastrophic fire damage. This includes integrating space satellite observation systems for global wildfire surveillance, fire monitoring systems for unmanned aerial vehicles (UAVs) used in tactical firefighting and ground-based systems on elevated platforms. The CSIR is developing space and UAV-based camera payloads for fire detection using the K-line sensor technology.

Under the exclusive technology licence agreement between the CSIR and Autonosky, the CSIR's K-line payload technology will be integrated into Autonosky's drone-based fire-fighting technology.

The CSIR K-line technology aboard an Autonosky drone to assist the Western Cape Fire Emergency Services with firefighting efforts.

02 Improve the competitiveness of high-impact industries to support South Africa's re-industrialisation by collaboratively developing, localising and implementing technology

SMME improves its testing and certification process for pneumatic actuators with new test bench

CSIR experts in robotics and engineering have developed a novel test bench that can simultaneously test two pneumatic actuators for a KwaZulu-Natal-based small, medium and micro enterprise (SMME).

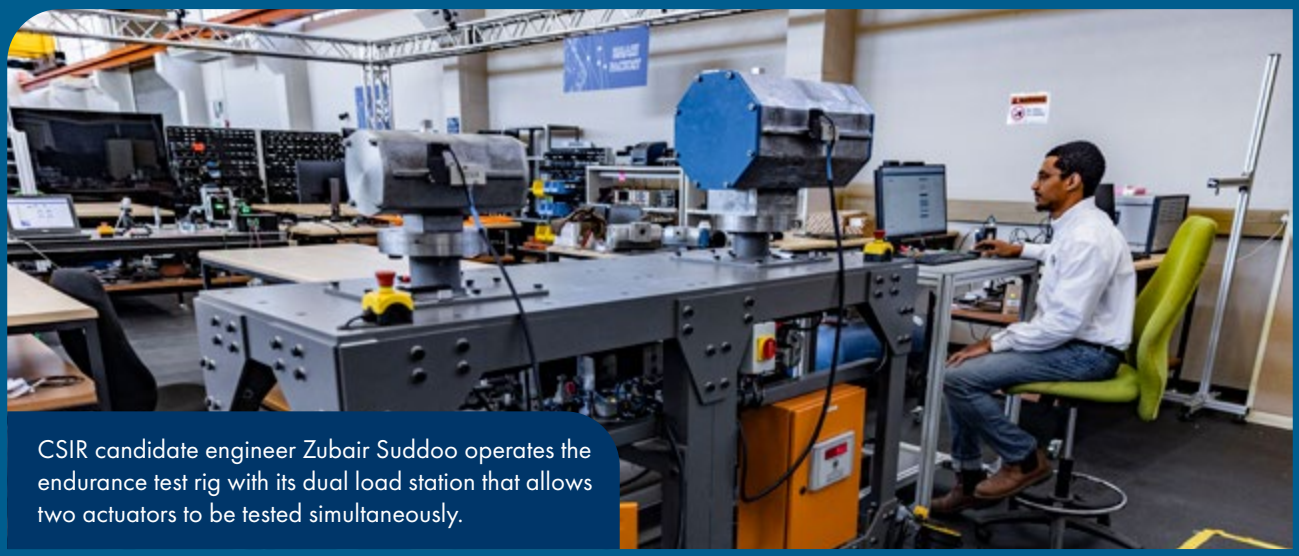
Aumanat specialises in complete valve automation solutions for the petrochemical and wastewater treatment industries. The SMME manufactures pneumatic actuators and is an agent for a leading electric actuator brand, AUMA. Their product range includes valve gearboxes for various industrial applications. The Aerospace Industry Support Initiative (AISI), a South African government initiative aimed at improving the competitiveness of the local aeronautics, space, defence and sector-wide advanced manufacturing industries, commissioned the CSIR to assist Aumanat.

Pneumatic actuators are devices that utilise compressed air to produce mechanical motion and force. They are used in various industrial applications requiring controlled and precise movement and operation, such as valve control and isolation used in the water and waste sector, as well as power generation, paper, sugar, steel mills and most industrial plants.

The new test bench continuously monitors parameters that are specified in EN 15714-3.2009, the international standard used for endurance testing of pneumatic actuators. An example is the torque that needs to be adjusted to the correct level and logged every 15 degrees when opening and closing the valve. Endurance testing requires millions of cycles, hence the capability to test two actuators of different sizes simultaneously, saves a lot of testing time.

The CSIR developed a user requirement specification document according to the certification standards to ensure market acceptance. This European standard helps companies ensure safety and quality in manufacturing processes.

AISI has supported more than 40 local companies in 2023/24 as part of its commitment to supporting local companies develop and localise technologies to contribute to economic growth and enhance the country's manufacturing capabilities.



CSIR candidate engineer Zubair Suddoo operates the endurance test rig with its dual load station that allows two actuators to be tested simultaneously.

02 Improve the competitiveness of high-impact industries to support South Africa's re-industrialisation by collaboratively developing, localising and implementing technology

CSIR establishes a foundry centre to grow the manufacturing sector

South African foundry companies can now access a variety of essential infrastructure, including furnaces, metal injection moulding, melting and sand equipment, as well as quality control and testing services, all housed at the CSIR.

This development follows the establishment in March 2024 of the Foundry Technology Centre of South Africa, which aims to bolster various manufacturing sectors through research, development and innovative initiatives while nurturing strategic industry collaborations for sustainable progress. The centre results from a partnership between the CSIR and the National Foundry Technology Network and aims to tackle the challenges confronting the foundry sector.

The centre's core focus is revitalising local foundry activities and leveraging digital technologies to improve operational efficiency and competitiveness.

It offers essential support to foundries and other stakeholders in a coordinated endeavour to secure positions on the original equipment manufacturers' global supplier lists.

New valve developed for very high operating temperatures

In this joint technology development project, CERadvance and the CSIR conceptualised and designed a low-cost, high-temperature four-way valve specifically for controlling the charging and discharging between two fixed-bed regenerators. These regenerators, which store thermal energy by heating or cooling a solid material, require a continuous supply of hot or cold gas for multiple purposes.

In creating a new fixed bed regenerator, the CSIR and CERadvance, a local company specialising in engineering ceramics and ceramic components, had encountered a problem with the lack of affordable, simple valves that could work at high temperatures and low pressures. This obstacle prevented them from achieving the thermal energy management application cost-effectively. The team subsequently developed a novel valve to overcome this issue.

The valve offers numerous advantages over conventional counterparts, including lower cost, simpler design, reduced risk of malfunction and the use of local materials. Its performance has been thoroughly validated through successful testing at CERadvance and computational fluid dynamics modelling at the CSIR. Moreover, its dimensions and insulation thickness can be tailored to accommodate various temperature ranges and applications.

The collaboration between CERadvance and the CSIR exemplifies the CSIR's commitment to joint technology development, aimed at addressing industry-specific challenges. The intervention not only overcomes the hurdles faced by CERadvance but also presents a pioneering solution with broad applicability and significant market potential.

CSIR engineer Muhammad Sheik at CERadvance with a CSIR-developed thermal battery capable of storing waste heat and re-using it in the process when required.

02 Improve the competitiveness of high-impact industries to support South Africa's re-industrialisation by collaboratively developing, localising and implementing technology

Spectrum switch technology opens up the digital economy to communities

Six communities in six South African provinces have, to date, benefitted from the roll-out of CSIR technology that uses idle radio frequency spectrum for broadband services.

Television white spaces (TVWS) are the unused spectrum channels in the TV broadcasting frequencies. The CSIR developed a tool that dynamically identifies and makes available these idle radio frequency spectrum resources, which are primarily allocated for broadcast television services, to provide affordable broadband services. Such services can be offered by wireless network operators without causing interference with the primary licensed services. This harmonious co-existence between TVWS-based wireless broadband networks and TV broadcasting networks is made possible through the CSIR-developed technology that serves as a dynamic spectrum switch.

Since 2020, the CSIR and the United Nations Development Programme have supported youth and women-owned small, medium and micro enterprises (SMMEs) to bridge the digital divide in rural and township communities using the CSIR spectrum switch. Other collaborating partners supporting the Rural TVWS Operator Support Programme include the British government through the Foreign Commonwealth Development Office and SEACOM, a commercial network company with extensive information and communications technology and data infrastructure in South Africa.

The programme enhances access to affordable broadband internet connectivity through public hotspots, provides broadband internet connectivity to public facilities, improves digital literacy and creates job opportunities for the 13 SMMEs that serve as rural operators. The programme has been implemented in KwaZulu-Natal, the Free State, Eastern Cape, Limpopo, the Western Cape and Mpumalanga.

By April 2024, beneficiary SMMEs in both phases have collectively created 111 job opportunities. Some 70 025 users were connected to the network through 212 public facilities, 2 637 households, 273 local small businesses and 183 public hotspots.

The technology has enhanced the lives of rural and township communities in South Africa, enabling their participation in the digital economy and unlocking the benefits of the fourth industrial revolution.

Small, medium and micro enterprises benefitted from a support programme for rural television white space operators. At a gathering at the CSIR, are, from left, Njabulo Hadebe, CEO of Africa Learn; Nkosinathi Mbele, CEO of AdNotes; Tshego Mpete from Broadband Infraco; Genesis Phasha, CEO of Eyelook; Songezo Mhambi, CEO of Mdantsane Mobile; Lwakhe Sangweni, CEO of Sleeptime Solutions; and Thabo Mokgotho, CEO of Kasi WiFi Connect.

02 Improve the competitiveness of high-impact industries to support South Africa's re-industrialisation by collaboratively developing, localising and implementing technology

Turning waste into a green building block

The CSIR has partnered with a small, medium and micro enterprise (SMME) and a non-profit organisation to demonstrate a new type of interlocking block, made from recovered glass and building rubble waste, for the housing and manufacturing sectors. The block project is expected to provide informal employment opportunities for women, especially in rural areas.

Grant funding from the Department of Science and Innovation enabled the CSIR, Use-It (a KwaZulu-Natal-based waste beneficiation incubator and non-profit organisation) and Key Bricks Pty Ltd (a block machine design and fabricator) to showcase the new green block.

The new block offers several benefits, including the use of less virgin materials and natural resources such as river sand, stone and water. It is designed to interlock like LEGO® blocks, requiring minimal mortar and cement for bonding. This design allows for built structures to be easily 'deconstructed' and the blocks to be reused. Additionally, the blocks feature an internal opening for water pipes or electrical conduits, reducing the need to cut grooves or channels into the blocks and ensuring the blocks remain intact.

The block-making machine is currently being demonstrated to private sector and municipal officials, housing-sector representatives and other SMMEs in the building and block-making sectors.

The mix ratios for the blocks and the design of the structures are informed by CSIR research.

The partners are seeking certification from Agrément South Africa, the regulator of non-standardised construction products and systems, to promote market uptake.

Up to 70% of the traditional raw materials in the new building block can be replaced by recyclable materials such as collected glass and construction waste.

Glass collected by community members is crushed in a hammer mill. The aggregate is channelled through a rotating screen trommel to separate the different grades of recovered glass.

02 Improve the competitiveness of high-impact industries to support South Africa's re-industrialisation by collaboratively developing, localising and implementing technology

Southern African startups win big in the Innovation Bridge Fintech Challenge

Ten innovative southern African startups triumphed in the Innovation Bridge Fintech Challenge, funded by the World Bank and the Swiss State Secretariat for Economic Affairs. The challenge provided entrepreneurs with access to markets, business networks and investment opportunities.

Spearheaded by the CSIR's Hosted National Programmes, the fintech challenge fostered growth and promoted inclusive financial solutions for disadvantaged communities. Equipped with newfound skills, these startups can now help drive economic empowerment.

The Innovation Bridge Fintech Challenge is one of many initiatives created by the Innovation Bridge Portal and its partners to support innovation and entrepreneurial ecosystems.

The challenge set out to harness fintech advancements for low-cost and appropriate savings and de-risking products for the low and middle-income markets, as well as lending solutions for small and medium-sized enterprises.

Each of the top 10 startups received $5 000 (approximately R100 000). From 86 applications, the top 10 were selected after a rigorous process and an intensive eight-week investment readiness programme that included mentorship and masterclasses.

The Innovation Bridge Portal is an initiative of the South African National Departments of Science and Innovation and Small Business Development. The initiative is co-funded by the European Union.

Marino Cuenat, Deputy Head of Mission at the Embassy of Switzerland to South Africa, Botswana, Eswatini, Lesotho, Mauritius and Namibia, delivers his opening remarks at the Innovation Bridge Fintech Challenge and Miss Amina Patterson, Founder of Solve4x and Entrepreneur in Residence at Allan Gray Orbis Foundation during her address.

02 Improve the competitiveness of high-impact industries to support South Africa's re-industrialisation by collaboratively developing, localising and implementing technology

Testing body cooling garments to keep mining rescue teams safe underground

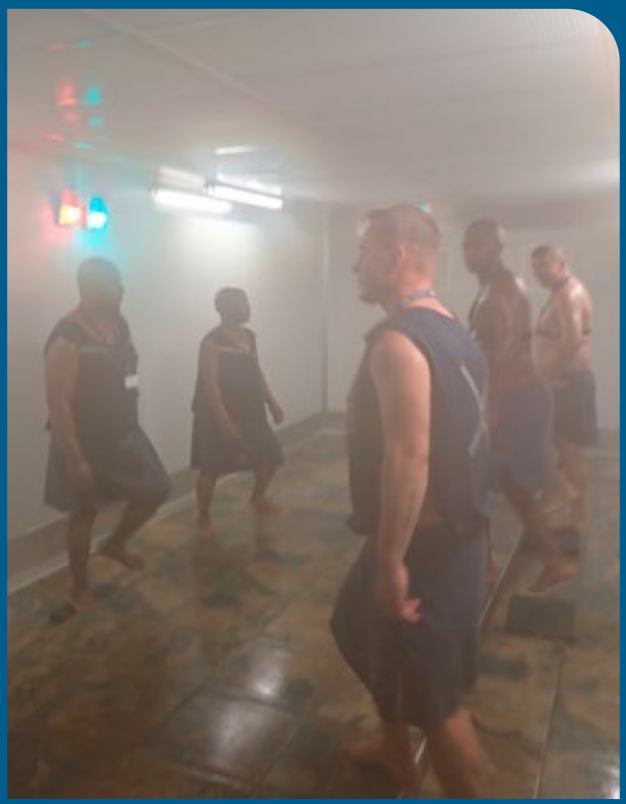
Mine rescue teams face extreme heat stress when working underground. The CSIR was commissioned by Sibanye-Stillwater Ltd to assess the effectiveness of a body cooling garment developed and used by Mines Rescue Services South Africa in extending users' tolerance times beyond the current upper limit of 30 minutes at an emergency heat stress index of above 38°C.

Occupational heat stress is a significant health and safety hazard that can lead to heat disorders, including heat stroke. In South African mines, emergency rescue or maintenance work is often conducted in abnormally hot environments. Body cooling garments are a form of personal protective equipment that can help keep rescue teams cooler – and subsequently safer – for longer periods.

The cooling garment selected for the study is a jacket fitted with four pouches on the inside, into which eight lightweight, frozen gel packs are inserted. Rescue team members wore these jackets during testing to evaluate their effectiveness in mitigating heat stress.

During the test regiment, 23 rescue team members from Mines Rescue Services were placed in a temperature-controlled climatic chamber to simulate an abnormally hot thermal environment. They were required to complete a bench-stepping regiment at an approximate work rate of 54 watts per minute while wearing the cooling garment. Heart rate, core body temperature, skin temperature, rectal temperature and sweat rates were measured.

The results indicated that increases in rectal temperatures were lower with the use of the garment than without it. However, there was insufficient evidence to support extending tolerance times beyond the currently recommended limits. Further recommended research includes garment design modifications and testing at additional environmental temperatures and work rates.



Testing inside a temperature-controlled climatic chamber, where an abnormally hot thermal environment is simulated. (Above) Taking stock of body temperatures after the testing exercise.

03 Drive socioeconomic transformation through RDI that supports the development of a capable state

Supporting South Africa's Blue Economy: Science and engineering at work for South Africa's ports

Efficient ports are key to flourishing economies, with approximately 80% of global merchandise trade transported via sea routes. The CSIR draws on its science, engineering and technology capabilities and infrastructure to provide decision-support on port layouts, marine structure design and port operations for safe, efficient and sustainable ports.

CSIR senior researcher Chris Troch uses the vessel motion forecast tool, a CSIR-developed solution for ports around the world, to forecast the motion of moored ships.

Forecasting the motion of moored ships

A new simulation tool developed by the CSIR can accurately forecast the motion of moored ships in a port, contributing to operational efficiency and port safety. Initially tested in the Port of Ngqura in the Eastern Cape, the tool can be customised for specific ports and integrated into most existing infrastructure.

Moored vessels often experience motion due to winds and waves, which can lead to operational hindrances, downtime and even the breaking of mooring lines during severe environmental events.

The vessel motion forecast tool helps in managing mooring and long-period wave problems at ports. Predicting the effects of long wave events on moored ships is often challenging for port operators. However, the CSIR-developed tool allows for the accurate assessment of these impacts on particular vessels at specific berth locations inside the port, ensuring data-based decision-making.

This is achieved by linking numerous state-of-the-art numerical models, enabling the modelling of complete long-period wave climates and the resulting moored ship motions.

While the tool was first developed for use by the Transnet National Ports Authority in South Africa, it is relevant to any port impacted by severe vessel motions.

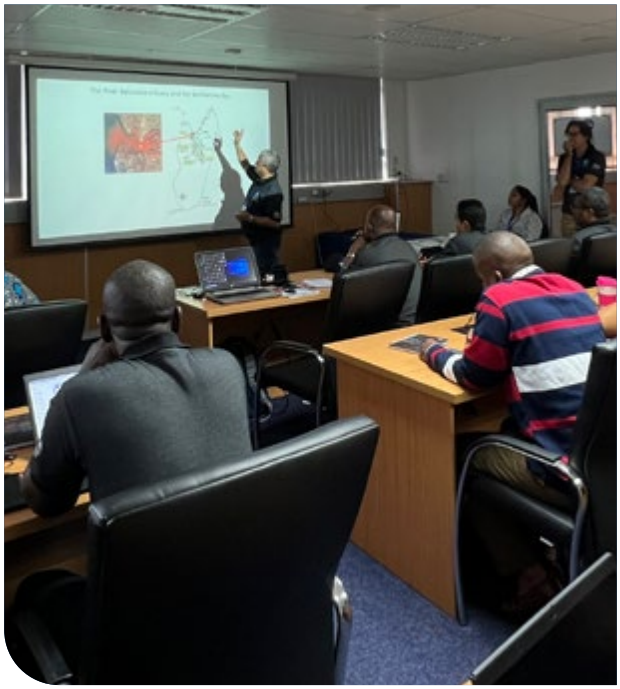
03 Drive socioeconomic transformation through RDI that supports the development of a capable state

Green ports for blue growth

The United Nations Environment Programme commissioned the CSIR to develop a toolkit for sustainable port development in the West Indian Ocean region. The toolkit comprises a range of best practise guidelines applicable throughout all stages of port development and operation, addressing environmental, social, climate and economic challenges faced by ports in the region.

Recognising the necessity for ports to track and demonstrate their progress towards sustainability, the CSIR has also developed a sustainability performance index for ports. This index has proven invaluable, serving as a foundational tool for prioritising sustainability interventions among ports in the region.

Given the need for development and trade growth in Africa, coupled with regional recognition of the potential of the Blue Economy, these decision support frameworks and tools for sustainable ports are timely. Interest in the CSIR's scientific contributions to port sustainability resulted in presentations in various forums, including the African Development Senior Managers' Forum, the Western Indian Ocean Science Policy Platform, the Africa Maritime Cabotage and Blue Economy Conference and the Annual General Meeting of the Port Management Association of Eastern and Southern Africa.



Working together to ensure the protection of the West Indian Ocean marine waters. The CSIR is advancing a new framework for coastal and marine water quality management at national and local levels. (Above) Participants attending a country-level training programme tour the CSIR's Ecotoxicology Laboratory.

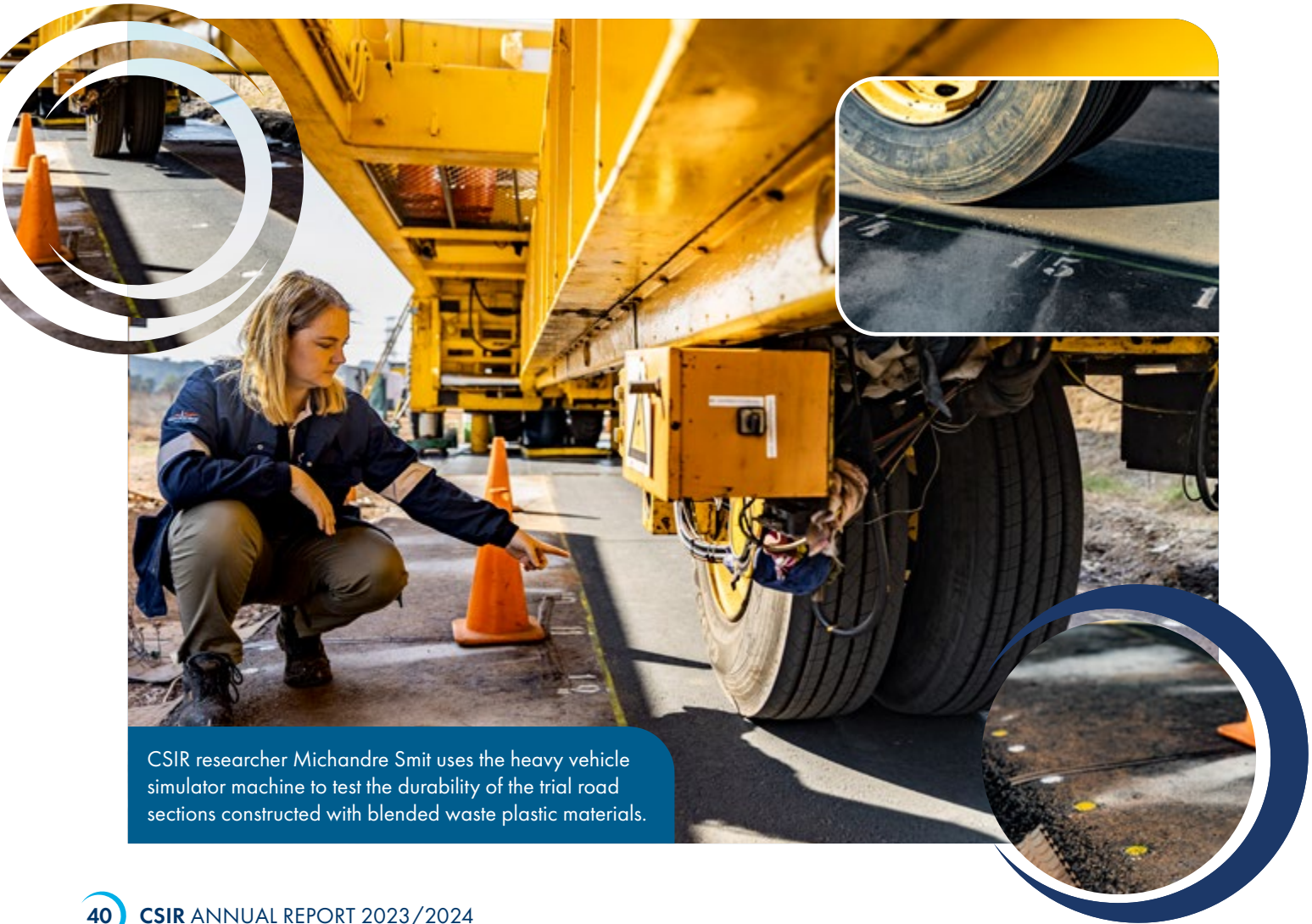
Tests prove the viability of using plastic waste for roadmaking

The CSIR has demonstrated its ability to use plastic waste materials in creating a durable road surface at a low cost. Tests on a trial road section indicated that asphalt modified with plastics performed exceptionally well, showing no signs of failure even under heat exposure.

The CSIR concluded accelerated pavement testing on a plastic trial road section at the University of Pretoria's Engineering 4.0 facility. One side was paved with a patented blend of traditionally non-recyclable plastic and bitumen, while the other side was paved with a standard road surface mixture. Researchers used the CSIR heavy vehicle simulator to conduct the durability test of the 100-metre-long trial road section. This machine simulated two decades' worth of traffic in three months to assess the performance of the modified waste plastic bitumen technology in road construction. This comparative test demonstrated the real-world differences in how these two types of pavements respond to various stressors such as heat and heavy loads.

The technology addresses two critical problems: reducing the current waste burden by reintegrating non-recyclable waste plastic into the economy and providing innovative and resilient road construction solutions.

The project was a collaborative effort by public and private sector partners, including the Department of Science and Innovation, WBHO Construction, the South African Bureau of Standards and the Southern African Bitumen Association.



CSIR researcher Michandre Smit uses the heavy vehicle simulator machine to test the durability of the trial road sections constructed with blended waste plastic materials.

03 Drive socioeconomic transformation through RDI that supports the development of a capable state

Solution for gunner safety integrated on SANDF Mamba Mk III vehicles

The CSIR has completed the integration of 360° manual turrets onto an additional 10 Mamba Mk III armoured personnel carriers for operational deployment. The CSIR-designed turret provides protection to gunners aboard personnel carriers and offers a 360° firing capability.

The design allows for retrofitting the turret to existing armoured personnel carriers, making it a robust and cost-effective solution to enhance the capability of existing vehicles.

The Mamba Mk III is a South African National Defence Force armoured vehicle designed to transport troops to and from operational deployments. These vehicles often traverse combat scenarios without the availability of fitted armament for defence.

The vehicles have now been equipped with a 360° basic ballistic-protected turret for the machine gun operator, offering protection from small arms fire. The turret design allows for multi-weapon mounts and is robust yet lightweight.

The CSIR technology stands out for its manual rotation capability, enabling the gunner to control the 360° arc of fire from within a protected turret. This retrofitted turret provides enhanced firepower capability to troop carriers, improving the safety and survivability of the crew.

The CSIR-developed turret can be retrofitted to a range of personnel carriers to provide protection to the gunner. It provides a 360° firing capability.

Fingerprint recognition device rolled out at correctional services facilities

The CSIR has developed a handheld fingerprint acquisition device to assist the Department of Correctional Services with the identity management of offenders. The department will use the scanner to compare the fingerprints of a person brought to a correctional facility from court to those on the warrant of detention form.

As part of the partnership agreement, the CSIR has piloted the fingerprint scanner at Kgosi Mampuru Prison in Pretoria and the Johannesburg Prison.

The fingerprint device is a standalone contactless unit equipped with a standard digital camera used to verify an individual's identity.

Developed by CSIR biometrics experts, the device can be used for various tasks requiring fingerprint comparison, such as remand management, where an offender awaiting trial is held in a prison.

It can also be used to identify and count offenders during roll calls and verify identities during community correctional visits. The device partitions transactions based on the deployment location.

Although initially developed for the department, the device can also be used to verify motorists' identities when stopped by traffic officials by comparing their fingerprints to those on a driver's licence.

The CSIR-developed handheld fingerprint device will assist the Department of Correctional Services with offender recognition.

03 Drive socioeconomic transformation through RDI that supports the development of a capable state

Biometric fingerprint system for forensic pathology rolled out in Gauteng and Limpopo

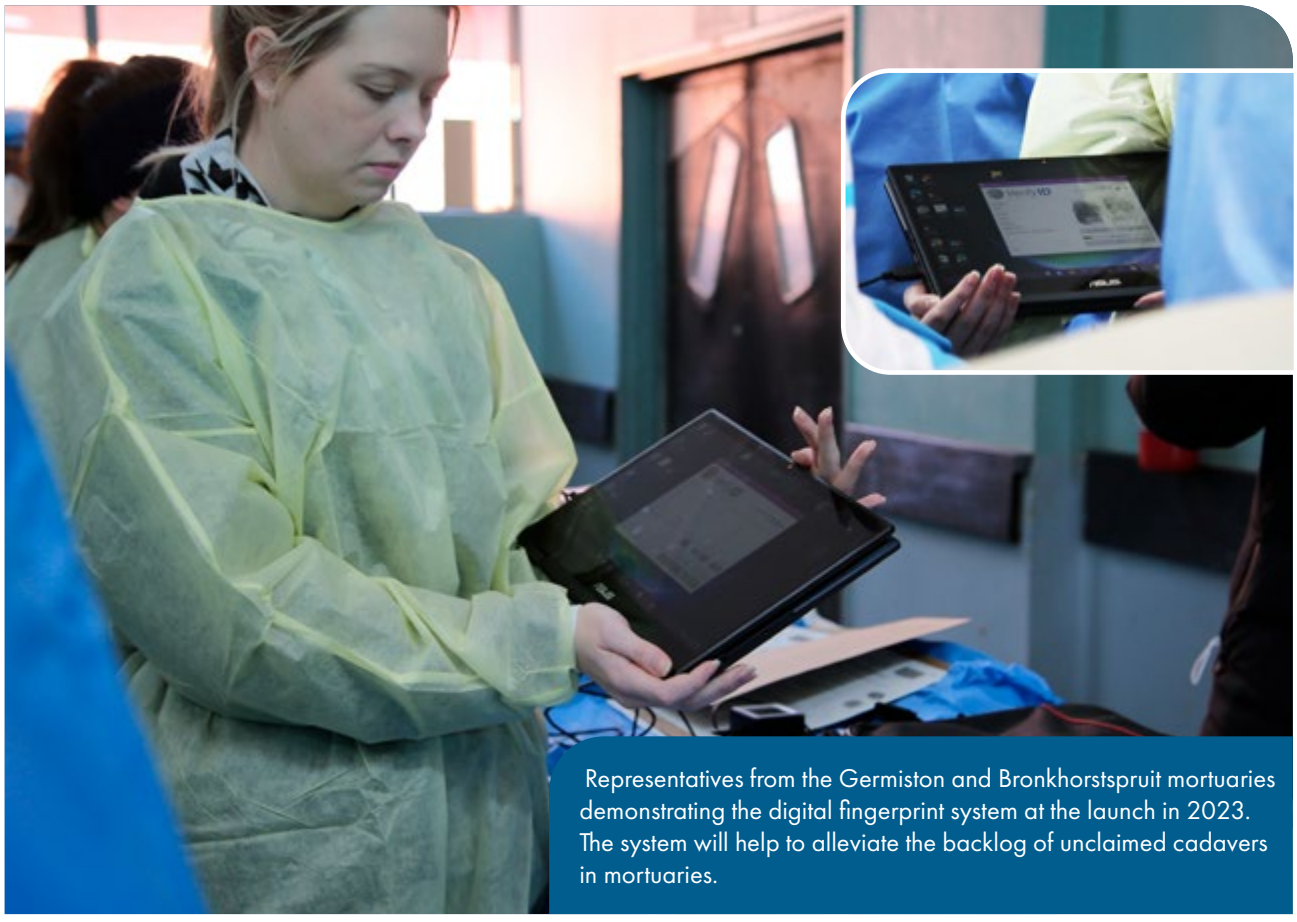
A CSIR-developed digital fingerprint system was handed over to the Gauteng and Limpopo provinces as part of a nationwide pilot to aid in the identification of unclaimed cadavers. The system, developed in collaboration with the Gauteng Department of Health and the Forensic Pathology Services, aims to improve identification turnaround times and reduce the burden of storing unidentified cadavers for extended periods.

Supported by the Centre for Public Service Innovation, the system was piloted in July 2023 at three Forensic Pathology Services facilities in Gauteng: Bronkhorstspruit, Pretoria and Germiston.

Biometric sensors are used to acquire fingerprints from cadavers, which are then digitally queried against various databases to determine their identity. The system interfaces with databases administered by different government entities using their official interfaces. For instance, the local criminal records centre of the South African Police Service (SAPS) uses the SAPS Form 91A for fingerprint queries. Traditionally, forensic pathology services personnel used inkpads to deposit fingerprints on the form for courier to SAPS.

The CSIR and Forensic Pathology Services have digitised the form, integrated multiple fingerprint sensors and tied in the credentials of the querying official. The functionality to query against the database of the Department of Home Affairs has also been demonstrated.

The system will alleviate the pressure on resource-constrained forensic mortuaries, which handle countless unclaimed and unidentified bodies. The system will be rolled out to the rest of the country as part of the pilot programme.



Representatives from the Germiston and Bronkhorstspruit mortuaries demonstrating the digital fingerprint system at the launch in 2023. The system will help to alleviate the backlog of unclaimed cadavers in mortuaries.

03 Drive socioeconomic transformation through RDI that supports the development of a capable state

Neighbourhood watch in Mitchells Plain starts using CSIR-developed application for crime insight

The CSIR has developed a mobile application (app) called BlockWatch that provides real-time insight into violence, crime patterns and risk factors by integrating artificial intelligence and geographical information systems.

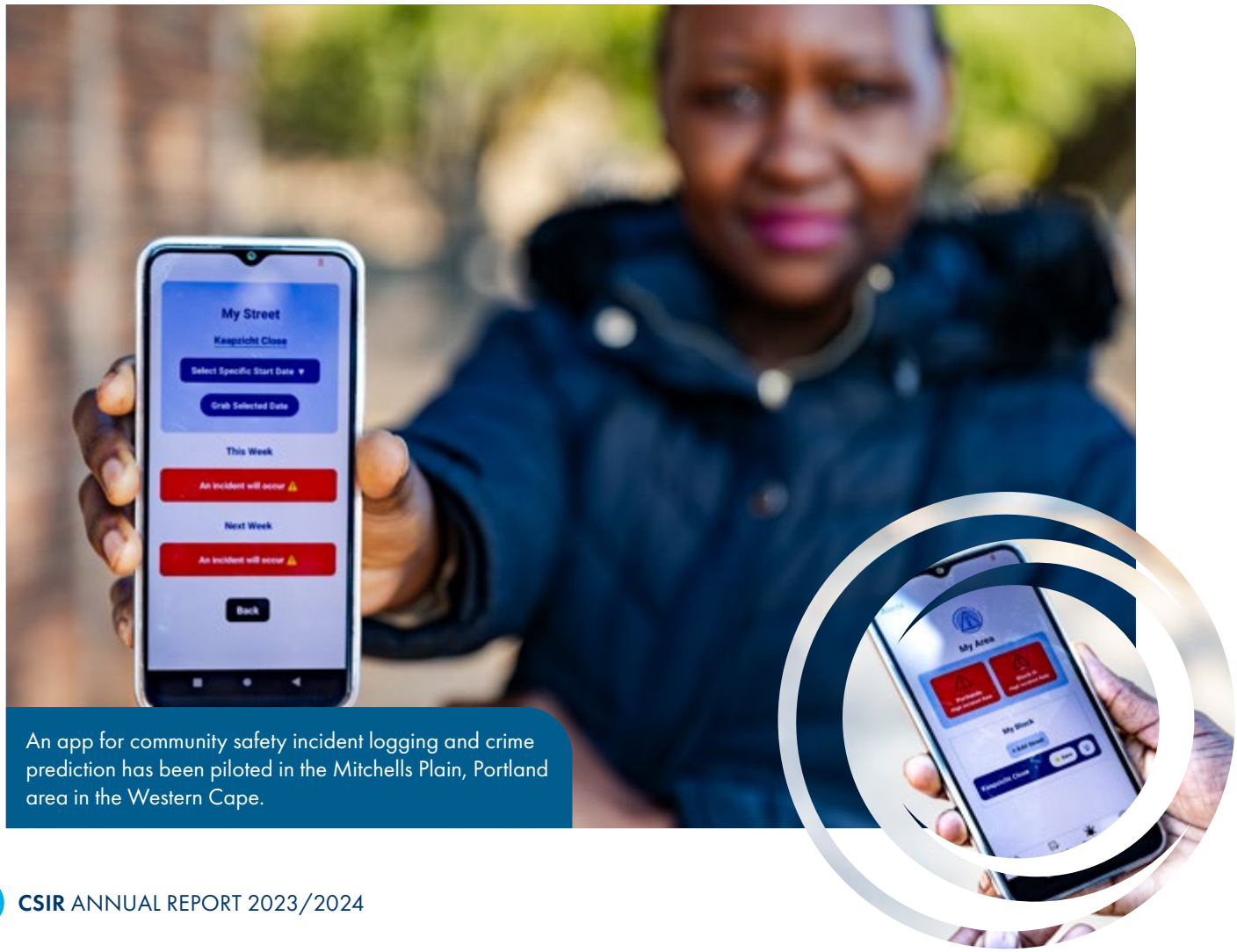
The app's artificial intelligence enhances the user community's awareness and decision-making by accurately predicting future locations of crime and violent incidents on a weekly basis. On 27 November 2023, the mobile app was unveiled at Portland High School in Mitchells Plain in the Western Cape. The CSIR held a training workshop to help Portland Block H Neighbourhood Watch members with installing the app, as well as registration and authentication processes.

BlockWatch leverages predictive analytics to notify Neighbourhood Watch members about potential hotspots for crime and violence in real time, enabling individuals to stay informed and take proactive measures to protect themselves and their communities.

The technology allows users to record incidents, including the location and timestamp for all observations made during patrols.

Other project collaborators include the Western Cape Government Departments of Health and Wellness, and Police Oversight and Community Safety.

The pilot project will help assess the app's suitability for determining the spatial patterns of crime and violence in the area and for decision-making in addressing sporadic flare-ups of incidents in highly volatile communities.



An app for community safety incident logging and crime prediction has been piloted in the Mitchells Plain, Portland area in the Western Cape.

03 Drive socioeconomic transformation through RDI that supports the development of a capable state

Noise attenuation integration in urban environments

The CSIR has developed a traffic noise attenuation tool to help address noise disturbance challenges in urban schools.

Urban schools located near busy roads struggle to provide a conducive learning environment due to excessive traffic noise infiltrating classrooms through windows. This noise hampers students' concentration and comprehension, impacting their academic performance and well-being. Traditional noise attenuation methods often require specialised expertise in acoustics, making them inaccessible to architects and school planners lacking such knowledge.

The CSIR's Traffic Noise Attenuation Design Tool addresses these challenges by providing a novel, user-friendly software solution accessible to architects and school planners with no prior acoustics expertise. The tool does not aid in the design of the classroom itself but leverages a sophisticated backend comprising multiple simulations and data analysis to simplify complex noise attenuation principles into intuitive design parameters.

Users can adjust variables such as distance from the road, building orientation, height and position of noise barriers and vertical positioning of classrooms. This empowers designers to optimise classroom layouts for noise reduction while maintaining ventilation requirements.

The tool can evaluate whether the proposed design configurations meet standard indoor ambient noise levels for classrooms, considering ideal conditions and scenarios accommodating students with hearing or learning impairments. This allows for building designs tailored to specific educational needs.

The user interface of the digital tool created to design out traffic noise in urban classrooms.

03 Drive socioeconomic transformation through RDI that supports the development of a capable state

South Africa's high-speed network for research impresses with high data transfer rates

In response to the need to move large datasets at high speed, specifically for data-intensive research, the South Africa National Research Network (SANReN) implemented a backbone network with 100 Gbps capacity and 100 Gbps data transfer nodes in Cape Town and Johannesburg. Using this infrastructure, a record data transfer result of one terabyte in three minutes was achieved between Johannesburg and Colorado in the United States of America (USA).

Moving large amounts of data poses a significant challenge. Networks optimised for business operations are typically neither designed nor capable of meeting the data movement requirements of data-intensive research. When scientists attempt to run data-intensive applications over these general-purpose or enterprise networks, poor results are achieved. This poor performance significantly impacts the scientific mission, leading to challenges such as not receiving data on time or resorting to drastic measures like shipping disks.

The CSIR, through SANReN, increased network capacity and associated data transfer services to facilitate the movement of large datasets by South African researchers and scientists.

Leveraging the infrastructure deployed as part of the AmLight Express and Protect (AmLight-Exp) collaboration using the South Atlantic Cable System connecting Africa and the USA, the SANReN 100 Gbps data transfer nodes were demonstrated at the Supercomputing Conference 2023 hosted in Denver, Colorado, USA last year, where the link capacity was filled to approximately 98%. A remarkable 2.5 Tb/s in data transmission between the conference venue and points in the USA, Brazil and South Africa was achieved.

A map of the AmLight-Exp network (in red), connecting Africa and the US, that was demonstrated at the Supercomputing Conference 2023.

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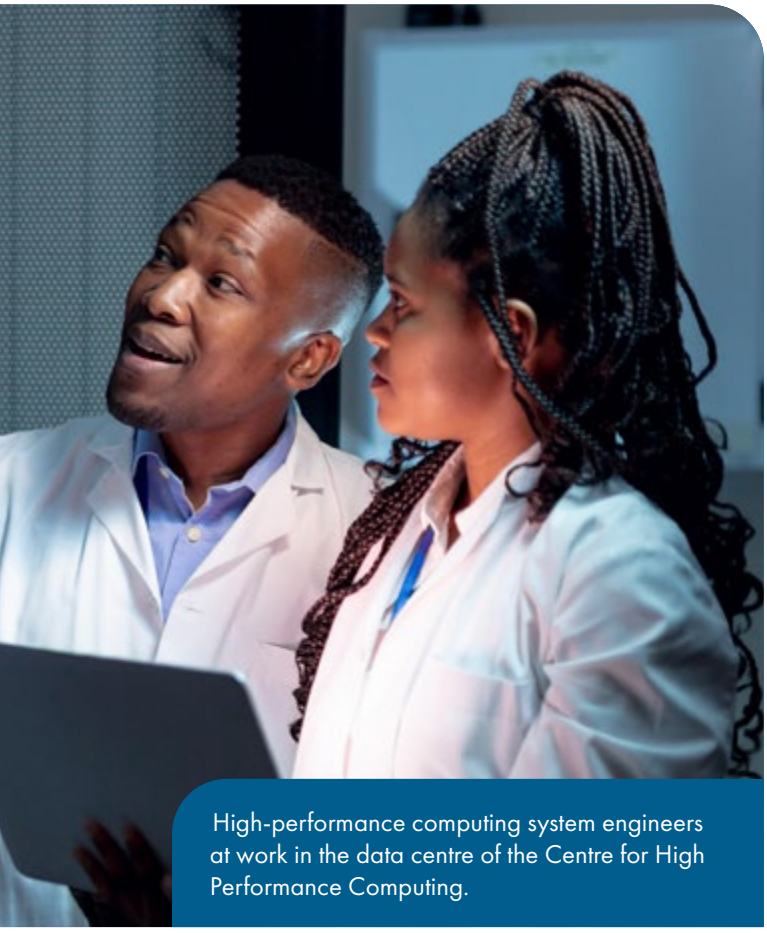
Lengau supercomputer key in South African research

The computational capacity of the Lengau supercomputing cluster at the Centre for High Performance Computing (CHPC) has enabled the production of 336 peer-reviewed, published articles in 2023/24.

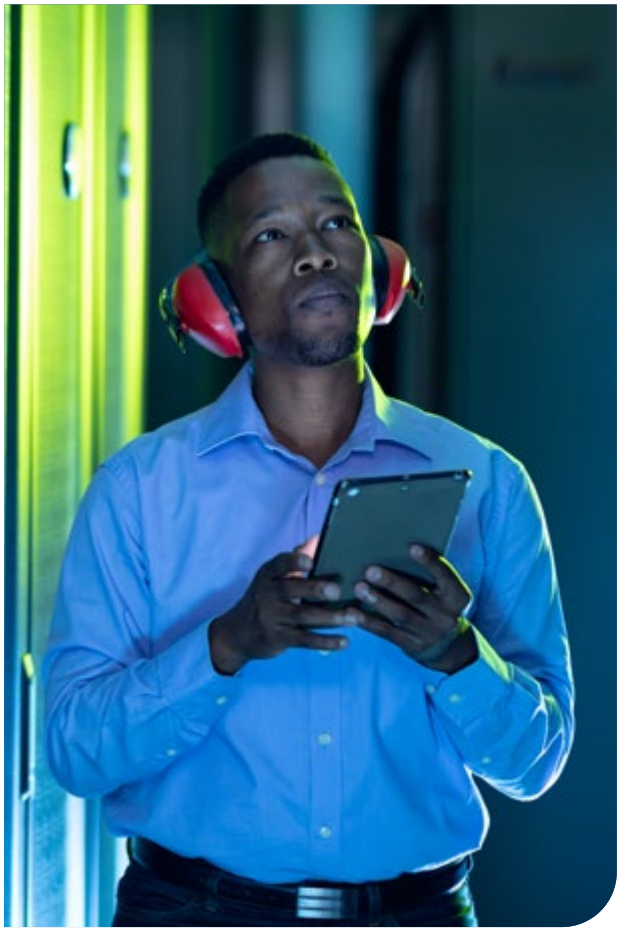
Among these, 28 were dissertations for Honours, 39 for Master's and 18 for PhDs. The remaining publications included scientific posters and presentations at conferences.

This has been made possible by the increased computational capacity provided to users, specifically in the last quarter, even during periods of loadshedding.

These outputs indicate that CHPC resources are being suitably utilised and contribute to the research and development capacity of the country.



High-performance computing system engineers at work in the data centre of the Centre for High Performance Computing.



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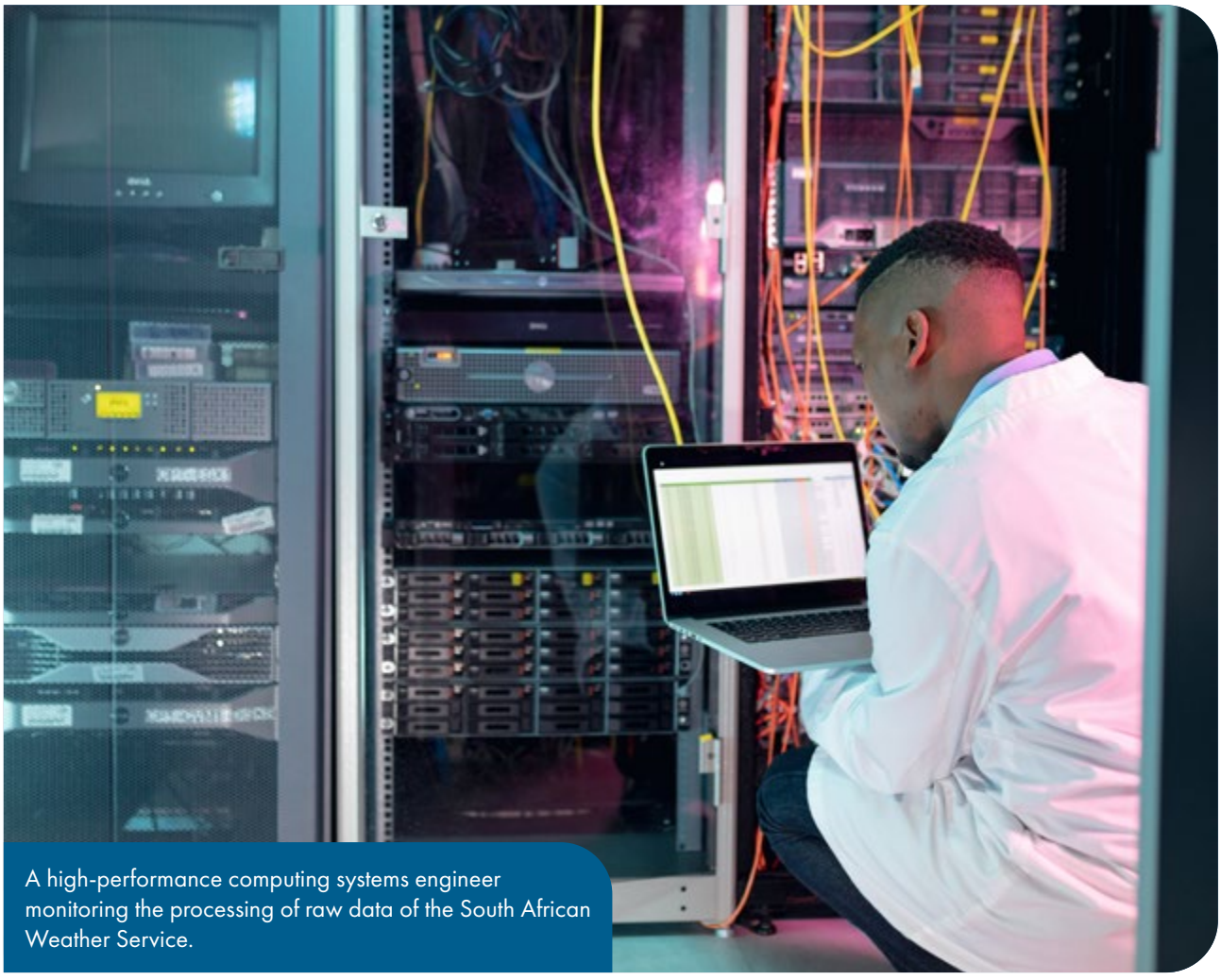
Sharing high-performance resources and knowledge for uninterrupted weather forecasting

The Centre for High Performance Computing (CHPC) has provided critical high-performance computing resources to the South African Weather Service (SAWS), ensuring timely and accurate weather forecasting for South Africans.

Weather forecasting is crucial for South African industries and societies as they navigate the challenges of climate change. The SAWS relies on high-performance computing to run its numerical weather prediction programme and has found a valuable partner in the CHPC.

During system failures, the CHPC's Lengau supercomputing cluster has provided seamless high-performance computing resources and support, ensuring that the SAWS could maintain essential weather services. This support was particularly critical during the SAWS's relocation in October and November 2023. Additionally, high-performance computing experts have provided specialised training to SAWS staff, enhancing their capabilities.

For over a decade, the CHPC has offered large-scale research computing capabilities. As a national cyber-infrastructure intervention supported by the Department of Science and Innovation and managed by the CSIR, the CHPC continuously updates and meticulously maintains its infrastructure to comply with international standards.



A high-performance computing systems engineer monitoring the processing of raw data of the South African Weather Service.

03 Drive socioeconomic transformation through RDI that supports the development of a capable state

CSIR accepted as an associate member of large international experiment at CERN

The CSIR has become a full participant in the international experiment ALICE (A Large Ion Collider Experiment) through the National Integrated Cyberinfrastructure System (NICIS). NICIS brings expertise and resources in high-performance computing, large-scale data storage and highspeed bandwidth to the project. ALICE is designed to study the physics of strongly interacting matter at extreme energy densities.

NICIS was granted associate membership in ALICE, a project at the European Council for Nuclear Research (CERN) for three years. CERN is renowned for its cutting-edge particle physics research, which requires processing, analysing and storing vast amounts of data generated by experiments like ALICE.

To support this, CERN relies on purpose-built high-performance computing infrastructure, large-scale storage and high-speed connectivity services provided by a global network of high-performance cluster node facilities. NICIS will enhance ALICE's computational capabilities and enable faster data processing and analysis by providing the only tier two high-performance computing node in Africa.

Additionally, further collaboration opportunities will be explored. The associate membership status will be reviewed in three years, with the potential to expand the collaboration to include ground-breaking scientific research in high-energy physics.

South African ALICE experiment collaborators, from left, the CSIR's Mervyn Christoffels and Dr Happy Sithole, Prof. Zinhle Buthelezi representing iThemba LABS/University of the Witwatersrand, and University of Cape Town student Stephan Potgieter.

03 Drive socioeconomic transformation through RDI that supports the development of a capable state

Facilitating the uptake of open data policies in local government

The cities of Johannesburg, Tshwane, eThekwini and Ekurhuleni have adopted and integrated data policies co-developed by the CSIR into their existing policies on data governance as part of initiatives to facilitate the uptake of open data policies in South Africa's local government sector.

Open data is a key enabler for data-based decision making for the future and for smart city strategies. It will unlock the use of fourth industrial revolution technologies such as artificial intelligence, machine learning, internet of things and industrial internet of things, since these new technologies are dependent on access to data in open format for analysis. Furthermore, open data is a key driver for transparency, access to information by all and the inclusivity and participation of all citizens.

The CSIR had been tasked by the Department of Science and Innovation to assess the current implementation of open data policies by South African cities and to establish regulatory gaps that may inhibit large-scale implementation, as well as to co-design an open data actionable policy framework and a guideline for how local governments can develop specific policies and strategies on how data will be treated. CSIR experts worked with a network of early adopters to enable knowledge exchange and peer learning.

The work was funded by the Foreign, Commonwealth and Development Office, a ministerial department of the Government of the United Kingdom. Participation was secured from key stakeholders such as the South African Local Government Association, South Africa Cities Network, Department of Cooperative Governance and Traditional Affairs and the Department of Public Service and Administration.

In addition to the first outcome of four metro municipalities having integrated the open data principles into their existing data policies, the Department of Public Service and Administration adopted open data principles as one of its projects under the Open Data Pillar of the Open Government Partnership Programme, of which South Africa is a member.

The adoption of open data principles is now included in the Open Government Programme 2024 – 2026 National Action Plan to ensure further adoption and implementation.

Industry waste plan for tyres approved by cabinet

A CSIR-developed plan for waste tyre management in South Africa – with amendments from public comments – was approved by cabinet on 13 March 2024 and published for implementation.

Waste management is critical in South Africa and the National Environmental Management: Waste Act, 2008 (Act 59 of 2008) is a key policy instrument to address this issue. The CSIR was tasked with developing the industry waste management plan for tyres by the then Minister of Environment, Forestry and Fisheries, Barbara Creecy.

The plan is part of government initiatives to tackle waste pollution in the natural environment and supports the promotion of reuse, recycling and recovery of used car tyres in South Africa. It emphasises collaboration between the public and private sectors and aims to keep all waste generated from tyres out of landfills by promoting a circular economy.

03 Drive socioeconomic transformation through RDI that supports the development of a capable state

Interdisciplinary decision-making tools for a South African green hydrogen economy

The CSIR, in collaboration with the Department of Forestry, Fisheries and Environment, has developed an environmental impact assessment guideline for green hydrogen projects in South Africa. This guideline provides valuable information to assist in managing the impacts of a green hydrogen economy.

Green hydrogen and its derivative products could aid South Africa in decarbonising its energy economy, generating new revenue streams, creating jobs and skills and facilitating a just energy transition. However, for green hydrogen development to proceed at the envisaged scale, it must be guided by holistic, evidence-informed decision-making.

The guidelines were developed following the CSIR's appointment in 2022 to conduct an integrated assessment of the opportunities and risks associated with a domestic green hydrogen economy. The development was done in collaboration with GFA Consulting Group and funded by the German Development Cooperation (GIZ) South Africa.

The assessment leveraged interdisciplinary competencies across the CSIR to produce a diverse set of outputs to inform decision-making. These outputs include an online geospatial suitability application for potential green hydrogen projects, the environmental impact assessment guideline, a least-cost energy techno-economic analysis and a life cycle assessment.

CSIR contributes to national plan for a competitive local medical technology industry

The CSIR has provided key technical inputs into the Medical Technology Master plan, a plan that seeks to grow Africa's competitive medical technology industry over the next three years, focusing on the development of small and medium enterprises that will supply domestic and international markets. The organisation reviewed the Department of Trade, Industry and Competition's (the dtic's) draft medical technology masterplan and a concept proposal for a programme aimed at localisation, innovation and growth of medical technologies was submitted and accepted into the plan.

With 90% of the market value of medical devices being based on imports and only around 5% of South African medical companies engaged in manufacturing, the medical technology sector has been identified as a potential contributor to economic growth and employment, while also enabling improvements in healthcare for South Africans.

The CSIR has sound technical expertise in the development of point-of-care devices and supports new entrants to the medical device market with product lifecycle management. This support includes knowledge of technical and clinical testing phases, regulatory aspects, as well as design transfer for manufacturing and manufacturing processes. Signatories of the masterplan include the CSIR, **the dtic**, Department of Health, South African Medical Technology Industry Association and Medical Device Manufacturers of South Africa.

Contributing CSIR researchers, from left, Dr Priyen Pillay, Dr Lusisizwe Kwezi, Dr Manfred Scriba, Jeremy Wallis, Dr Amanda Skepu and Dr Duduetsang Saku.

04 Build and transform human capital and infrastructure

Scientists' ability to interrogate complex samples boosted with new mass spectrometry instrument

The CSIR and the University of Johannesburg's Research Centre for Plant Metabolomics have jointly acquired a new Synapt XS mass spectrometer machine, enabling scientists to interrogate complex biological mixtures. The acquisition of the cutting-edge mass spectrometry instrument was made possible through joint funding from the two institutions.

Research fields such as biocatalysis, pharmaceuticals, veterinary pharmaceuticals, plant metabolics, as well as flavours and fragrances, require the analysis and investigation of extremely complex samples. Advanced mass spectrometry instruments are essential for this purpose as they are highly sensitive and can provide accurate fragmentation data.

Ultra-performance liquid chromatography is a superior chromatographic resolution technique that can separate isomers and other structurally similar compounds.

When combined with a mass spectrometer, especially using time-of-flight technology, it allows for accurate mass data measurements (up to five decimal places), enabling compound characterisation and identification.

The new Synapt XS mass spectrometer, acquired jointly by the CSIR and the University of Johannesburg, equips scientists to interrogate complex biological mixtures.

04 Build and transform human capital and infrastructure

A boost for proteomics research as CSIR acquires new mass spectrometer

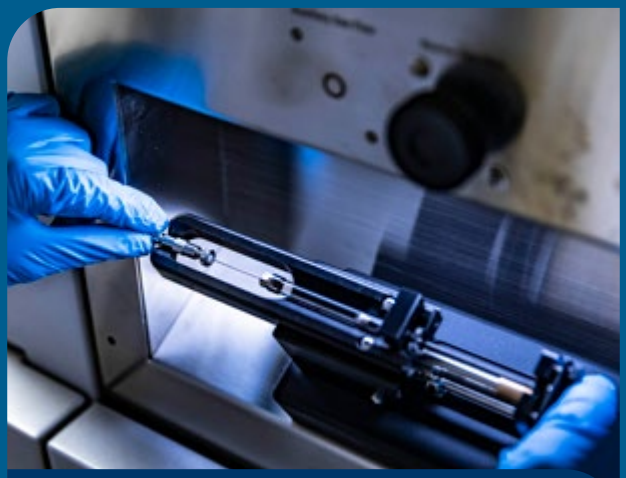
The CSIR has acquired a new Bruker Trapped Ion Mobility Spectrometry TOF HT mass spectrometer for proteomics research. Proteomics is the study of the structure and function of proteins, including the way they work and interact with each other inside cells. It has emerged as an important tool for studying diseases, as well as industrial biomanufacturing processes.

The instrument enables the facility to adhere to global standards, attracting further research and development income related to clinical and industrial proteomics. This capability unlocks the scientific value of underrepresented African clinical cohorts and how proteins in biofluids such as blood and urine relate to disease and outcomes. In addition to CSIR researchers, this equipment is accessible to researchers in the South African system of innovation.

CSIR principal researcher Dr Previn Naicker with the new mass spectrometer at the CSIR's proteomics facility.

The instrument and its coupled liquid chromatography systems were funded by DIPLOMICS, a South African Research Infrastructure Roadmap initiative, with co-funding from the CSIR for upgrades and extended maintenance contracts to ensure that the infrastructure remains operational far into the future.

Since its installation in January 2024, over a thousand biologically derived samples have been analysed using the instrument.



Dr Previn Naicker loads calibrant solution onto a syringe pump of the mass spectrometer and (below) adjusts the gas control on the tims cell of the mass spectrometer.

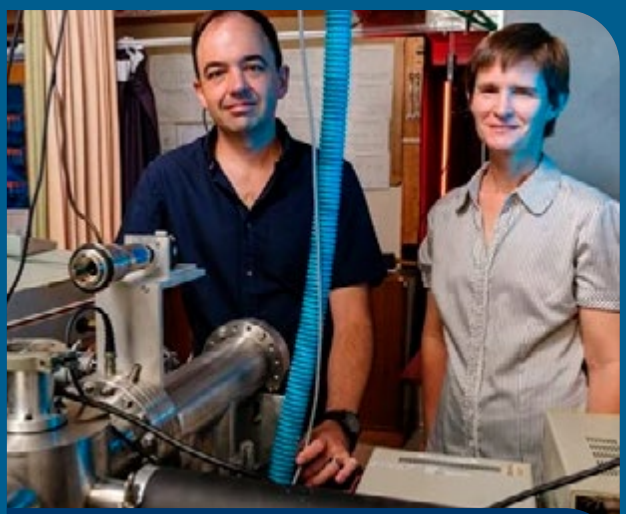
04 Build and transform human capital and infrastructure

CSIR laser infrastructure supports partnership for local radiopharmaceutical manufacturing

Leveraging the CSIR's infrastructure in laser-based research through a laser rental pool programme, Stellenbosch University and a local isotope production company, Enlightened Isotopes, are pioneering a process for manufacturing radioactive drugs.

The Stellenbosch Photonics Institute has been leading research in laser-based resonance ionisation, a technique used to purify atomic isotopes for medical use, for several years. Enlightened Isotope, a subsidiary of ASP Isotopes, is seeking innovative alternatives as traditional sources are being discontinued. Together, the partners are establishing a protocol for commercial production.

Funded by the Department of Science and Innovation, the Rental Pool Programme facilitates access to equipment at the beneficiary's host institution and infrastructure housed at the CSIR. Through this programme, researchers at the Stellenbosch Photonics Institute had the opportunity to experiment and refine a basic understanding of laser-based resonance ionisation spectroscopy. This has enabled the Stellenbosch group to conclude a commercial agreement with Enlightened Isotopes to develop the process for use on an industrial scale.



Prof. Pieter Neethling and Dr Christine Steenkamp in the high-resolution laser spectroscopy laboratory at Stellenbosch University.

The collaboration aims to address pressing healthcare needs by developing efficient methods for manufacturing radioactive drugs used in medical imaging and cancer treatment. It also seeks to stimulate local innovation and industrial growth.

04 Build and transform human capital and infrastructure

CSIR robotic platform supports further research at local universities

The CSIR donated robotic platforms to three local universities: the University of Pretoria, Stellenbosch University and the University of Cape Town. These robots are designed to aid research in robotics and related fields. Equipped with advanced processing capabilities, the CSIR-developed robots can perform complex tasks such as mapping, path planning, localisation and obstacle avoidance using a 3D lidar scanner.

The robots serve as experimental platforms for developing algorithms that control their movements and interactions. Additional sensors can be incorporated to enhance their environmental perception and provide data for algorithmic refinement. With onboard cameras, the robots can map environments, identify objects and, with the addition of an arm, perform physical tasks like opening doors and carrying items.

The donation aims to stimulate academic research in robotics, leveraging these robots as practical tools for investigating control, perception, navigation, behaviour and the integration of artificial intelligence into robotics tasks. The CSIR-developed robot is the first entirely locally developed robotic platform of its kind.

The Voyager, a collaborative robotic system to further skills and capabilities and foster collaboration within the artificial intelligence and robotics space.

At the handing over of the Voyager robot, are, from left, the CSIR's Mxolisi Gumede, Murray Louw, Dr Natasha Botha and, from the University of Pretoria, Prof. Schalk Els, Tokologo Komana and Glenn Guthrie.

04 Build and transform human capital and infrastructure

CSIR builds pipeline of visionary leaders

The CSIR's commitment to cultivating a positive organisational culture has resulted in two new programmes aimed at enhancing its management and leadership.

The CSIR Executive Coaching Programme adopts a learning approach that creates self-awareness, drives transformational change and provides support to individuals at executive level.

A second programme, the Executive Development Programme, is a collaboration between the CSIR and the University of Cape Town Graduate School of Business. It is designed to equip senior leaders with strategic thinking, an innovative mind-set and values-based leadership, which are needed to ensure a long-term competitive advantage for the CSIR. Eleven CSIR senior leaders participated in the nine-month programme.

These new programmes build on the momentum generated in the first year by the CSIR Leadership and Management Development Programme, with 137 employees making up the second cohort in August 2023. The programme focuses on increasing the organisation's leadership capacity – equipping employees with skills to manage their teams for better performance results.

Pictured at the Executive Development Programme graduation ceremony, are, from left, front to back, University of Cape Town (UCT) Graduate School of Business (GSB) Academic Programme Coordinator, Shandre Van Rheede; CSIR Group Executive: Legal, Compliance and Business Enablement, Adv. Esmé Kennedy; CSIR Specialist: Intellectual Property Management and Technology Transfer, Nirvashnee Seetal; UCT GSB Academic Director, Dr Beverly Shrand; CSIR Cluster Executive Manager: Smart Mobility, Nomsa Dlamini; CSIR Chief Information Officer, Kweku Arthur; CSIR Divisional Human Capital Manager, Polelo Madalane; CSIR Chief Executive Officer, Dr Thulani Dlamini; CSIR Group Executive: Human Capital and Communication, Andile Mabindisa; CSIR Manager: Technology for Special Operations Management, Dr Mathetha Mokonyama; UCT GSB Business Development Director, Rayner Canning; CSIR Cluster Executive Manager: NextGen Enterprises and Institutions, Dr Lulama Wakaba; CSIR Manager: e-Government, Matthew Chetty; CSIR Manager: Spatial Planning and Systems, Prof. Pravesh Debba; and CSIR Group Executive: Smart Society, Dr Sandile Malinga.

04 Build and transform human capital and infrastructure

CSIR Entrepreneurship Development Programme empowers South African youth

In 2023, the CSIR, in collaboration with the National Mentorship Movement and the Industrial Development Corporation (IDC), launched the CSIR Entrepreneurship Development Programme.

The programme empowers aspiring entrepreneurs in South Africa, particularly youth from disadvantaged backgrounds in Gauteng, KwaZulu-Natal and the Western Cape.

The programme focuses on nurturing businesses that contribute to local economies through mentorship from experienced members of the CSIR Alumni programme.

Participants receive practical guidance and support to develop essential entrepreneurial skills. Currently, the programme supports 20 entrepreneurs across diverse industries such as agro-processing, technology development, e-commerce, manufacturing and health. The programme equips young entrepreneurs with the necessary tools and guidance to succeed in South Africa's business landscape.

The entrepreneurs are expected to present their business proposals to a panel of experts from the IDC, the National Mentorship Movement and the CSIR in July 2024.

Dr Thulani Dlamini, CSIR Chief Executive Officer.

04 Build and transform human capital and infrastructure

CSIR researchers ascending the career ladder

In 2024, the CSIR welcomed three principal researchers to the second highest ranking on its career ladder, each bringing a wealth of expertise to their respective fields. Dr Namosha Veerasamy, specialising in cybersecurity and cyber terrorism research, joined the ranks alongside Prof. Yolandy Lemmer, whose expertise lies in active drug targeting and diagnostics, as well as Dr Previn Naicker, who focuses on molecular diagnostics.

Their appointments serve as an indication of the organisation's capacity to fulfil its mandate and underscore its commitment to maintaining its status as a leading research institution on the continent.

Attaining these positions requires local and some international recognition with a sustained track record and significant outputs in a specialised research field, coupled with proven impact, both within the research community and in industry and society.

CSIR Chief Executive Officer Dr Thulani Dlamini and CSIR principal researcher Dr Previn Naicker.

CSIR Chief Executive Officer Dr Thulani Dlamini and CSIR principal researcher Prof. Yolandy Lemmer.

CSIR Chief Executive Officer Dr Thulani Dlamini and CSIR principal researcher Dr Namosha Veerasamy.

04 Build and transform human capital and infrastructure

CSIR helps build skills in collaboration with Youth Employment Service

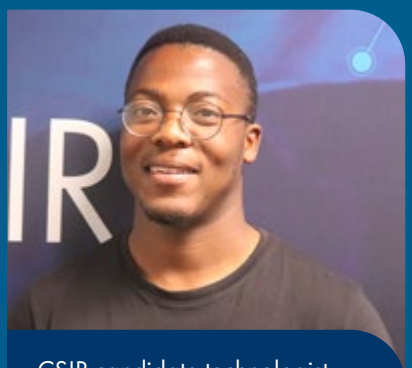
Interning alongside experts is a proven method for transferring knowledge and nurturing young talent in various fields, including science, engineering, finance and communications. In 2023/24, a new cohort of 66 young South Africans, funded by the Youth Employment Service (YES) programme, commenced their internships, bringing the total number of young South Africans supported through the YES programme since its inception to 241.

The CSIR first partnered with the YES programme in 2020 to offer South African youth job opportunities and job readiness skills. From this year's cohort, three interns (pictured below) were absorbed into permanent positions at the CSIR. Additionally, the programme has supported 31 youth living with disabilities.

In addition to the YES programme, the organisation provides internship opportunities to over 150 graduates, funded by the CSIR and in some instances in partnership with other organisations.

CSIR candidate technologist Obey Manganyi.

CSIR technician Talifhani Phalanndwa.



CSIR candidate technologist Taelo Molabe.

Sharing knowledge and expertise through staff exchanges

Staff exchange programmes between the CSIR and its industry partners play a crucial role in fostering best practices, nurturing human capital and driving business advancement.

In 2023/24, 47 staff members from the CSIR and its partners participated in staff exchange initiatives through secondment agreements.

These exchanges included international secondments, such as the European Organization for Nuclear Research hosting a CSIR researcher in high-performance computing and the CSIR hosting staff from the National Commission on Research, Science and Technology in Namibia, focusing on agro- and bioprocessing.

The CSIR also hosted staff from the Tshwane University of Technology to work on cannabis and hemp extraction, the Pan African Information Communication and Technology Association on cybersecurity technologies and Rapid Casting Solution Pty Ltd to focus on metal casting.

04 Build and transform human capital and infrastructure

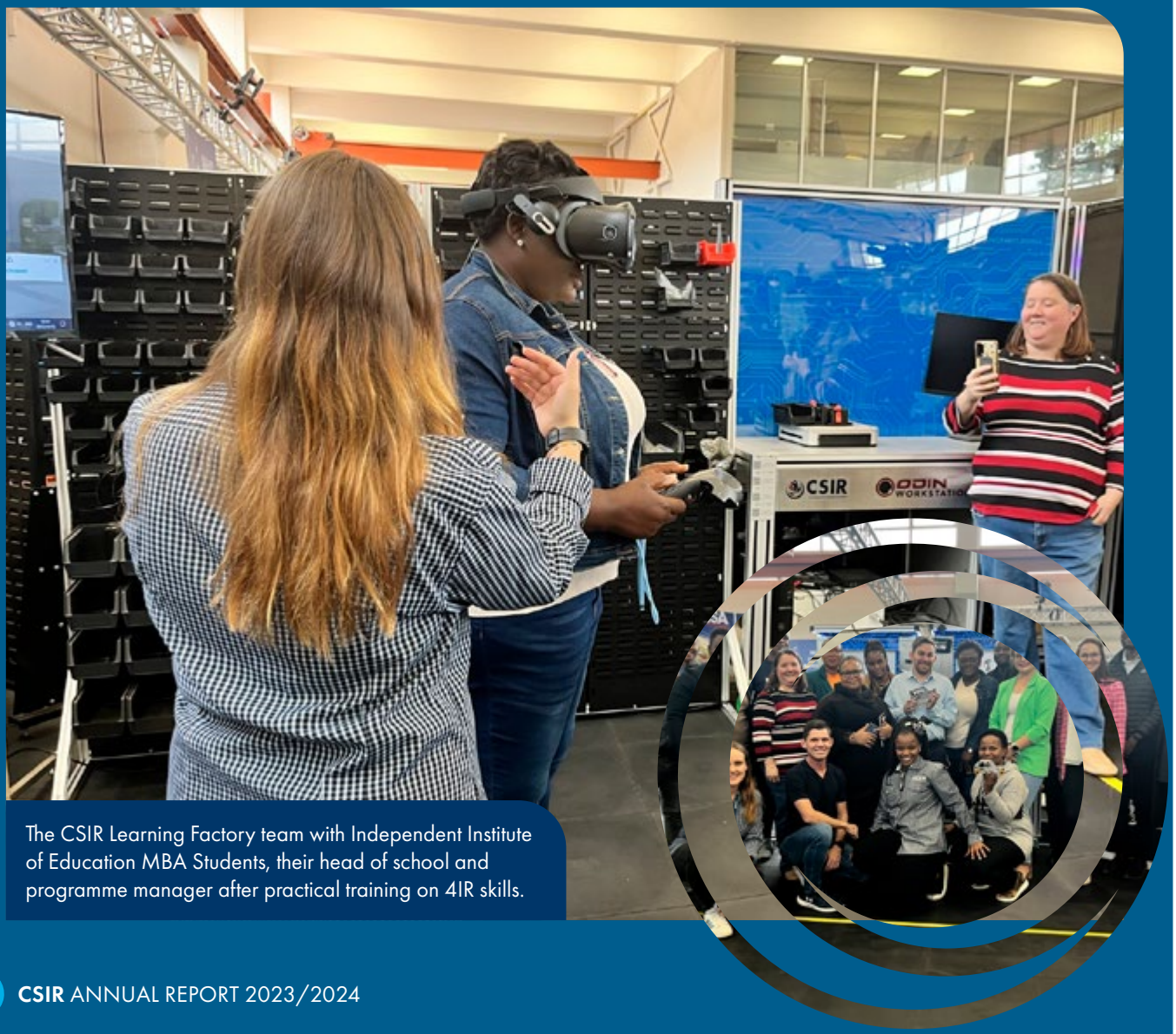
Pilot training session for MBA students at CSIR Learning Factory

The CSIR has partnered with the Independent Institute of Education Proprietary Limited (IIE) to drive industry-focused skills development and innovation support initiatives leveraging the CSIR Learning Factory.

A learning factory emulates a real-world working environment to deliver future-oriented education and training while nurturing innovation. Leveraging transformative technologies underpinned by the fourth industrial revolution (4IR), the CSIR Learning Factory provides diverse skill development opportunities across industries.

The CSIR Learning Factory conducted a pilot training session tailored for Master of Business Administration (MBA) students of the IIE, enabling researchers to gather valuable feedback to expand the scope of the Learning Factory and identify collaborative opportunities for future training courses and educational materials within higher education.

The training blends theoretical knowledge with practical applications, covering topics such as 4IR technologies, three-dimensional printing and blockchain essentials. This equips the MBA students with the requisite knowledge and skills to thrive in the 4IR era.



The CSIR Learning Factory team with Independent Institute of Education MBA Students, their head of school and programme manager after practical training on 4IR skills.

04 Build and transform human capital and infrastructure

Working with South Africa's SETAs to develop skills

The CSIR has received funding for 15 bursaries from the Safety and Security Sector Education and Training Authority (SASSETA). SASSETA has also committed funding for a cybersecurity project aiding 100 small businesses.

The CSIR leverages its strong science, engineering and technology skills base to develop technologies for air, land, sea and cyber defence and security.

South Africa's Sector Education and Training Authorities (SETAs) contribute to the improvement of skills in South Africa.

The CSIR collaborates with various SETAs to support the country's skills development efforts. This collaboration has led to numerous agreements and support for various programmes, including leadership training initiatives, bursaries, internships and support for small businesses.

In addition to the support in the safety and security sector, the CSIR has partnered with the Mining Qualification Authority, Premier's Office of Limpopo and Department of Higher Education and Training to establish a mining academy in Limpopo.

Cyber Excellence Academy produced its first graduates

The Cyber Excellence Academy, a collaborative undertaking to grow expertise in cybersecurity, has produced its first cohort of graduates. The academy aims to nurture the next generation of skilled cybersecurity professionals capable of proactively safeguarding organisations against ever-evolving cyber threats.

The programme was established in 2023 by partners Take Note IT, the Media, Information and Communication Technologies Sector Education and Training Authority, the University of Venda and the CSIR. The academy's commitment to fostering excellence and innovation in cybersecurity education was recognised during the GovTech 2023 conference, where the programme won the "Community Builder Recognition Category" award.

The CSIR's extensive experience and expertise in cybersecurity, coupled with Take Note IT's track record of delivering high-quality information technology solutions, provide participants with an unparalleled learning experience.

As part of the programme, students gained industry experience and were exposed to facilities at the CSIR.

Senior CSIR and TakeNote IT representatives celebrate with students at the graduation ceremony. The collaboration aims to equip the youth with cybersecurity skills for the future.

Building specialised skills for the African vaccine production sector

The CSIR has made a significant contribution to building the competence base in vaccine production in Africa. The organisation conferred certificates of completion to 21 participants of a course in vaccine production technologies as part of the African Biomanufacturing Workforce Training and Skills Development Programme.

The course focused on building competence and transferring skills across all aspects of vaccine production through a curriculum that covers the challenges and solutions for production and scale-up across various expression platforms, including fungal, yeast, bacterial, mammalian and plant systems.

Participants were from academic institutions; small, medium and micro enterprises; industry organisations within vaccine manufacturing and research councils from Botswana, Ethiopia, Kenya, South Africa and Zimbabwe. Over four weeks, participants gained insight into single-use and perfusion systems and acquired hands-on experience in bench-scale cell culture production at the CSIR's facilities in Pretoria.

The African Biomanufacturing Workforce Training and Skills Development Programme is offered to African manufacturers, scientists and other key players in the development and scaling-up of vaccine production processes and active pharmaceutical ingredient. A second intake of trainees will take place in July 2024.

Participants from Botswana, Ethiopia, Kenya, South Africa and Zimbabwe who successfully completed a course in vaccine production technologies, as part of an African Biomanufacturing Workforce Training and Skills Development Programme at the CSIR.

05 Research, development and innovation for Africa

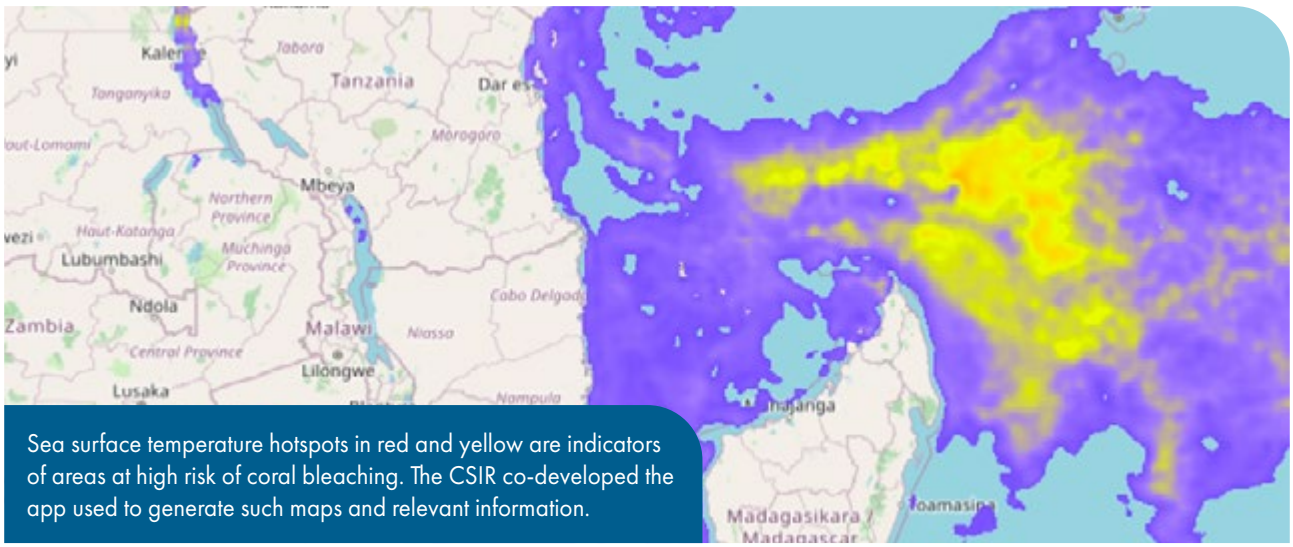
West Indian Island states benefit from CSIR co-developed application to monitor coral bleaching

Occurrences of coral reef bleaching can now be monitored thanks to an application developed by the CSIR and Coastal Oceans Research and Development in the Indian Ocean (CORDIO) East Africa. When corals are stressed by changes in conditions such as temperature, light or nutrients, they expel the symbiotic algae living in their tissues, causing them to turn white. Monitoring these incidents is crucial for conservation management.

The user interface offers an interactive map-based product viewer with clickable pixel information, a selection of graphical virtual stations at key monitoring sites, and in situ bleaching observations from CORDIO East Africa. This service enables area-based assessment and calculations of coral health in East Africa.

The work resulted from the CSIR's collaboration with a number of African countries to improve satellite observations of the ocean and coastal areas as part of the Marine and Coastal Operations for Southern Africa and Indian Ocean territories programme (MarCOSIO). MarCOSIO is funded by a grant from the African Union Commission's Global Monitoring for the Environment and Security programme. The programme partners include Angola, Namibia, Mozambique, Tanzania, Kenya, Mauritius, Madagascar, Comoros, the Seychelles and South Africa.

From left: CSIR Group Executive: Business Excellence and Integration, Dr Kaven Naidoo; CSIR Spatial Information Systems Research Group Leader, Sives Govender; Executive Manager: CSIR NextGen Enterprises and Institutions, Dr Lulama Wakaba; CSIR Group Executive: Smart Society, Dr Sandile Malinga; AUC Space Applications Training and Project Management Unit Officer, Meshack Kinyua; Executive Director of the Southern Africa Science Service Centre for Climate Change and Adaptive Land Management (SASSCAL), Dr Jane Olwoch; CSIR e-Government Impact Area Manager, Matthew Chetty; SASSCAL Director of Science and Technology and Capacity Development, Dr Budzanani Tacheba; and WaterNet Executive Manager and Head of the Secretariat, Prof. Jean Marie Kileshye Onema.



Sea surface temperature hotspots in red and yellow are indicators of areas at high risk of coral bleaching. The CSIR co-developed the app used to generate such maps and relevant information.

Enabling efficient heavy vehicle travelling between South African and Namibia

The CSIR has provided training to the Namibian Road Authority on the CSIR-developed abnormal loads permit systems.

The system is implemented in all nine South African provinces and Namibia. Heavy vehicles transporting goods across South Africa and Namibia must adhere to specific dimensions to protect the road infrastructure and ensure its longevity.

The CSIR developed the abnormal loads system to issue permits for heavy vehicles travelling between South Africa and Namibia. The software underlying the system increases the accuracy of data capture, is more cost-efficient, contributes to environmental sustainability and offers better compliance with regulations by providing an auditable trail of all permit applications and issuances.

The training provided by the CSIR equips users to utilise the system to its full capacity.

Vehicles cannot traverse public roads when exceeding prescribed limitations in dimensions or mass outlined in the Regulations of the National Roads Traffic Act, 1996 (Act 93 of 1996). The abnormal loads permit system requires the registration of abnormal vehicles and considers the mass, dimension, specific load carried and the duration of the trip. The system also checks if the driver needs an official traffic escort. The road authority issues the permit once all approvals have been completed and payments have been processed.

CSIR transport technologists and software developers also worked with the Namibian Roads Authority to compile guidelines aligned with South African and Namibian road rules.

CSIR candidate researcher Thendo Malima, senior technologist Lydia Kwange and candidate researcher Hlulani Nkuna are part of the team behind a CSIR-developed abnormal load permit system.

05 Research, development and innovation for Africa

Growing future African researchers and innovators in photonics and optics

In the past year, over 130 African students benefitted from funding and research support through the African Laser Centre (ALC). The ALC is a virtual centre of excellence, comprising a network of research institutes across Africa.

Membership is open to all African research institutes actively involved in photonics, laser and optics-related domains through research and development, education or training to support researchers and industrialists in these fields. The CSIR Photonics Centre coordinates activities in southern Africa, as leader of the Southern Node of the ALC, and is supported by funding from the Department of Science and Innovation.

Marking its 20th year of existence in 2023, the ALC is a flagship project of the New Partnership for Africa's Development programme.

Each year, four calls are issued to the ALC network and all South African universities for participation in four distinct ALC programmes.

The output of the ALC research collaboration in 2023/24 included 20 research collaboration projects, 75 refereed journal papers and 55 conference proceedings.

Fifty-six researchers from Africa and 84 researchers from South Africa participated in ALC projects. Participating students included 43 studying towards a Master's and 47 studying towards a PhD.

The ALC Scholarship programme supported 12 scholarships at doctoral degree level and four at Master's level.

The CSIR is home to experts and infrastructure in biophotonics, additive manufacturing and laser-based applications such as surface refurbishment, welding and cutting, and other light-based systems. The organisation coordinates activities of the African Laser Centre in southern Africa.

05 Research, development and innovation for Africa

Assisting Zambia to address plastic pollution

The CSIR is assisting Zambia in developing an evidence-based strategy to address plastic pollution. This is an important first step in assisting African countries meet the requirements of the global treaty being developed to reduce plastic pollution.

The treaty is expected to be finalised for implementation in 2025 and country-specific interventions will require careful consideration of the local context in each country.

The CSIR's experience in applying the Pathways modelling framework and software tool to develop an evidence-based strategy for addressing plastic pollution in South Africa has underlined the tool's potential to also assist other countries. Pathways can help develop strategies tailored to local conditions and data to reduce plastic pollution.

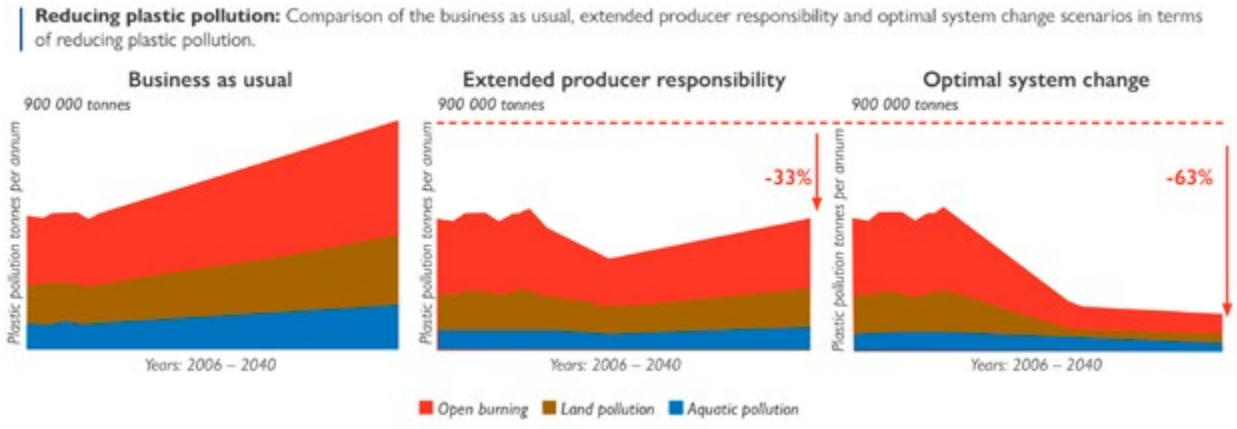
Pathways evolved from the Pew Charitable Trust "Breaking the Plastic Waste" report. It enables the analysis of current and projected plastic material flows and the effects of strategies and policy interventions on reducing plastic pollution. Additionally, it provides an opportunity for multi-objective optimisation. In the South African context, this was guided by the need to reduce plastic pollution and greenhouse gas emissions while ensuring socio-economic development through job creation and infrastructure provision at reasonable costs.

Pathways results clearly indicate that while the current waste management systems in South Africa are not conducive to plastic pollution mitigation, the policy and legislative interventions currently considered will only slow down pollution impacts over time. However, the optimal change scenario developed by the CSIR using Pathways is likely to have long-term positive impacts.

Following successful testing and application of Pathways in South Africa, the Pew Charitable Trusts contracted the CSIR to assist Zambia.

The CSIR is providing training on the use of Pathways and offering thought leadership to develop appropriate scenarios tailored to the Zambian context.

Moreover, the CSIR aims to also assist other African countries in a move to developing a regional strategy to combat plastic pollution.



Reducing plastic pollution: Comparison of the business as usual, extended producer responsibility and optimal system change scenarios in terms of reducing plastic pollution.

South Africa

05 Research, development and innovation for Africa

Bespoke laser diamond sorting system deployed in Botswana

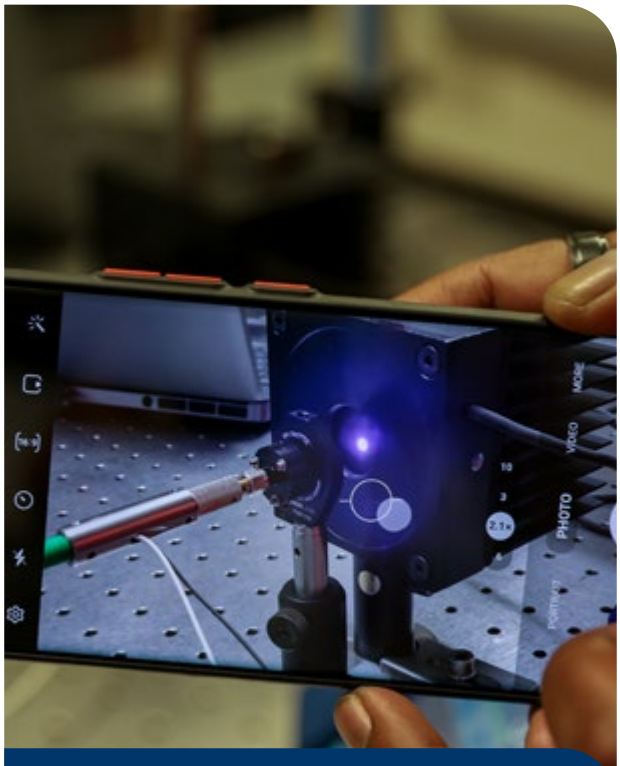
The CSIR, in partnership with De Beers Ignite, has completed a bespoke laser system for implementation in De Beers' diamond sorting operations at a leading mine in Botswana.

The system is wholly South African-designed and produced and marks the first commercial laser product developed by the CSIR's novel lasers team. It utilises Raman spectroscopy to detect molecular structures based on the interaction of light with matter, allowing it to distinguish diamonds from quartz despite their similar molecular signatures.

De Beers approached the CSIR for a solution after existing systems became unreliable and unstable. A compromised sorting process can impact the entire mining process, from blasting to the transportation of raw materials and ultimately to diamond sorting. Due to design constraints and the available infrastructure within the laser, it was not possible to improve the existing system, leading the CSIR to investigate several alternatives.

The laser system was developed as a robust turnkey solution and is the first fully integrated laser system used by De Beers. The system's stability was verified through a 24-hour test, showing only a 0.3% power fluctuation. Technical performance was evaluated in the CSIR's Photonics Prototyping Facility – a laboratory environment used by inventors and entrepreneurs developing laser-based products and systems, such as 3D printers, medical devices and optical detectors.

The prototype has operated for almost two years with stable and reliable performance and represents a milestone in developing next-generation, high-tech systems using fourth industrial revolution capabilities.



The output light of the laser is measured on a power meter during testing of the integrated diamond sorting system.

The system detects diamond particles to distinguish it from quartz.

SECTION C

Performance information

SECTION C

Performance information

This section provides an overview of the organisation's performance against the set objectives and targets for the 2023/24 financial year.

The overview provides a description of any significant developments that may have impacted on the organisation's ability to deliver on its Strategic Plan and Annual Performance Plan.

Auditor's Report: Predetermined objectives

The Auditor-General South Africa currently conducts the necessary audit procedures on performance information to report on the usefulness and reliability of material performance information. This audit conclusion on performance against predetermined objectives is included in the report to management, under the report on the annual performance report section of the Auditor's report.

Refer to page 144 for the Auditor's Report, published in Section G: Annual Financial Statements.

Overview of performance

Service delivery environment

One of the five areas identified by the CSIR to ensure the success of its business model is ensuring greater collaboration with state-owned enterprises (SOEs) and the government in general. The CSIR is a Schedule 3B national government business enterprise with no service delivery mandate. However, the CSIR assesses the organisation's effectiveness by how well it implements projects on behalf of government departments and SOEs in support of a capable state.

In the 2023/24 financial year (FY), the CSIR has implemented more initiatives for government than it has in the past five years. Below are a few illustrative examples of how the CSIR supported the energy, mining, transport and logistics and health sectors, as well as decision support and ensuring efficiencies in information and communications (ICT) systems for national departments.

CSIR supports Eskom with turbine repairs, reducing downtime costs and loadshedding risks

The CSIR has completed a large-scale steam turbine repair project for Eskom, bringing the total to three over the past year – one for Tutuka and two for the Majuba power stations. Previously, entire sets of blades were scrapped by Eskom due to defective blades. Laser-assisted repair technology developed by the CSIR in collaboration with Eskom's Research, Testing and Development (Eskom RT&D) group has made it possible to repair and refurbish blades at a considerably lower cost and with shorter downtime.

The CSIR has long participated in Eskom's turbine blade refurbishment programme, developing technology solutions for rebuilding turbine journals, addressing erosion damage and repairing blade tenons to reduce equipment failure and operational downtime. The technology for this repair project was developed under the CSIR-Eskom bilateral agreement for funding of research and development, where both organisations have invested in developing technology for Eskom-owned steam turbines used in its coal-fired power stations.

The turbine repair project was undertaken under contract from Eskom Rotek Industries, which has extensive manufacturing and refurbishment workshop facilities in Rosherville, Gauteng. This facility manages servicing and repair of large, high-value components (weighing up to 70 tons) used in the Eskom fleet.

The design of turbines presents a challenge due to inclined blades placed in different stages on the turbine shaft, leaving little room between blades to operate repair equipment. A manoeuvrable robotic arm was necessary to position the laser in these tight spots.

The financial benefit of refurbishing versus replacing a turbine is significant, even without factoring in the lost time associated with decommissioning, procurement and installation of replacements. This work can ultimately be done in situ, further reducing the risk associated with moving large rotors from power stations to Eskom Rotek Industries' workshops. The faster turnaround time for repairing blades rather than replacing them also positively impacts efforts to reduce loadshedding.

Laser weld overlay or laser cladding are techniques used to extend the lifespan of high-value components such as bearing journals, gears, drive shafts and turbines. The benefits include less equipment downtime and faster repair times (often performed onsite), lower costs and reduced wastage from replacing parts instead of repairing them. This technology can also increase the performance of existing components when tailored welding processes are used to improve wear or corrosion resistance.

The CSIR has a diverse and specialised portfolio of laser-based technologies to support local industries across sectors such as power generation, manufacturing, defence, mining and transport.

CSIR technology detects a gas leak at Eskom's Electrical Switch Gear Facilities

Electrical switch gear is used by Eskom to switch large voltages and currents on electrical power transmission and distribution lines. Such systems contain insulating gases that require careful management in order to reduce the chance of system failure due to loss of gas at seals, valves and joints. The GasCAM camera has been developed in collaboration with Eskom and the Technology Innovation Agency (TIA) to detect such gas leaks using visual means. The same camera is capable of detecting volatile organic compounds at petrochemical plants

through its ability to swap out the cooled infra-red detector component, something that can be done by a non-expert user.

A significant milestone was reached for GasCAM after it successfully detected a sulphur hexafluoride gas leak at an Eskom switch gear facility in Johannesburg. Agreement has been reached with TIA on the technical completion aspects of the project and a proposal has been prepared for TIA's Pre-commercialisation Fund by the CSIR in collaboration with the GasCAM technology licensee, UViRCO, that will aim to industrialise the remaining technical aspects of the camera ahead of the technology transfer to UViRCO. UViRCO is the leading supplier of Corona/Ultraviolet (UV) discharge detection solutions to the world's power industry.

CSIR supports DFFE to develop, implement and improve Renewable Energy Development Zones

The CSIR has assisted the Department of Forestry, Fisheries and Environment (DFFE) to develop, implement and improve Renewable Energy Development Zones (REDZs) in South Africa for several years. This started with the Phase 1 Wind and Solar Photovoltaic (PV) Strategic Environmental Assessment, which has been expanded on in Phase 2, and during 2023 the CSIR was appointed to initiate Phase 3 which seeks to make further improvements and optimise the effectiveness of the REDZ. The work provides scientifically sound information to provide for streamlined environmental authorisation, while maintaining levels of environmental protection, for renewable energy development in the zones identified.

CSIR establishes a Logistics Observatory for South Africa

The efficiency of a logistics system is integral to every economy. The services which move goods and people should be provided in a safe, efficient and cost-effective manner, and designed to address policy objectives such as promoting economic growth, productivity and competitiveness. Improved efficiency in logistics enables the *economy*, as the cost of logistics affects all sectors (*Roadmap for the freight logistics system in South Africa, 2023*).

The CSIR developed a pilot Logistics Observatory, as forerunner to a comprehensive integrated platform that will serve as an entry point to validated logistics data and information, and in turn allow for the strengthening of decision support for logistics in the country. The first phase of the Logistics Observatory platform is in place, with an online data registry. The next step is to scale the system and develop an appropriate business model, ideally within the context of a public-private partnership to support national level logistics challenges.

Collaborative networks are also being built to support future work. Central to the Observatory's mission is the Logistics Observatory Forum, an initiative to foster collaboration where government officials, industry leaders, and logistics experts converge to explore multiple possibilities for this initiative.

CSIR research shows that Smart Trucks are safer, cost effective and low on carbon emissions

The CSIR delivered an evaluation and status update on the Performance-Based Standards (PBS) Smart Truck Project for heavy vehicles in South Africa to the National Department of Transport. The PBS pilot project is a national research initiative that is exploring the impact of introducing high-productivity road freight vehicles. This initiative is being led by stakeholders including the CSIR, government, industry and academia. These Smart Trucks are designed and regulated according to a PBS framework, which has proven to be highly effective in Australia, New Zealand, Canada and parts of Europe.

The pilot project was initiated in South Africa in 2004 and has since grown to include 1 421 demonstration vehicles in various industries. All vehicles participating in the pilot project are closely monitored for impact and performance. Almost 490 million vehicle km of data have been collected and processed to date, indicating net positive results against a wide range of metrics, including: a 12% reduction in fuel use and emissions, a 12% reduction in road-wear impact, a 40% reduction in road crashes, and 28% fewer truck kms travelled on South African roads. The decision on formal implementation and adoption of PBS in South Africa is pending and to be recommended to the Committee of Transport Officials (COTO) and Ministers and Members of Executive Council (MINMEC).

Road Asset Management System for the Gauteng Province

The CSIR provides comprehensive support on the Road Asset Management System (RAMS) of the Gauteng province. Operational support includes the implementation and support of road asset management systems for roads and road structures as well as support with the visual and automated condition assessments of the road network, bridges and culverts. This is an essential decision support system for assessing the condition of the Gauteng provincial road network and quantifying maintenance needs and budgetary requirements. It allows staff members of the Gauteng Province, political leadership and members of the public to access information regarding the Gauteng provincial road network via the web.

Accessible data encompasses inventory information and condition data for roads, bridges and major culverts, alongside current traffic count statistics and road proclamations. Additionally, a web-based RAMS Geospatial Decision Support System (Viewer) has been developed, allowing public access to view and download data on the provincial road network, including condition and traffic data, as well as information on planned road developments. Moreover, the CSIR has developed a mobile

application (app) for public use, facilitating the reporting of potholes and traffic signal faults. Additionally, a dedicated app aids maintenance teams in reporting daily maintenance activities, ensuring timely resolution of infrastructure issues.

CSIR supports City of Johannesburg to develop secondary public transport network

The CSIR is collaborating with the City of Johannesburg (CoJ) to develop a responsive secondary public transport network in support of the primary network approved by the CoJ in 2001. While the primary network comprises high-capacity corridors and appropriate technologies, the secondary network encompasses lower capacity services spanning an extensive geographical footprint. Designed to meet specific sustainable transport objectives, the secondary network comprises a well-defined network of demand-responsive services. This framework facilitates improved future service contracting, inclusive of minibus taxis and buses, in line with the National Land Transport Act. By refining the definition of primary and secondary networks, the CoJ aims to advance its readiness to assume the role of a fully-fledged contracting authority. This strategic shift ensures heightened accountability of local government delivering quality public transport services.

CSIR involved in several projects for Transnet National Ports Authority

The Integrated Port Operation Support System (IPOSS) is a sophisticated decision support system that provides real-time wind, wave, tide and ocean currents data, alongside forecast data, to port operators across the eight national ports. Developed by the CSIR, this system is indispensable for operational decision-making related to berthing and sailing, while its archived data hold significant value for port design and modifications. IPOSS plays a huge role in cargo management across all eight national ports by furnishing them with National Centres for Environmental Predication forecast data together with real-time environmental information. This integration enables ports to verify forecast information and plan with confidence.

Moreover, the system integrates applications that provide insights into long waves affecting vessel motions and under keel clearance. Port operators make use of these applications to optimise vessel loading and berthing, ensuring safety and efficiency of vessels and cargo.

Originating from the deployment of a single Waverider™ wave recording buoy at the Slangkop station, IPOSS has evolved into a real-time decision support system supplied under contract to Transnet National Ports Authority.

Environmental data from sensors strategically installed within the ports are transmitted to a central server at the CSIR Stellenbosch campus via a Global System for Mobile Communication and radio network links. These data are prominently displayed at port control centres, where operators rely on them daily for safe and efficient port operations. The same data is also available to ports through dedicated internet sites with the CSIR team at the Stellenbosch campus ensuring system availability 24/7.

Information system downtime diagnostics and remedial action support to the Department of Home Affairs

The Department of Home Affairs (DHA) and the CSIR have a long history of engagement and have successfully worked together on several projects to date. To provide a framework for a long-term relationship between the DHA and the CSIR, a Memorandum of Understanding (MoU) was concluded on 6 February 2023. At the beginning of 2023, the parties engaged on issues contributing to DHA's service disruption. To this end, a project aimed at undertaking a diagnostic assessment of the DHA's Information and Communication Technology (ICT) system, developing a solution concept, and piloting some solutions at selected sites, was conceptualised and initiated.

The DHA required the support of the CSIR to stabilise and improve its ICT infrastructure (network connectivity, hardware and software) to address the service disruption challenges it is experiencing. The CSIR proposed an end-to-end diagnostic study to identify and understand the issues affecting its ICT service disruption. The project included six workstreams. Three of the six workstreams (people, cybersecurity, governance) completed their planned tasks by the end of 2023/24, while the remaining three workstreams on networks, applications and the enterprise architecture are continuing in the 2024/25 FY.

The team was also able to observe and report on cybersecurity threats on the DHA network, in real-time. The enterprise architecture workstream developed a custom enterprise architecture model which integrated the current governance information from the DHA. The responsible departmental staff were upskilled, and the model was transferred for continuous maintenance.

The networks workstream selected a representative sample of branch offices for the deployment of monitoring devices in order to provide insights into possible factors contributing to system downtime. This workstream also made significant progress in deploying an alternative network connection between a subset of the selected sites in order to monitor improvement over a network featuring larger bandwidth and higher stability. A changeover of these sites onto the alternative network commenced in April 2024 with positive results and monitoring is ongoing.

The applications workstream implemented monitoring systems for priority applications in collaboration with various third party service providers. By the end of March 2024, this exercise indicated several issues contributing to slow response times which are being systematically addressed.

Work in support of the DHA is continuing in the 2024/25 FY to address priority areas of concern.

CSIR contributed to the development of National Data and Cloud Policy

The CSIR was invited to comment on the National Data and Cloud draft policy in 2021 and several inputs were made, including a recommendation that other entities such as **the dtic** and DSI should be involved in the formulation of the overarching regulatory frameworks for data. The DSI's focus is on research data, the the Department of Trade, Industry and Competition (**the dtic** focus) would be on the commercial value of data.

On 27 March 2024, cabinet approved the publication of the National Data and Cloud Policy and its publication in the Government Gazette in line with the Electronic Communications Act, 2005 (Act 36 of 2005). The policy seeks to strengthen the capacity of the State to deliver services to its citizens and to ensure information is readily available for citizen empowerment. This policy seeks to enable South Africans to realise the socioeconomic value of data through the alignment of existing policies, legislation and regulations.

Once implemented, the policy will promote connectivity and access to data and cloud services, remove regulatory barriers and enable competition and development of SMMEs.

Urban Knowledge Exchange Southern Africa

The Urban Knowledge Exchange Southern Africa (uKESA) online repository is a free-to-access open-source content management system that the CSIR has developed and managed since 2019. It has been designed to enable the sharing of reliable urban knowledge to improve practice and innovation for the delivery and maintenance of more sustainable human settlements in South Africa. With over 10 000 users annually, it makes available a variety of curated content quickly and easily to state and non-state actors to improve the application of best practice, technologies and design support tools. The initiative builds trust between the state, the private sector, and civil society by fostering the sharing of content and engagement around the content.

Over the last three months, it successfully assisted the national Department of Human Settlements in calling for and securing public comment on their new white paper policy. In addition to many active knowledge partners from academia, civil society, professional bodies, think tanks and the construction and property sectors, there is direct participation on the uKESA Advisory Committee of the South African Local Government Association (SALGA), SA Cities Network, the Housing Development Agency, the Gauteng City-Region Observatory, the CoJ's Department of Human Settlement, the eThekwini Municipal Institute of Learning, the Western Cape Economic Development Partnership, the National Treasury's City Support Programme, the Department of Human Settlements and the DSI. The DSI funded the platform, since 2016. The CSIR is currently expanding the funding base and exploring ways to commercialise some aspects of the initiative. The uKESA platform with its large user base and content collection, strengthens the ability of the CSIR to act as a knowledge broker and helps to effectively build a capable state.

CSIR supports KZN provincial disaster management

The CSIR conducted a technical provincial work session in Pietermaritzburg, with the KwaZulu-Natal (KZN) Disaster Management group on the implementation of CMORE as a solution to manage future disaster scenarios.

The work session was conducted at the Provincial Disaster Management Centre (PDMC) headquarters of the KZN province. A contract was awarded to implement a pilot implementation in the province, which will strategically position the CSIR for future expansion of the CMORE capability in the province.

CMORE is an innovative situational awareness and decision support technology platform developed by the CSIR. A whole-of-government or whole-of-society solution requires coordination and a common understanding between agencies to provide a sustainable effort towards the solution. This approach requires significant capabilities from an information technology perspective. Information management is a key element of a complete solution and includes the capability to secure sensitive information, as well as the ability to securely share information that supports collaboration and cooperation between separate agencies. During a disaster, information management for decision support is critical for an integrated resolution.

CSIR team provides support to local government and municipalities during cholera outbreak

The CSIR supported local government and municipalities with analytical support during a cholera outbreak in Hammanskraal. It conducted a basic condition monitoring of the infrastructure at Temba Water Treatment Works where there was a cholera outbreak. The water sector uses the CSIR's cholera testing capabilities, with the laboratory testing water samples daily.

Nationwide extension of the Digital Fingerprint System to identify unclaimed cadavers

A CSIR-developed digital fingerprint system was delivered to the Limpopo province as part of the nation-wide pilot to aid in the identification of unclaimed cadavers. The system was initially developed by the CSIR in collaboration with the Gauteng Department of Health and the Forensic Pathology Services (FPS). Biometrics sensors are used to acquire fingerprints of cadavers and digitally queries different databases to determine the identity of the unclaimed or unidentified cadaver.

The system was piloted in July 2023 at three FPS facilities in the Gauteng Province; Bronkhorstspruit – the facility with which the CSIR developed the system, Pretoria and Germiston.

The system interfaces with databases administered by different government entities using their official interfaces. The local criminal records centre of the South African Police Service (SAPS) uses the SAPS Form 91A to query fingerprints. Traditionally, forensic pathology services personnel used inkpads to deposit fingerprints on the form and courier them to the SAPS. The CSIR and the FPS have digitised the form, provided for integration with multiple fingerprint sensors and tied in the credentials of the official making a query. The functionality to query the Department of Home Affairs has also been demonstrated.

The system will alleviate pressure from the resource-constrained forensic mortuaries with some having up to a thousand unclaimed and unidentified bodies.

Organisational environment

The following context paints a current picture of the internal environment at the CSIR:

Budget constraints

The CSIR received a baseline Parliamentary Grant (PG) allocation from the DSI, in line with Vote 35 on Science and Innovation of the Estimates of National Expenditure presented to Parliament by the Minister of Finance during the Budget Speech. The DSI received communication from National Treasury (NT) regarding the 2023/24 Adjusted Estimates of National Expenditure (AENE), indicating budget cuts to the CSIR. This resulted in a reduction of R103.59 million (R90.08 million excluding VAT) in the 2023/24 CSIR PG allocation to the CSIR comprising:

- A reduction in baseline PG allocation of R34.69 million including VAT (R30.16 million excluding VAT); and
- A reduction in the ring-fenced allocation related to the Infrastructure Programme of R68.9 million including VAT (R59.92 million excluding VAT).

The baseline PG for 2023/24 decreased by 4% (originally a 0.4% increase) in comparison to the 2022/23 allocation, which represents an even larger decrease in real terms against inflation and the numerous budget cuts that were effected by DSI/NT over the past few years.

The ongoing decline in PG remains a concern since the execution of our developmental mandate through maintenance of essential capabilities should always be adequately supported. It is of vital importance that the State continues to fund the R&D space and not see it as an expense, but rather as an investment into the future. Many successful countries have achieved their success through their continued investment in R&D.

Ageing infrastructure

An ageing infrastructure base, compounded by lack of capital investment, especially with the current constraints in the fiscus, could derail the organisation's ability to create the desired impact in the long term. Current Infrastructure is prone to failure, downtime and costly maintenance. Low investment will result in obsolescence and a non-competitive real estate offering.

Security of energy supply

Increased load shedding may increase the risk of supply losses to nation-wide sites. The organisation is developing a long-term strategy to ensure sustainable operations.

Scarce and critical skills

Competition for experienced scientists and engineers remains a challenge to building competitive capabilities in strategic areas of the organisation. The CSIR continues to drive efforts to attract/retain skills in high demand sectors like ICT, aerospace and defence as well as transport and logistics.

Cost of digital transformation

There is a lack of resources to drive digital transformation to enhance the agility and efficiency of the organisation.

Security

The CSIR is implementing mitigation strategies to combat asset theft and to comply with the Protection of Critical Infrastructure Act.

Health capabilities at risk

There is limited funding available to support capabilities for localisation of vaccines and biological therapies. Health capabilities are now administered under the care of the CSIR Future Production: Chemicals and CSIR Advanced Agriculture and Food clusters.

Review of CSIR Future Production: Manufacturing cluster and Energy and Water Research Centres

Offerings, capabilities and business models of these areas are under review to enhance relevance and sustainability.

Appointments in leadership positions

The previous CSIR Chief Financial Officer (CFO) resigned, and a new CFO was appointed during the 2023/24 FY.

Several other leadership positions were filled during the 2023/24 FY, including the Chief Information Officer, Executive Cluster Managers (ECM) for CSIR Advanced Agriculture and Food, CSIR Future Production: Chemicals, CSIR Future Production: Manufacturing and a Research Centre Manager for CSIR Centre for Robotics and Future Production.

Key policy developments and legislative changes

Instruction Note 4 of 2022/23, which seeks to align SOEs financial reporting with international financial norms, came into effect on 3 January 2023. The move was aimed at ensuring that entities maintain high standards of transparency and accountability in their financial reporting and reporting irregular expenditure to the National Treasury.

The National Treasury issued guidelines on cost containment, focusing particularly on recruitment and travel expenditure within SOEs. These measures are part of broader efforts to stabilise the public service wage bill and bring fiscal frameworks to sustainable levels. The guidelines specified control measures on recruitment processes and detailed rules governing travel arrangements, emphasising the use of virtual platforms where possible and minimising unnecessary expenditure.

The CSIR has actively participated in providing commentary and assessing the impact which the Public Procurement Bill will bring, if enacted, on its operations. The Critical Infrastructure Protection Act, which provides a framework for the protection of vital assets which are crucial for the functioning of SOEs, was enacted. The CSIR will be impacted from the perspective of infrastructure that is in place at the Pretoria Campus and is critical to some parts of the organisation's operations.

Progress towards achievement of institutional impacts and outcomes

Five years of focus on industrial development

The CSIR Strategy was launched in the 2019/20 FY to amplify the "I" in CSIR through research, development and innovation (RD&I) activities that support re-industrialisation and to introduce a business model that enables increased relevance of the CSIR's product and service provision to the private sector.

The intention of the strategy speaks to growth, sustainability, impact and relevance. Guided by this intention and the organisation's strategic objective, we have a set of Key Performance Indicators to direct and guide the organisation's actions and decisions. Looking at CSIR performance in the past FY and over the past five years, we are very pleased with how far the organisation has come with the implementation of the strategy.

a) Deepening partnerships with industry

This meant forging closer proximity with private sector partners. In 2023/24, there was a 211% increase in the number of technologies localised for the organisation's industry partners compared to 2019/20, an 82.6% increase in the number of joint technology development activities with industry partners, and a 46% increase in the number of SMMEs.

Staff exchange programmes with industry partners have increased by 327% in 2023/24 compared to where the organisation was in 2019/20.

b) Creating a balanced innovation portfolio

The organisation needed to shift its innovation portfolio towards technology development and technology transfer activities to balance basic research activities. This meant more focus on the later stages of the innovation cycle (higher technology readiness levels (TRLs)).

In 2023/24, the organisation realised a 108% increase in technology demonstrators compared to 2019/20. In terms of TRLs, the CSIR realised a 129% increase in technologies at TRL 6 in 2023/24 compared to 2019/20, a 20% increase in technologies at TRL 7-9. This shows a movement in the direction intended by the strategy.

c) Deepening partnerships with higher education institutions

Even though there are no specific KPIs for partnership with Higher Education Institutions (HEIs); the CSIR continues to invest in the development of strategic relationships with HEIs and to create a pipeline of human capital in partnership with HEIs.

The CSIR currently has 15 relationships with South African universities that are at various stages of development, where there are agreements (MoUs) either signed (Sefako Makgatho Health Sciences University, Nelson Mandela University, Stellenbosch University, Tshwane University of Technology, University of Johannesburg, University of Limpopo, University of Venda, Durban University of Technology) or are in advanced stages of being negotiated for signature (Mangosuthu University of Technology,

University of the Witwatersrand), or engagements have been initiated with a view to concluding agreements (North-West University, Cape Peninsula University of Technology, Sol Plaatjie University, University of Cape Town, University of Zululand).

A few examples of these relationships are in the following areas:

- The Mandela Mining Precinct (MMP) and the CSIR collaborate with the University of the Witwatersrand on mining-related initiatives. The CSIR has partnered with Sefako Makgatho Health Sciences University (SMU) on human capital development and is exploring opportunities to host visiting postgraduate students on a regular basis. The CSIR is collaborating with the University of Pretoria (UP) through the establishment of a Research Chair in Smart Mobility.
- The CSIR co-hosts the AUDA-NEPAD Centre of Excellence in Science, Technology, and Innovation together with the University of Stellenbosch. The centre was established to serve as a platform for upscaling tested and proven innovations across Africa to respond to the continent's most pressing challenges and needs.
- The CSIR and Nelson Mandela University (NMU) have an active MoU and currently there are discussions with uYilo eMobility Programme to partner with the CSIR. uYilo was established in 2013 as an initiative of the Technology Innovation Agency to enable, facilitate and mobilise electric mobility in South Africa.
- The Centre for High Performance Computing (CHPC) provides resources to universities, science councils and to some extent, industries. The universities use around 72% of the computational resources and this comes from a spectrum of science and engineering domains and all the universities around the country. CHPC provides the infrastructure for researchers and assistance on the domain-specific expertise for researchers who require assistance on their simulations and modelling.

The CSIR is actively engaging the Ministerial Task Team, which has been appointed to lay the groundwork for the establishment of two new universities, namely the University of Science and Innovation in Ekurhuleni, and the University of Policing and Crime Detection in Hammanskraal.

In 2023/24, the number of Science, Engineering and Technology (SET) staff with PhDs was almost 3% lower than it was in 2019/20; the number of publication equivalents allocated to the CSIR has also dropped by 11%. There may be an opportunity to leverage the organisation's relationships with universities to deliver on these areas of performance.

d) Collaborating with state-owned enterprises (SOEs) and government

In supporting the development of a capable state, the CSIR has performed exceptionally well.

In 2023/24, the organisation realised a 12.5% increase in the number of reports that support policy development compared to 2019/20, a 110% increase in the number of standards developed for the state, and a 175% increase in the number of projects implemented on behalf of government departments and SOEs. These results show that the performance is in line with strategy intentions.

e) Increasing the focus on innovation and commercialisation

In 2023/24, the CSIR realised a 160% increase in the number of technology licence agreements signed with industry partners compared to 2019/20, but the number of patents granted decreased by 24%.

The CSIR has officially launched its commercialisation enterprise, named CSIR C^3 (pronounced as CSIR C-Cubed), to accelerate the pace and increase the scale of the commercialisation of its technologies and Intellectual Property (IP). CSIR C^3, a company fully owned by the CSIR, will have a dedicated capacity to drive all aspects of technology commercialisation, providing adequate financial resources along the technology de-risking process through to commercialisation.

The standalone enterprise will hold all CSIR IP and act as an incubator for start-up enterprises underpinned by strong technical and non-financial support. It will enable the commercialisation of CSIR IP through the development of a network of investors and entrepreneurs. The CSIR aims to accelerate the pace and expand the scope of commercialising the intellectual property assets generated by the organisation.

Several other elements of strategy implementation that are captured in the KPIs speak to the transformation of SET staff, investment in Property, Plant and Equipment (PPE), income diversification and good governance.

f) Transformation of SET staff

In 2023/24, the total number of SET staff was 17.4% higher than it was in 2019/20; the percentage of SET staff who are black was 8.6% higher, and the percentage of SET staff who are female was 4% higher.

In 2023/24, the number of chief researchers was 45% higher than it was in 2019/20; the percentage of chief

researchers who are black was 6.8% higher, and the percentage of chief researchers who are female was 1% higher at this level.

In 2023/24, the number of principal researchers was 31% higher than it was in 2019/20; the percentage of principal researchers who are black was 12.8% higher, and the percentage of females was 5.9% higher.

g) Infrastructure investment

In 2023/24, the amount of money invested in PPE was 207% higher than it was in 2019/20.

h) Income diversification

Total revenue has increased by 15.74% since 2019/20, despite a 5.77% reduction in the organisation's PG in nominal terms. Private sector income increased by 28.43% since 2019/20, and income from international sources as a percentage of total income has doubled over the period. The organisation's public sector income has increased by 10.52% over this period.

i) Good governance

The organisation's Broad-Based Black Economic Empowerment (B-BBEE) score was at a level 4 in 2019/20, and by 2020/21, it improved to a level 1 and has been maintained at that level since.

The organisation's safety record was at 1.82, which is a recordable incident rate, and now it is at 0.09 and has been decreasing over the period.

The CSIR has maintained an unqualified audit record for the past 14 years.

The strategic intent of the new CSIR Strategy can be summarised as growth, sustainability, impact and relevance. These four pillars bring alignment between responding to the organisation's mandate and addressing internal organisational imperatives.

Growth: The results demonstrate growth in all areas of performance, except for the number of patents granted and SET staff with PhDs and publications. There is a growing need in the organisation for engineering capabilities in order to support industry partners effectively with technology solutions and translation of research outcomes.

Publication equivalents are mainly generated through PG support from Parliament, and this grant has decreased in nominal terms in recent years, due to several budget cuts since the Covid-19 pandemic.

The granting of patents is a process that is outside of the organisation's control as it depends on prosecuting times in the various examining jurisdictions around the world. However, it is noted that one needs a healthy pipeline of priority patents applications in order to maintain sustainable performance in this area, as it can take up to 10 years from the time of filing, in some instances, to be granted a patent. Equally true, is the need to ensure that the CSIR monetises its patent portfolio.

Relevance: The good performance in the area of supporting a capable state means that the government trusts the CSIR as the go-to partner for the development of solutions for the state. Most of the CSIR's contract research and development income comes from the public sector. In addition, the outstanding performance in the areas of technology localisation, SMME support and joint technology development projects with industry partners demonstrates the organisation's relevance to both industry and government.

Impact: A steady growth in the number of technology licence agreements with the private sector has been noted. The establishment of CSIR C^3 is a critical enabler for the organisation to deliver in this area.

Sustainability: The outstanding performance in the areas of technology localisation, SMME support and joint technology development projects with industry partners indicates that the organisation has developed technologies for and with industry partners to increase their sustainability. Further, the CSIR has managed to sustain a steady growth in income as total revenue has surpassed the R3 billion mark for the first time in history.

Institutional programme performance information

The CSIR Strategy translates to clearly defined Strategic Objective (SOs):

SO 1: Conduct research, development and innovation of transformative technologies and accelerate their diffusion

This SO seeks to ensure that the CSIR undertakes cutting-edge research and development and delivers innovation in areas that will bring transformative change in the South African economy and society.

SO 2: Improve the competitiveness of high-impact industries to support South Africa's re-industrialisation by collaboratively developing, localising, and implementing technology

This SO seeks to improve the competitiveness of South Africa's high-impact industries through research, development, technology localisation and industrialisation in a collaborative manner with partners, thereby contributing to the re-industrialisation of the country.

SO 3: Drive socioeconomic transformation through research, development and innovation that supports the development of a capable state

This SO emphasises the CSIR's role in supporting the development of a capable state and enabling the government to drive the socioeconomic transformation of South Africa through RD&I.

SO 4: Build and transform human capital and infrastructure

This SO seeks to build and transform the required human capital and invest in infrastructure to drive industrialisation and the advancement of society.

SO 5: Diversify income and maintain financial sustainability and good governance

This SO seeks to improve the CSIR's financial sustainability by diversifying revenue sources and optimising the business model to achieve competitiveness supported by good (efficient and sound) governance.

SO 1: Conduct research, development and innovation of transformative technologies and accelerate their diffusion

The CSIR exceeded performance in two (2) KPIs under this SO (see table 1).

In the 2023/24 FY, the CSIR exceeded the target for patents granted and technology demonstrators by 100% and 43% respectively.

The CSIR only reached 63% of the target for new priority patents filed, 72% of the target for new licence agreements signed, and 96% of the target for publication equivalents. The achievement for publication equivalents was within the set threshold of 95%.

Table 1: KPIs that measure knowledge generation, IP protection, prototype development and licencing of technologies

SO 1: Conduct research, development and innovation of transformative technologies and accelerate their diffusion

Output Indicator	Audited Actual Performance 2021/2022	Audited Actual Performance 2022/2023	Planned Annual Target 2023/2024 until date of re-tabling	Revised Annual Target 2023/2024	Actual Achievement 2023/2024	Deviation from Revised Target to Actual Achievement 2023/2024	Reasons for deviations	Reasons for revisions to the Outputs/ Output indicators/ Annual Targets
KPI 01: Publication equivalents	422.5	398	408	408	390	-18	Performance within acceptable threshold	N/A
KPI 02: New priority patent applications filed	7	8	8	8	5	-3	Limited pipeline	N/A
KPI 03: New patents granted	16	19	8	8	16	+8	Target exceeded	N/A
KPI 04: New technology demonstrators	55	62	56	54	77	+23	Target exceeded	4% reduction in PG
KPI 05: Number of technology licence agreements signed	12	10	28	18	13	-5	Process of signing technology licence agreements takes long	4% reduction in PG

Tables 2, 3, and 4 indicate a list of new priority patents, patents granted, and technology licence agreements signed during the 2023/24 FY. For the patent KPIs, the tables indicate the countries in which the patents were filed and granted. For the licencing KPI, the table indicates the technology being licensed and the company/entity to which the licence has been assigned.

Table 2: List of new priority patents filed in 2023/24

No	Patent title	Application number	Filing date	Country
1	Bacteriophage T7 Endonuclease I	2023/11262	7 December 23	South Africa
2	BP59	2318968.1	12 December 23	United Kingdom
3	Method and system of analysing biological material	2036648	22 December 23	The Netherlands
4	A method and system for performing port scan detection in a network	2037243	13 March 24	The Netherlands
5	Microfluidic liquid dispensing system	2024/02447	27 March 24	South Africa

Table 3: New patents granted in 2023/24

No	Patent title	Application number	Filing date	Country
1	Plant-produced chimaeric orbivirus viral-like particles (VLPs)	AP 6697	16 March 23	African Regional Intellectual Property Organisation
2	Build platform guidance device for additive manufacturing apparatus	7 280 004	15 May 23	Japan
3	Recycling of multi-layered packaging materials	ZL 201980088159.4	28 April 23	China
4	Cathode material	11 621 416	4 April 23	United States of America (USA)
5	Microwave egg pasteurisation method and apparatus	2018102251	31 May 23	Australia
6	Thermo optical control of focus position of an energy beam in an additive manufacturing apparatus	3814040	12 July 23	European Patent Office
7	Dual active cathode material for lithium ion battery	7295837	13 June 23	Japan
8	Electronically deriving a conclusion of the condition of slurry flow in a non-vertical conduit	2 961 646	5 September 23	Canada
9	A method and system for analysing a biological sample of label-free cells for presence of an infective agent	448203	29 August 23	India
10	A gas detection system and method	ZL 201880065933.5	25 July 23	China
11	A cathode material	ZL201880077211.1	5 January 24	China
12	A gas detection system and method	10-2596253	26 October 23	Korea

Table 3: New patents granted in 2023/24 (continued)

No	Patent title	Application number	Filing date	Country
13	Gas detection system and method	11,927,529	12 March 24	USA
14	Thermo optical control of focus position of an energy beam in an additive manufacturing apparatus	ES2960786	6 March 24	Spain
15	Dual active cathode material	10-2645751	5 March 24	Korea
16	A field effect transistor and a gas detector including a plurality of field effect transistors	468377	10 November 23	India

Table 4: Technology licence agreements signed in 2023/24

No.	Licensee	Technology	Date signed
1	Kiara Health (Pty) Ltd and Innocom Global (Pty) Ltd	Breath analyser	24 May 23
2	Producer Responsibility Organisation Alliance (Pro Alliance)	South Africa Waste Pickers Registration System	9 October 23
3	Tokabio	Foot and Mouth Disease point-of-care diagnostics	27 March 24
4	Puris Natural Aroma Chemicals (Pty) Ltd	Orris root butter	28 March 24
5	Linuset (Pty) Ltd	Formulation and production of racemic phenibut	28 March 24
6	Matongoni (Pty) Ltd	Polyamide polymer nanocomposite	6 February 24
7	Matongoni (Pty) Ltd	Method of production of maleic anhydride grafted polyolefins	7 February 24
8	Aweru Holdings (Pty) Ltd	Veristic-Print	28 March 24
9	AutonoSky (Pty) Ltd	K-line Unmanned Aerial Vehicle payload	28 March 24
10	IOIIOO (Pty) Ltd	Veristic-Print	28 March 24
11	The Matlala Group	A method of switching from a first encoded video stream to a second encoded video stream	28 March 24
12	Datron	WinNuwei	28 March 24
13	Guduza System Technologies (Pty) Ltd	Goafwarn	28 March 24

SO 2: Improve the competitiveness of high-impact industries to support South Africa's re-industrialisation by collaboratively developing, localising and implementing technology

The CSIR exceeded performance in all the KPIs under this SO (see table 5).

In the 2023/24 FY, the CSIR exceeded the targets for new technologies localised, joint technology developments with industry partners and SMMEs supported by 100%, 45% and 98%, respectively.

Table 5: KPIs that measure CSIR support to re-industrialisation

SO 2: Improve the competitiveness of high-impact industries to support South Africa's re-industrialisation by collaboratively developing, localising and implementing technology

Output Indicator	Audited Actual Performance 2021/2022	Audited Actual Performance 2022/2023	Planned Annual Target 2023/2024 until date of re-tabling	Revised Annual Target 2023/2024	Actual Achievement 2023/2024	Deviation from Revised target to Actual Achievement 2023/2024	Reasons for deviations	Reasons for revisions to the Outputs/ Output indicators/ Annual Targets
KPI 06: Number of localised technologies	14	16	15	14	28	+14	Target exceeded	4% reduction in PG
KPI 07: Number of joint technology development agreements being implemented for industry	25	37	30	29	42	+13	Target exceeded	4% reduction in PG
KPI 08: Number of SMMEs supported	99	116	90	86	170	+84	Target exceeded	4% reduction in PG

SO 3: Drive socioeconomic transformation through research, development and innovation that supports the development of a capable state

The CSIR exceeded performance in all the KPIs under this SO (see table 6).

In the 2023/24 FY, the CSIR exceeded the targets for reports contributing to national policy, standards delivered or contributed, and projects implemented to increase the capability of the state, by 28%, 133% and 206%, respectively.

Table 6: KPIs that measure CSIR support to government and SOEs

SO 3: Drive socioeconomic transformation through research, development and innovation that supports the development of a capable state

Output Indicator	Audited Actual Performance 2021/2022	Audited Actual Performance 2022/2023	Planned Annual Target 2023/2024 until date of re-tabling	Revised Annual Target 2023/2024	Actual Achievement 2023/2024	Deviation from Revised target to Actual Achievement 2023/2024	Reasons for deviations	Reasons for revisions to the Outputs/ Output indicators/ Annual Targets
KPI 09: Number of reports contributing to national policy development	22	14	22	21	27	+6	Target exceeded	4% reduction in PG
KPI 10: Number of standards delivered or contributed in support of the state	8	14	9	9	21	+12	Target exceeded	N/A
KPI 11: Number of projects implemented to increase the capability of the state	86	130	60	60	184	+124	Target exceeded	N/A

SO 4: Build and transform human capital and infrastructure

The CSIR exceeded performance in 10 of the KPIs under this SO (see table 7).

Table 7: KPIs that measure transformation of SET staff and investment in research infrastructure

SO 4: Build and transform human capital and infrastructure								
Output Indicator	**Audited Actual Performance 2021/2022**	**Audited Actual Performance 2022/2023**	**Planned Annual Target 2023/2024 until date of re-tabling**	**Revised Annual Target 2023/2024**	**Actual Achievement 2023/2024**	**Deviation from Revised target to Actual Achievement 2023/2024**	**Reasons for deviations**	**Reasons for revisions to the Outputs/ Output indicators/ Annual Targets**
KPI 12: Total SET Staff	1551	1555	1598	1598	1605	+7	Target exceeded	N/A
KPI 13: Percentage of SET staff who are Black	67.8%	70%	67%	67%	72%	+5%	Target exceeded	N/A
KPI 14: Percentage of SET staff who are female	39.1%	39%	38%	38%	39%	+1%	Target exceeded	N/A
KPI 15: Percentage of SET staff with PhDs	20.5%	20%	21%	21%	19%	-2%	PhD employees disengage-ments ex-ceeded the number of appointments for the FY, resulting in a –11 net appointments vs disengage-ments	N/A
KPI 16: Total Chief Researchers	15	15	16	16	16	0	Target achieved	N/A
KPI 17: Percentage of Chief Researchers who are Black	13.3%	27%	19%	19%	25%	+6%	Target exceeded	N/A

SO 4: Build and transform human capital and infrastructure (continued)

Output Indicator	Audited Actual Performance 2021/2022	Audited Actual Performance 2022/2023	Planned Annual Target 2023/2024 until date of re-tabling	Revised Annual Target 2023/2024	Actual Achievement 2023/2024	Deviation from Revised target to Actual Achievement 2023/2024	Reasons for deviations	Reasons for revisions to the Outputs/ Output indicators/ Annual Targets
KPI 18: Percentage of Chief Researchers who are female	13.3%	20%	13%	13%	19%	+6%	Target exceeded	N/A
KPI 19: Total Principal Researchers	188	195	189	189	195	+6	Target exceeded	N/A
KPI 20: Percentage of Principal Researchers who are Black	34%	38%	35%	35%	41%	+6%	Target exceeded	N/A
KPI 21: Percentage of Principal Researchers who are female	19%	21%	20%	20%	22%	+2%	Target exceeded	N/A
KPI 22: Number of staff involved in exchange programmes with industry	31	42	31	31	47	+16	Target exceeded	N/A
KPI 23: PPE investment (Rm)	104	161.30	148	148	263	+115	Target exceeded	N/A

SO 5: Diversify income, maintain financial sustainability and good governance

The CSIR exceeded performance in five (5) of the KPIs under this SO – total income, net profit, percentage contract R&D income from SA public sector and international sources, and the Recordable Incident Rate (see table 8).

The organisation achieved a net profit of R36.47 million, surpassing the targeted loss of R38.07 million by R74.57 million. While this represents a decrease of R7.1 million compared to the net profit for the same period in the previous year, it still demonstrates a significant improvement in financial performance, especially considering the reduction in the CSIR PG in the current FY. Total operating income of R3 178.74 million was realised for the FY, exceeding the target of R3 053.73 million.

Factors that impacted total revenue include:

a. Key contracts with public sector clients, such as Armscor, the South African National Defence Force (SANDF), and the Centre for High Performance Computing (CHPC) Lengau Support contract within the National Integrated Cyberinfrastructure System (NICIS), were secured towards the end of the previous FY, significantly increasing revenue from this sector in this financial period.
b. Noteworthy assets funded by grants, including the Hot Isostatic Press, the CHPC TRANE Air-Cooled Chillers, the Data Intensive Research Initiative of South Africa (DIRISA) long-term archival system, and the CHPC Network Security System, were successfully delivered in the last quarter, leading to an increase in income from the public sector. Additionally, assets funded by grants under the Bill and Melinda Gates contract were capitalised, contributing to the organisation's international income.
c. Revenue from the international sector was largely driven by wind tunnel tests and radar projects within CSIR Defence and Security, projects undertaken for Anglo American Plc, as well as a contract with the US Department of Health and Human Sciences' Centre for Disease Control.
d. These developments played a vital role in mitigating the revenue shortfall experienced in the private sector and the reduction in PG due to cuts imposed by the National Treasury. Additionally, the above offset the inability to secure planned large-value rental agreements with tenants that further negatively impacted on the organisation's planned revenue generation.

The SA public sector income stream contribution to total income is 59%, which is 2% above the target of 57%.
This is due to lower than anticipated private sector income.

The contribution of R238.48 million from the SA Private Sector to total income accounts for 8%, falling short of the budget contribution target of 11% by 3%. This shortfall stems from lower-than-expected sales secured across various clusters. Secured contracts with the private sector amounted to only 73% of the total target for the FY by the end of the FY, resulting in a monetary decline of R28.59 million compared to the previous fiscal period.

The international contract income stream contribution of R315.84 million to total income is 10%, which is 1% ahead of the budget contribution target of 9%.

The CSIR has maintained its Level 1 Broad-Based Black Economic Empowerment (B-BBEE) rating during the latest verification period that ended in July 2023.

The recordable incident rate for the current year is 0.09, which is below the target of less than 0.6.

The audit for the 2023/24 FY was completed with an unqualified audit report with no significant audit findings.

Table 8: KPIs that measure CSIR's income diversification, financial sustainability and good governance

SO 5: Diversify income, maintain financial sustainability and good governance

Output Indicator	Audited Actual Performance 2021/2022	Audited Actual Performance 2022/2023	Planned Annual Target 2023/2024 until date of re-tabling	Revised Annual Target 2023/2024	Actual Achievement 2023/2024	Deviation from Revised target to Actual Achievement 2023/2024	Reasons for deviations	Reasons for revisions to the Outputs/ Output indicators/ Annual Targets
KPI 24: Total Income (Rm)	2654	2861	3104	3054	3179	+125m	Target exceeded	4% reduction in PG
KPI 25: Net Profit (Rm)	137	43.57	11.5	(38.1)	36.47	+R74.57m	Target exceeded	4% reduction in PG
KPI 26: SA public sector income (% total income)	56%	56%	56%	57%	59%	+2%	Target exceeded	4% reduction in PG
KPI 27: SA private sector income (% total income)	9%	9%	11%	11%	8%	-3%	Lack of secured sales	N/A
KPI 28: International contract income (% total income)	6%	9%	9%	9%	10%	+1%	Target exceeded	N/A
KPI 29: B-BBEE rating	2	1	1	1	1	Achieved	Target achieved	N/A
KPI 30: Recordable incident rate	1.8	0	≤0.6	≤0.6	0.09	Exceeded	Target exceeded	N/A
KPI 31: Audit opinion	Unqualified Audit Opinion	Unqualified Audit Opinion	Unqualified Audit Opinion	Unqualified Audit Opinion	Unqualified Audit Opinion	Achieved	Target Achieved	N/A

Strategy to overcome areas of under performance

The CSIR did not achieve the desired performance levels for five (5) key performance areas.
These include priority patents filed, licence agreements, SET staff with PhDs, SA private sector income and publication equivalents.

The remedial strategies are as follows:

a. **Priority patents filed and licence agreements**
The CSIR is not limited when it comes to potential technologies which could be patented. However, decisions to patent have to be considered against the commercialisation strategy of the technology, the market and the cost associated with the patent. One of the strategies that could be employed is to strategically categorise technologies as a means of rationalising the costs related to patent filings. Technologies could be categorised according to level of priority, and a divisional patenting strategy developed around the different categorisations. For instance, technologies with the likelihood of high business impact and good novelty could fall into the high priority category and be earmarked for high-value patenting (several territories, triadic offices, etc.).

b. **SET staff with PhDs**
To ensure that the target is met for the 2024/25 FY, the recruitment for current positions that require a PhD will translate into a possible addition of 12 staff members with PhDs in the short to medium term. Other interventions, which include studentships (eight staff), current staff completing PhD studies in the 2024/25 FY (24 staff) and five Capability Investment Development Programme (CIDP) potentials will contribute to reaching the target in the 2024/25 FY. The CSIR is also evaluating the ideal level of PhDs given the needs of the market.

c. **SA private sector income**
To ensure financial sustainability, the Business Development and Commercialisation functions together with clusters will continue to focus efforts on pipeline development. The following are just a few ways in which proximity to local private sector stakeholders can be increased in order to identify industry needs that can be solved with technology solutions and to securing revenue generating opportunities by utilising existing networks, exploring non-conventional funding streams, collaborating with industry foundations, memberships with industry associations, subscribing to international platforms, attending industry events, and establishing industry advisory panels.

d. **Publication equivalents**
As indicated previously, publication equivalents are mainly generated through PG support from Parliament, and this grant has decreased in nominal terms in recent years, due to several budget cuts since the Covid-19 pandemic. The strategy going forward would be to leverage relationships that have been forged with HEIs in order to collaborate and to co-publish. Already, the CSIR is publishing with HEIs, but there is an opportunity to do more in this area.

Revenue collection

The over collection of revenue as reflected in table 9 relates to projects that commenced during the 2022/23 FY and were completed in the 2023/24 FY. The contract income target was exceeded as reflected in table 9.

Royalty income of R1.99 million exceeded the target of R1.68 million due to securing licencing/royalty agreements for Qfrency and Datron WinNuwei (vehicle overload monitoring system) and increased royalties from Resyn Biosciences.

The collection of long outstanding debt is one of the key focus areas of the entity and is being closely monitored. This has proven successful, despite the economic strain experienced globally and customers delaying payments. Debt older than 30 days has consistently reduced to R88.33 million in March 2024 (3.65% of Contract Income) from R94.74 million in March 2023 (4.56% of Contract Income). Debtors over 90 days have slightly increased by R2.67 million from R47.21 million (March 2023) to R49.88 million (March 2024) and represents 15.2% of the debtor's book (March 2023 14.4%); R6.13 million of this debt was however paid by customers in the first week of April 2024.

The bad debt provision was increased by R5.63 million from R28.07 million (March 2023) to R33.70 million (March 2024). Debt greater than 90 days that has not been provided has been carefully considered in accordance with IFRS9 and the CSIR has a firm written commitment from customers to pay outstanding balances.

Debt older than 365 days increased to R21.79 million (6.64%) in March 2024 from R16.27 million (5%) in March 2023. R5.64 million (25.88%) of this debt is handed over for external debt collection.

Table 9: Sources of revenue generation for the CSIR

	2023/2024			2022/2023		
Sources of revenue	**Estimate R'000**	**Actual Amount Collected R'000**	**Over/(Under) Collection R'000**	**Estimate R'000**	**Actual Amount Collected R'000**	**Over/(Under) Collection R'000**
PG	714,311	729,724	15,413	741,615	738,476	(3,139)
Contract income	2,338,629	2,418,968	80,339	2,157,023	2,079,076	(77,947)
Royalty income	1,684	1,986	302	4,500	1,645	(2,855)
Total	**3,054,624**	**3,150,678**	**96,054**	**2,903,138**	**2,819,197**	**(83,941)**

Property, plant and equipment investment

The CSIR targeted an investment of R148.4 million in property, plant and equipment (PPE) during the 2023/24 year (table 10). These targets were exceeded significantly due to additional funding secured and earmarked to be invested in capital infrastructure as well as the donation of assets from external customers in the public and private industry. These assets are categorised as grant-funded assets.

These grant-funded asset investments amounted to R196.99 million for the year and is a noteworthy improvement from the investment in the 2022/23 financial year. The implementation of the National Integrated Cyber infrastructure System and the investment in the Hot Isostatic Press (HIP) equipment contributed to 20% each of the total grant funding investment.

The maintenance of assets is prioritised to ensure operational efficiency, reduce risks, maximise the value of investments in assets, and continue the generation of future economic benefits from these assets.

The Facilities Management portfolio concluded a building condition assessment to identify buildings requiring maintenance, repair, or renovation, and to prioritise future facility management activities. No facilities have been identified to be closed down or downgraded.

During the financial year, assets with a cost of R69.86 million were disposed of due to assets reaching the end of their useful life, assets being sold, and a small percentage of assets were disposed of due to theft (R0.82 million/1.18%).

The loss due to the disposal of assets amounted to R1.27 million and represents the accelerated depreciation at the time of disposal. Management prioritises the safeguarding of assets and has drafted a Mobile Asset Management Framework to be implemented in the 2024/25 financial year.

This framework will promote the effective monitoring of mobile assets and the implementation of necessary controls to maintain their integrity and optimise their use. The administration of assets is further governed by the Fixed Asset Policy and includes the requirement for annual verification of assets by asset custodians and the review of the useful life of assets where applicable.

The policy further guides the appropriate actions required to safeguard assets and update the status on the fixed asset register. There were no significant audit findings identified by the internal or external audit processes during the year.

Table 10: CSIR targeted investment in PPE

	2023/2024			2022/2023		
Asset Category	**Budget R'000**	**Actual Expenditure R'000**	**Over/(Under) Expenditure R'000**	**Budget R'000**	**Actual Expenditure R'000**	**Over/(Under) Expenditure R'000**
IT equipment	7,200	32,082	24,882	39,719	21,819	(17,900)
Equipment	4,300	23,749	19,449	96,350	19,703	(76,647)
Buildings	33,200	8,696	(24,504)	20,810	46,433	25,623
Vehicles	2,200	-	(2,200)	500	-	(500)
Furniture and fixtures	1,100	1,912	812	2,514	301	(2,213)
Total CSIR Assets	**48,000**	**66,439**	**18,439**	**159,893**	**88,256**	**(71,637)**
Grant-funded assets	100,400	196,988	96,588	99,907	78,752	(21,155)
Total	**148,400**	**263,427**	**115,027**	**259,800**	**167,008**	**(92,792)**

SECTION D

Governance

SECTION D

Governance

The CSIR Board, along with its various committees, is responsible for the oversight of the application of the CSIR mandate through delivering on the annual plan and the performance of the organisation. This section provides an overview of the governance systems, processes and controls in place to hold the organisation to account.

Introduction

Corporate governance encompasses the processes and systems that direct, control and hold public entities accountable. In addition to legislative requirements based on a public entity's enabling legislation and the Companies Act, 2008 (Act 71 of 2008), corporate governance for public entities is applied through the precepts of the Public Finance Management Act (PFMA), 1999 (Act 1 of 1999) and its associated regulations. This governance framework runs in tandem with the principles contained in the King IV Report on Corporate Governance. Although the King IV Report on Corporate Governance is not legally binding, it serves as a benchmark for assessing the conduct and performance of the CSIR's governance structures, ensuring the CSIR acts independently and in the best interest of the organisation, thereby supporting its mandate to accelerate socioeconomic prosperity through leading innovation.

Parliament, the Executive and the Accounting Authority of the public entity are responsible for corporate governance.

The CSIR Board, along with its various committees, oversees the application of the CSIR mandate by delivering on the annual plan and assessing the organisation's performance. This section provides an overview of the governance systems, processes and controls in place to hold the organisation accountable.

Accountability engagements

The Chairperson of the Board and the Executive Committee (Exco) hold bilateral meetings with the Executive Authority to ensure that performance aligns with the Shareholder's Compact.

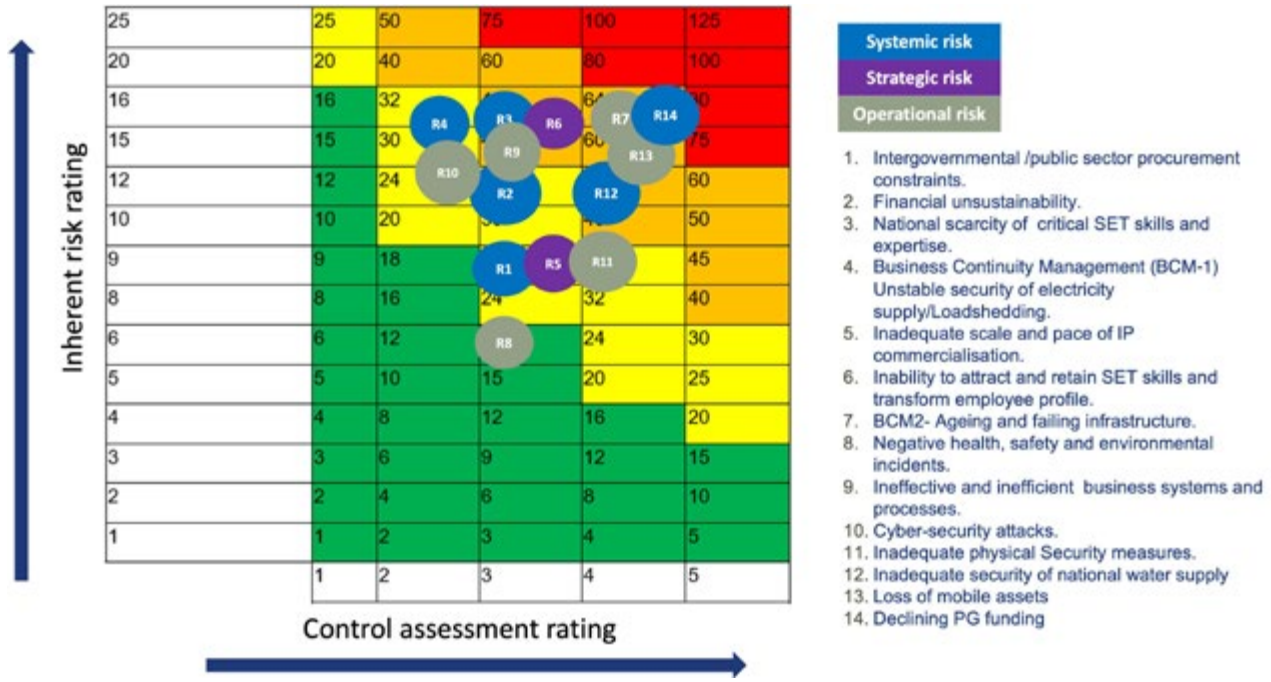
Table 1: CSIR/Parliament engagements

Date	Activity	Details	Type of Engagement	Delegation
19 April 2023	Presentation on the 2023/24 CSIR Shareholder's Compact	Portfolio Committee (PC) on Higher Education, Science and Innovation	Accountability	Board/Exco
12 May 2023	Briefing by the Department of Science and Innovation on the Advanced Manufacturing Technology Strategy and the CSIR on CSIR Future Production: Manufacturing	PC on Higher Education, Science and Innovation	Science Advisory	Dr Kaven Naidoo and Dr Ajith Gopal
23 May 2023	Science and Innovation Budget Vote Media Broadcast and Panel Discussion	Department of Science and Innovation	Networking	Dr Kaven Naidoo
23 May 2023	Attended the Parliamentary Debate on Budget Vote 35: Science and Innovation	Minister of Higher Education, Science and Innovation and PC on Higher Education, Science and Innovation	Networking	Dr Kaven Naidoo
20 June 2023	Formed part of a Panel at a Parliamentary Dialogue on 4IR; this event served as the launch of a campaign entitled "In Search of South African Youth Innovators"	Deputy Speaker of Parliament	Science Advisory	Dr Lehlo Ledwaba and Prof. Luzango Mfupe
13 September 2023	Briefing by the Department of Science and Innovation and the Mandela Mining Precinct on the South African Mining Extraction, Research, Development, and Innovation (SAMERDI) Strategy	PC on Higher Education, Science and Innovation	Science Advisory	Dr Motodi Maserumule; Sibongile Ntsoelengoe and Johan Le Roux
21 September 2023	Tabling of the 2022/23 CSIR Annual Report in ATC 124 of 2023	Minister of Higher Education, Science and Innovation	Accountability	Board/Exco
20 October 2023	Presentation on the 2022/23 CSIR Annual Report	PC on Higher Education, Science and Innovation	Accountability	Board/Exco
13 March 2024	Consideration and adoption of the Legacy Report on the Science and Innovation Portfolio during the 6th Administration	PC on Higher Education, Science and Innovation	Networking	CEO and Board Chairperson
25 March 2024	Tabling of the 2024/25 CSIR Shareholder's Compact in ATC 39 of 2024	Minister of Higher Education, Science and Innovation	Accountability	Board/Exco

Areas of risk and the implementation plans/actions the CSIR undertook

The graph below presents the top risks identified for the organisation during the last year and reflects the risk profile at year-end.

For each of these risks, the organisation has defined a mitigation strategy and assigned an executive risk owner to monitor mitigation progress and risk movement. This information is presented to Exco monthly and to the Board and Audit and Risk Committee quarterly.



CSIR overview risk heat map presented quarterly

Executive Authority

The Executive Authority of the CSIR is the Minister of Higher Education, Science and Innovation. The Accounting Authority of the CSIR is the CSIR Board, duly appointed by the Minister. The Practice Note issued by the National Treasury on the submission of corporate plans requires the inclusion of the following in the corporate plan:

a. Five-year Strategic Plan
b. Annual Performance Plan
c. Governance Structures
d. Risk Plan
e. Fraud Plan
f. Financial Plan
g. Materiality/Significance Framework

The Executive Authority requires quarterly reporting from the CSIR on prescribed dates. For the 2023/24 financial year, the following reports were submitted.

h. Quarter 1 Report – 20 July 2023
i. Quarter 2 Report – 20 October 2023
j. Quarter 3 Report – 20 January 2024
k. Quarter 4 Report – 20 April 2024

No issues were raised by the Executive Authority on reports submitted.

The Accounting Authority/Board

Introduction

The governance infrastructure of the CSIR encompasses the collection of governance operating models, people, processes and systems, established to govern daily organisational activities.

This infrastructure also includes the processes used to gather and report information to the Board, external stakeholders and management.

The Board is responsible for oversight across the organisation in areas such as business and risk strategy, organisational structure, financial soundness and regulatory compliance.

The CSIR governance operating model assists the Board in engaging management to provide the information necessary for governance and risk oversight. It ensures the requisite oversight and provides input on policies that influence governance practices. Additionally, it actively engages management to understand governance activities at various organisational levels and supports management in efforts to enhance programme efficiency and effectiveness.

The Board Committees are governed by charters that define their responsibilities and address linkages between a committee, the broader executive team and the Board of Directors.

The CSIR's organisational design and reporting structure provides a clear, comprehensive framework that defines reporting lines for decision-making, risk management, financial and regulatory reporting, public disclosures and crisis preparedness and response.

The Board of Directors, constituting the Accounting Authority, is responsible for the preparation and fair presentation of the consolidated and separate financial statements in accordance with International Financial Reporting Standards and the requirements of the PFMA. They ensure the necessary internal controls are in place to enable the preparation of financial statements free from material misstatement, whether due to fraud or error. In preparing these financial statements, the Accounting Authority is responsible for assessing the Group's ability to continue as a going concern, disclosing, as applicable, matters related to this assessment and using the going concern basis of accounting.

The role of the Board:

The responsibilities of the Board are governed by the Scientific Research Council Act, 1988 (Act 46 of 1988) and the PFMA. The Board approves the strategy, goals, operating policies and priorities for the organisation and monitors compliance with policies, applicable legislation and achievement against objectives. Except for the Chief Executive Officer (CEO) of the CSIR, all members of the Board are non-executive. Board members are actively involved and bring independent judgement to the Board's deliberations and decisions. The Board, whose current number of members adheres to the statutory minimum requirements, meets quarterly.

For the year under review, the Board met nine times. The meetings were held on 30 May 2023, 27 July 2023, 26 October 2023, 13 November 2023 (special), 8 December 2023 (special) and 14 February 2024. A two-day Board strategic session was held on 24 and 25 August 2023. The annual financial statements for the 2022/23 financial year were approved on 27 July 2023. The Board further engaged in various ad hoc meetings to provide advice and input on matters of strategic importance.

The Board comprises three sub-committees: the Audit and Risk Committee; the Human Resources, Social and Ethics Committee and the Research, Development and Innovation Committee (see page 103). These committees are selected according to the skill sets required to fulfil their functions. The Board has adopted formal Terms of Reference reflected in the Board Charter, while the Board committees are governed by their respective charters, which define their roles and responsibilities in their advisory capacities to the Board of Directors.

Board Charter

The CSIR Board Charter outlines the functions and responsibilities of the Board, along with certain matters relevant to its operations. These responsibilities align with the provisions of the Scientific Research Council Act, PFMA and the King IV Report on Corporate Governance.

The CSIR Board of Directors has decided to apply the corporate governance principles of the Protocol on Corporate Governance in the public sector and the King IV Codes on Corporate Governance to their activities to regularise and improve the corporate governance of the CSIR. This Board Charter sets out the corporate governance policies of the CSIR as adopted by the Board and must be read in conjunction with the Shareholder's Compact between the CSIR and the Minister of Higher Education, Science and Innovation.

While this Charter includes references to minimum acceptable standards of governance, it emphasises that substance should prevail over form. The Charter reaffirms the Board's intention to exceed these corporate governance standards wherever reasonable, considering:

- Recognised standards of governance;
- Best practice locally and internationally;
- The recommendations of the King IV Code on Governance;
- The Protocol on Governance of State-Owned Entities; and
- The objectives set out in Section 3 of the Scientific Research Council Act.

The Board Charter aims to regulate the parameters within which the Board will operate and ensure the application of the principles of good corporate governance in all dealings by, in respect of, and on behalf of the organisation.

The Board has made significant progress in compliance with the Charter by:

- Guiding the continued integration of the CSIR's values and standards of conduct and ensuring adherence through input and oversight of the review and re-alignment of all CSIR policies;
- Providing leadership to the CSIR within a framework of prudent and effective controls that enable the assessment and management of risk;
- Reviewing the CSIR's directions, strategies and financial objectives annually, ensuring that the necessary resources are in place to meet objectives and assessing progress quarterly;
- Overseeing and ensuring that the performance of CSIR Executive Management and the Board itself (and Committees) is assessed and monitored regularly; and
- Overseeing information technology governance through quarterly engagements on business development, commercialisation and technology innovation through the Research, Development and Innovation Committee and annual interactions with and reporting by the Research Ethics Committee.

Composition of the Board

April 2023 to March 2024

Vuyani Jarana
CEO,
Ilitha Telecommunications

Dr Thulani Dlamini
CEO,
CSIR

Maleke Matolong
Chairperson of Finance Committee,
North West Cricket Board

Mahesh Fakir
Independent Consultant

Jules Newton
Executive Director, Innovation
Green Business Value Chain Portfolio

Dr Vuyo Mthethwa
Deputy Vice Chancellor: People and Operations,
Durban University of Technology

Prof. Arnold van Zyl
Retired President,
Baden-Wuerttemberg Cooperative State University
Germany

Dr Christine Render
Independent Consultant

Michelle Govender
CEO
Octarity

Prof. Yunus Ballim
Retired Emeritus Professor,
University of the Witwatersrand

Mike Mulcahy
CEO, GreenCape
Chairman of the International Cleantech Network

Composition of the Board (continued)

April 2023 to March 2024

Name	Date appointed	Date resigned	Qualifications	Area of expertise	Board directorships	Other committees or task teams	Number of meetings attended
Vuyani Jarana	January 2023	Active	Stellenbosch University: Master of Business Administration Honours degree in business administration University of Transkei (Walter Sisulu University): BCom in Economics Business Commercial Law University of South Africa: Advanced Executive Programme Olifantsfontein College: Diploma in telecommunications institution	New sources of growth broadly (digital capabilities, blockchain and internet of things)	Non-Executive Director: ECDC Teconica Telecommunications Executive Director: Ilitha Telecommunications Ilitha Infrastructure (Pty) Ltd Jarana Investment Holdings Council Member Walter Sisulu University Related party company (Spouse) JBV Consulting Agency		Eight
Dr Thulani Dlamini (CSIR CEO)	2017	Active	University of the Witwatersrand (Wits): PhD in chemistry, catalysis; BSc (Hons) in chemistry and BSc in chemistry University of South Africa: Master's in business leadership		Council Member: National Advisory Council on Innovation Board Member: Industry Advisory Board of the Faculty of Engineering and Built Environment, Wits University United Nations Development Programme (UNDP) SA Programme Director: Stellar Ventures	ARC RDIC HRSEC	Nine

Composition of the Board (continued)

April 2023 to March 2024

Name	Date appointed	Date resigned	Qualifications	Area of expertise	Board directorships	Other committees or task teams	Number of meetings attended
Prof. Arnold van Zyl (Interim Board Chairperson until 27 July 2023)	January 2023	Active	University of Cape Town: PhD (Engineering) MSc (Engineering) BSc (Engineering)	Industrial Development / Research New sources of growth broadly (digital capabilities, blockchain and internet of things) Intellectual property management, technology transfer and commercialisation, Scientific development for directed research	None	ARC RDIC (Chair) HRSEC	Nine
Dr Vuyo Mthethwa	2019	Active	University of KwaZulu-Natal: PhD (Higher Education Governance)	Human resources	Deputy Vice Chancellor: People and Operations Durban University of Technology	HRSEC	Seven
Mike Mulcahy	July 2023	Active	University of Cape Town Graduate School of Business: MPhil (Development Finance) University of Cape Town: Bachelor of Business Science with Honours in economics		Non-Executive Director: The International Cleantech Network Executive Director: The GreenCape Sector Development Agency	ARC	Four
Dr Christine Render	2019	Active	Leeds University: PhD (Chemical Engineering) BSc (Hons) (Chemical Engineering)	Industrial Development/ Research New sources of growth broadly (digital capabilities, blockchain and internet of things) Intellectual property management, technology transfer and commercialisation Scientific development for directed research	Partner/ shareholder/ Owner: Team Consultation (Pty) Ltd	RDIC	Nine

Composition of the Board (continued)

April 2023 to March 2024

Name	Date appointed	Date resigned	Qualifications	Area of expertise	Board directorships	Other committees or task teams	Number of meetings attended
Prof. Yunus Ballim	January 2023	Active	University of the Witwatersrand: BSc (Chemistry) BSc (Hons) (Chemistry) PhD (Chemistry, Catalysis) University of South Africa: Master of Business Leadership	Academic representative	Trustee Chair: ABB Education Trust Trustee: Gallagher Foundation Trust	HRSEC RDIC	Nine
Mahesh Fakir	January 2023	Active	University of London: MSc (Development Finance) University of Durban – Westville: Master of Business Administration, MSc University of Natal: Post-Graduate Diploma in civil engineering BSc (Civil Engineering) ML Sultan Technikon: National Diploma	Legal and governance	Non-Executive Director (Chairperson): South African Maritime Safety Authority (SAMSA)	RDIC ARC	Nine
Jules Newton	January 2023	Active	University of the Witwatersrand BA (Education)	Social and entrepreneurial skills	Non-Executive Director: Inhlabathi (Pty) Ltd Trustee: Jeppe Trust Executive Director and Shareholder: Newton van Rensburg Properties	HRSEC RDIC	Nine
Michelle Govender	January 2023	Active	University of KwaZulu-Natal: BSc (Electrical Engineering) Engineering Council of South Africa: Professional Engineer University of South Africa: Post-Graduate Diploma (Applied Risk Management)	New sources of growth broadly (digital capabilities, blockchain and internet of things)	CEO Octarity	ARC RDIC	Seven

Composition of the Board (continued)

April 2023 to March 2024

Name	Date appointed	Date resigned	Qualifications	Area of expertise	Board directorships	Other committees or task teams	Number of meetings attended
Maleke Matolong	January 2023	Active	North-West University Master of Business Administration BCom (Accounting) Short Learning Programme in project management University of South Africa Programme in entrepreneur and small business management BCom (Law) Business (Current Studies) Accountant In Practice: Chartered Institute of Business Accountants	Finance	Board Member: North West Cricket Board Chairperson: Finance Committee (North West Cricket Board) Member of Remuneration Committee: Rustenburg Municipality - Audit Performance Committee	ARC	Nine

List of Board Committees

Committee	Number of meetings held	Number of members	Name of members
Audit and Risk Committee (ARC)	Five meetings were held: 23 May 2023 20 July 2023 25 July 2023 (Special) 19 October 2023 8 February 2024	Five	Mike Mulcahy – Chairperson Prof. Arnold van Zyl Maleke Matolong Michelle Govender Mahesh Fakir
Human Resources, Social and Ethics Committee (HRSEC)	Four meetings were held: 17 May 2023 19 July 2023 18 October 2023 7 February 2024	Four	Dr Vuyo Mthethwa – Chairperson Jules Newton Prof. Arnold van Zyl Vuyani Jarana (no longer a member effective Oct 2023) Prof. Yunus Ballim
Research, Development and Innovation Committee (RDIC)	Four meetings were held: 16 May 2023 18 July 2023 17 October 2023 6 February 2024	Five	Prof. Arnold van Zyl – Chairperson Prof. Yunus Ballim Michelle Govender Mahesh Fakir Jules Newton

Remuneration of Board members

Name	Remuneration	Other allowance	Other re-imbursements	Total
Vuyani Jarana	R5 387 per board meeting	R108 593	R3 270.13	R143 592.19
Mike Mulcahy	R4 005 per board meeting	R81 444.75	R478.00	R92 380.64
Dr Vuyo Mthethwa	R4 005 per board meeting	R108 593	R1 045.26	R151 494.00
Dr Christine Render	R4 005 per board meeting	R80 734	R 2 042.08	R125 788.00
Prof. Arnold van Zyl	R4 005 per board meeting	R108 593	R 4 183.72	R 197 812.00
Mahesh Fakir	R4 005 per board meeting	R80 734	R1 119.22	R144 310.00
Maleke Matolong	R4 005 per board meeting	R80 734	None	R121 282.00
Prof. Yunus Ballim	R4 005 per board meeting	R80 734	R1 442.40	R144 503.00
Michelle Govender	R4 005 per board meeting	R80 734	R1 176.45	R131 794.00
Jules Newton	R4 005 per board meeting	R80 734	R12 119.24	R146 694.00

Risk management

The Board is responsible for ensuring a comprehensive and effective system of risk management, including accountability for risk governance. Enterprise risk management at the CSIR is an ongoing process focusing on identifying, assessing, managing and monitoring all known risks across all operations. This structured process ensures that the CSIR's goals and objectives are attained, acknowledging that identified risks are often inter-linked and cannot be managed in isolation. Risk management responsibilities are assigned at appropriate levels across all areas of activity within the organisation to ensure adequate responses.

The CSIR has a Board-approved Risk Management Policy and a supporting framework. These are operationalised through the implementation of the supporting structures, standards, processes, technologies and systems/tools.

The CSIR publishes an annual risk management plan as part of the CSIR Shareholder's Compact, which is approved by the Board. Additionally, an annual Enterprise Risk Management Plan is approved and monitored by Exco to ensure the adequacy and effectiveness of the risk management system.

The CSIR Executive empowers the Enterprise Risk Management Services portfolio (a sub-portfolio within the Legal Compliance and Business Enablement portfolio) to ensure the delivery of risk management plans. The CSIR Risk Management, Audit and Compliance Committee (RACC) is established as a governance structure to assist Exco in establishing a combined assurance model for the organisation.

Quarterly systematic strategic and operational risk assessments are conducted to effectively manage existing business risks and identify and mitigate emerging risks. Line management in the clusters, portfolios, strategic projects and key collaboration partnerships/initiatives conduct the risk assessments. The outcomes of these assessments are collated to formulate the CSIR risk register, commonly referred to as the CSIR top risks.

The risk assessment process is structured to analyse and evaluate three key categories:

Systemic risks:
These risks originate from macro-economic and national challenges affecting the National System of Innovation and the National Government Business Enterprise space in which the CSIR operates.

Strategic risks:
These risks have a direct impact on the ability of the CSIR to deliver on its mandate.

Operational risks:
These risks include financial, legal and compliance risks that affect the systems, people and processes through which the CSIR operates.

The outcomes of the risk assessments are reported via the quarterly CSIR Risk, SHEQ, Legal and Compliance Report and reviewed/discussed as a standing agenda item in the quarterly ARC committee meeting. Relevant items are then noted at Board meetings if required. Additionally, current, emerging and future strategic risks and risk management are addressed as an agenda item during the annual Board strategy sessions.

To enhance the organisation's risk management stance, several key actions were undertaken with the Board's support:

- **Appointment of property valuers:**
  Property and asset valuations were conducted across all CSIR sites. This strategic initiative provides insight into the values of the CSIR's movable and immovable assets, which is important for financial reporting, determining replacement values for insurance purposes, assessing market value for potential property sales and supporting the strategy to improve rental income.
- **Insurance renewal/cover:**
  The insurance renewal process was completed, and agreements were signed with various insurance companies for the 2024/25 financial year. Management continuously reviews the insurance portfolio to align it with the strategic and operational needs of the organisation and ensures that the cover matches the organisation's risk appetite.
- **Improved visibility of risk management:**
  There is overall improved visibility of risk management activities within the organisation. This supports the organisational objective of embedding a risk-aware culture in all operations and decision-making processes.

Based on the internal audit reports, organisational results achieved, the audit report on the annual financial statements and the management report of the Auditor-General, the Board is satisfied that the risk management system has been effective during the year under review.

Internal audit and Audit Committee

The CSIR has an internal audit function responsible for reviewing the design and operating effectiveness of the organisation's governance, risk and internal control processes. The internal audit function reports to the Audit and Risk Committee (ARC), which approves the Internal Audit Charter, the annual audit plan and the budget to maintain its independence.

The annual audit plan is based on the key risks to the organisation, the outcome of the enterprise risk assessment conducted by management and specific areas highlighted by internal audit and the ARC. In addition, areas identified by the external auditors in internal control reviews are incorporated into the internal audit plan for follow-up.

In line with the PFMA requirements, the internal audit activity assured the ARC and management that the internal controls were appropriate and effective. This assurance was achieved through an objective appraisal and evaluation of risk management processes, internal control and governance processes. Additionally, the internal audit activity identified corrective actions and suggested enhancements to the controls and processes. A comprehensive report on the status of implementing the annual audit plan, key findings identified and the resolution status of previously reported internal and external audit findings is presented to the Audit and Risk Committee quarterly.

The internal audit activity is fully supported by management, the Board and the ARC, and has full, unrestricted access to all organisational activities, records, property and personnel.

For the period under review, internal audit evaluated the adequacy and effectiveness of controls in the following areas:

- Performance reporting;
- Human Capital management;

- Contract income and project management;
- Contract research and development;
- Hosted programmes;
- Intellectual property management;
- Royalty income and licencing;
- Financial management;
- Billing and accounts receivable;
- Property, plant and equipment;
- Operating expenses and accounts payable;
- CSIR International Convention Centre (ICC);
- Information, communication and technology;
- Health and safety;
- Board of Directors' and Executives' remuneration and expenses; and
- Follow-up of previous audit findings.

Key activities and objectives of the Audit and Risk Committee

The Audit and Risk Committee enhances the independence of the internal audit activity and provides oversight over risk management, governance and control processes. The Audit and Risk Committee assists the Board in the effective execution of its responsibilities with the ultimate aim of achieving the CSIR's objectives. The CSIR Audit and Risk Committee continues to function and has met four times during the period under review. The Audit and Risk Committee is responsible for improving the operations of the organisation by overseeing the audit functions, internal controls and the financial reporting process.

The ARC assists the CSIR by:

- Creating and maintaining an effective internal control environment, financial controls, accounting systems and reporting;
- Addressing all matters prescribed by the regulations issued regarding the PFMA and the Scientific Research Council Act;
- Identifying and managing material risks;
- Agreeing on the scope and reviewing the annual external audit plan and the work of the CSIR's internal auditors;
- Reviewing and approving the Internal Audit Charter and the risk-based three-year strategic internal audit plan and annual audit plan;
- Understanding the dynamics and performance of the organisation without restrictions;
- Ensuring that the CSIR can prevent, detect and respond to fraud and allegations of fraud; and
- Discharging its responsibilities related to:
  - safeguarding of assets;
  - operation of adequate procedures and controls;
  - reviewing financial information and preparing financial statements; and
  - ensuring attendance of ARC meetings by its members.

The table below discloses relevant information on the ARC members:

Name	Qualifications	Internal or external	If internal, position in the public entity	Date appointed	Date resigned	Number of meetings attended
Vuyani Jarana	Stellenbosch University: Master's in Business Administration Hons in Business Administration: University of Transkei (Walter Sisulu University) BCom Economics Business Commercial Law, University of South Africa Advanced Executive Programme, Olifantsfontein College Diploma in Telecommunications Institution	External		2023	Term ended as ARC Chairperson on 27 July 2023	Three
Dr Thulani Dlamini	University of Witwatersrand PhD Chemistry, Catalysis BSc (Hons) Chemistry BSc Chemistry University of South Africa: Master's in Business Leadership	Internal	CEO	2017	Active	Five
Mike Mulcahy	University of Cape Town Graduate School of Business: MPhil (Development Finance) University of Cape Town: Bachelor of Business Science with Honours in Economics	External		2023	Appointed as ARC Chairperson on 27 July 2023	Two
Prof. Arnold van Zyl	University of Cape Town PhD (Engineering) MSc (Engineering) BSc (Engineering)	External		2023	Active	Five

Name	Qualifications	Internal or external	If internal, position in the public entity	Date appointed	Date resigned	Number of meetings attended
Michelle Govender	University of KwaZulu Natal BSc (Electrical Engineering) Engineering Council of SA Professional Engineer University of South Africa Post Graduate Diploma: Applied Risk Management	External		2023	Active	Three
Maleke Matolong	North-West University (NWU) Master of Business Administration (MBA) BCom Accounting Short Learning Programme in Project Management UNISA Programme in Entrepreneur and Small Business Management Current Studies - BCom Law (UNISA) Business Accountant In Practice Chartered Institute of Business Accountants (CIBA)	External		2023	Active	Four
Mahesh Fakir	University of London MSc (Development Finance) University of Durban – Westville Master of Business Administration, MSc University of Natal Post Graduate Diploma in Civil Engineering BSc (Civil Engineering) ML Sulta Technikon National Diploma	External		2023	Active	Five

Compliance with laws and regulations

Throughout the financial year, the CSIR undertook rigorous efforts to enhance the compliance framework, crucial for meeting the specific regulatory demands governing the organisation's operations. This enhancement reflects on the ongoing commitment to upholding the highest standards of legal and regulatory compliance. The steps taken to ensure robust regulatory compliance include:

- **Identifying applicable regulations:** The CSIR pinpointed the specific laws and compliance regulations relevant to its industries and operational scope, documented in the regulatory universe.
- **Determining requirements:** The organisation meticulously identified and analysed the requirements of each applicable law and/or regulation, developing strategic plans for effective implementation.
- **Documenting compliance processes:** Clear documentation of compliance processes was established, including detailed instructions for each role involved in ensuring adherence to these processes.
- **Monitoring regulatory changes:** Given the dynamic nature of compliance regulations, the CSIR continuously monitors changes and assesses the regulation's relevance to the organisation's operations, integrating them appropriately into its framework.
- **Conducting compliance audits:** In-house compliance audits are critical for reviewing adherence to regulatory guidelines and preparing the organisation for external audits conducted by independent third parties.

This structured approach has fortified the CSIR's compliance framework, enabling the organisation to meet complex regulatory requirements while maintaining its commitment to ethical operations and governance.

Fraud and corruption

The CSIR Fraud Prevention Plan (FPP) was developed in compliance with section 3.2.1 of the Treasury Regulations of the PFMA. The CSIR subscribes to the principles of good corporate governance, which require business to be conducted in an honest, ethical and transparent manner. Consequently, the CSIR is committed to eradicating fraudulent behaviour at all levels within the organisation.

The CSIR's FPP encompasses controls that have four strategic objectives:

- Identifying possible fraud and corruption risks to which the CSIR may be exposed and areas of its business where these are likely to occur;
- Preventing instances of fraud and corruption from occurring;

- Detecting instances of fraud and corruption when they occur; and
- Responding appropriately and taking corrective action when fraud and corruption occur.

This FPP is premised on the CSIR's core ethical values driving its business, the development of its systems, policies and procedures, interactions with stakeholders in its value chain and overall value proposition, including public and private sector customers, members of the public at large, suppliers and service providers, employees and its shareholder.

In alignment with the CSIR's core organisational values of excellence, people-centredness, integrity and collaboration (EPIC), this FPP is the cornerstone of promoting ethical conduct and determining how incidents or suspected incidents of fraud and corruption will be prevented, detected and investigated.
The FPP is a dynamic plan, continuously evolving as the CSIR strives to further promote ethics and prevent fraud. The main principles upon which the CSIR's FPP is based are:

- Creating a corporate culture that is ethical, fair and intolerant to fraud, thereby aligning with the CSIR's core EPIC values;
- Deterring fraud and corruption;
- Reporting suspicious fraudulent activity without fear of reprisals or recriminations;
- Detecting fraud;
- Investigating any detected fraud;
- Taking appropriate action in the event of fraud, e.g., disciplinary action, recovery of losses and prosecution; and
- Applying sanctions, such as blacklisting suppliers or service providers guilty of corrupt practices.

This plan applies to all allegations, attempts and incidents of fraud that have an impact or the potential to impact the CSIR and its business. All CSIR employees and management must comply with the spirit and letter of the plan.

A person who holds a position of authority, as stipulated in section 34 of the Prevention and Combating of Corrupt Activities Act, 2004 (Act 12 of 2004), should report any suspected corrupt activity and/or an offence of theft/fraud to the police.

The CSIR's ARC significantly influences the fraud control environment, particularly by ensuring the right tone is set at the top of the organisation. This is achieved through the discharge of its duties in terms of the PFMA and Treasury Regulations. The ARC systematically oversees and periodically reviews the internal controls established at top management.

The policy of the CSIR is one of zero tolerance for fraud and corruption, as captured in the CSIR Ethics Statement and Code of Conduct. All alleged cases of fraud and corruption will be investigated and followed by the application of all remedies available within the full extent of the law and the implementation of appropriate prevention and detection measures. These measures include existing financial and related controls and verification mechanisms as prescribed in the systems, policies and procedures of the CSIR.

The CSIR aims to facilitate a culture of disclosing information relating to suspected fraud and related misconduct by employees. Employees and stakeholders are encouraged to report suspicions of fraudulent activity without fear of reprisals or recriminations.

The efficient application of instructions contained in the regulations, policies and procedures of the CSIR is one of the most important duties of employees in the execution of their daily tasks.

Minimising conflict of interest

Board members and employees must avoid situations where their personal interests conflict or could potentially conflict, with their duty to act in the best interests of the CSIR. This gives rise to the following duties:

- To act bona fide in the interests of the CSIR;
- Not to compete improperly with the CSIR; and
- To disclose any direct or indirect personal or private interests, as envisaged in the provisions of section 50 (3) (a) of the PFMA, which shall be duly recorded in the minutes of a Board meeting.

Board members are required to inform the Board, through the Board Secretary, in advance, of any conflicts or potential conflicts of interest they may have concerning particular items of business to be transacted at a meeting.

Board members may not vote and must not be counted in the quorum of a meeting to pass a resolution in respect of any business where they have a direct or indirect interest.

If any Board member wilfully or negligently fails to disclose an interest as required above or if they participate in the proceedings of the Board notwithstanding any conflict of interest, the relevant proceedings of the Board may, at the discretion of the other Board members, be declared null and void.

In exceptional circumstances, the Board may decide that, in light of interests disclosed by a Board member, such Board member shall not be entitled to receive any further information on any particular matter before the Board and shall instruct the Board Secretary accordingly. A Board member who is aggrieved by the Board's decision in this regard shall be entitled to make representations to the Board, which will refer the matter to an independent governance expert whose decision shall be final and binding on the parties.

Code of conduct

The Board and Exco have enacted and continually monitor compliance with the Ethics Statement and Code of Conduct (Code), reflecting the organisation's commitment to fair

dealing and integrity in all operations. The Code has been significantly updated to closely align with the CSIR values of excellence, people-centredness, integrity and collaboration, ensuring compliance with laws and regulations. It mandates that all employees maintain the highest ethical standards, ensuring that business practices are conducted beyond reproach. An Ethics Hotline has been established to facilitate the anonymous reporting of ethical transgressions. The CSIR consistently promotes adherence to the Code through various awareness activities and commemorates International Ethics Week annually in October as part of this programme.

Health, safety and environmental issues

The CSIR's commitment to sustainable development as a strategic priority encompasses its commitment to Safety, Health, Environment and Quality (SHEQ). In fulfilling its mandate, the CSIR prioritises the health and safety of colleagues, contractors, suppliers, customers and local communities, as well as environmental protection. The CSIR is committed to excellence in managing these areas through its SHEQ function.

The CSIR ARC and Exco assist the Board in monitoring the effectiveness of SHEQ management systems within the CSIR, guiding the Board in decision-making from a SHEQ perspective.

A dedicated SHEQ department collaborates with the business to ensure the development and implementation of effective policies, proactive risk assessment and professional remediation. In line with the CSIR's re-positioning of its support services, the SHEQ structure has been enhanced to provide significant operational oversight, advice and support in all SHEQ-related areas.

In the year under review, the CSIR achieved its target of securing a recordable incident rate (RIR) of less than 0.6, attaining an RIR of 0.09. Despite this achievement, the CSIR continuously monitors health and safety (H&S) risks and implements appropriate response measures to address undesirable trends as they are identified. This includes management safety walkabouts, H&S articles published on the intraweb and safety tips communicated with secretariats of SHE committees across clusters, centres, portfolios and regional sites to raise awareness about the number of recordable incidents that occurred during the year, the lessons learned and near misses.

Board Secretary

The responsibilities of the Board Secretary include:

- Providing the Board and individual Board members with guidance on the nature and extent of their duties and responsibilities, ensuring these are properly discharged in the best interests of the CSIR and its shareholder.
- Ensuring the induction of new and inexperienced Board members and, together with the Chairperson of the Board, developing mechanisms for continuous education and training for all Board members to improve and maintain the Board's effectiveness.
- Assisting the Chairperson in determining the annual calendar and annual Board plan and handling other administrative issues.
- Serving as a central source of guidance and advice to the Board on matters of business ethics and good governance. The Board Secretary's appointment is subject to the same 'fit and proper test' as that of a new Board member.

Social responsibility

During this reporting period, the CSIR undertook various social responsibility initiatives. Key initiatives included participation in Nelson Mandela International Day, supporting CSIR beneficiary schools and implementing the CSIR Entrepreneurship Development Programme. Each initiative is outlined below.

The CSIR launched an Entrepreneurship Programme to support SMMEs in the science and technology space, in partnership with the Industrial Development Corporation of South Africa and the National Mentorship Movement. Currently, 20 entrepreneurs are supported through mentorship and business development support.

Additionally, the CSIR participated in several youth outreach activities, targeting both learners in various communities and university students.

CSIR Nelson Mandela International Day

The Nelson Mandela Day initiative for 2023/24 supported seven schools across Gauteng, KwaZulu-Natal and the Western Cape. In Gauteng, the CSIR reached out to Sikhululekile Maths, Science and ICT School of Specialisation and Thuto KeMaatla Secondary School. In KwaZulu-Natal, support was provided to Phumanyova High School, Fundukhaliphe High School, Ukuphumula Secondary School and Chesterville Secondary School. In the Western Cape, Kayamandi Secondary School was supported.

The CSIR provided valuable support through painting of classrooms, donating science apparatus and chemicals for experiments prescribed by the Department of Basic Education, mathematical instruments and 27 computers. Additionally, the CSIR conducted science, technology, engineering, mathematics and innovation (STEMI) engagements, which included motivational talks, career guidance and coding and technology demonstrations. A total of 214 CSIR staff members across the CSIR regions participated in these initiatives as volunteers. The CSIR approved the participation of staff members as part of its commitment to social responsibility as an organisational imperative.

Support for CSIR beneficiary schools

During the CSIR Career Day held from 3 to 4 August 2023, three schools supported by the CSIR in KwaZulu-Natal as part of the CSIR Corporate Social Programme visited the CSIR to participate in the event. These schools included Fundukhaliphe Secondary School, Ukuphumula Secondary School and Phumanyova High School. The CSIR covered all expenses for the visit, including transportation, accommodation and meals. Each school was represented by two learners and one teacher, except for Fundukhaliphe Secondary School, which was represented by two learners and the school principal. The first day of the visit was common for all participating schools, featuring a standard programme. On the second day, tailored activities were arranged specifically for the KwaZulu-Natal schools. This included visits to the Learning Factory, Biomanufacturing Industry Development Centre, solar plant and Defence and Security facilities.

Youth outreach programme

Events supported and participated in during the reporting period include:

- Pella Career Exhibition 2023: Held on 24 April 2023 at Pella Matlhako Village in Rustenburg.
- School visits: Visited five schools with learners of colour in the Western Cape on 9 May 2023 and one school with learners with disabilities in the Northern Cape on 17 May 2023.
- National Science Week (NSW) launch 2023: Took place on 22 July 2023 at the University of Venda in Thohoyandou.
- Military Information and Communications Symposium of South Africa 2023: Held from 22 to 23 August 2023 at the CSIR International Convention Centre in Pretoria.
- SasolTechnoX: Participated from 14 to 18 August 2023 in Sasolburg.
- University of Western Cape career fair: Attended on 3 May 2023.
- Sefako Makgatho Health Sciences University career fair: Participated on 11 May 2023.
- South African National Space Agency Science Week: Engaged from 15 to 19 May 2023.
- Mapenane School of Specialisation launch: 17 August 2023.
- Outreach events: Conducted outreach events at the University of Limpopo Science Centre on 31 July and 1 August 2023, as well as in Mathabathe Village in Mafefe and Burgersfort in Tubatse town on 3 and 4 August 2023.
- Science and Tech Fair at Sebokeng: Attended on 23 November 2023.

CSIR Career Day

The CSIR hosted its 2023 Career Day at the CSIR campus on 3 and 4 August 2023 to coincide with NSW, an initiative of the Department of Science and Innovation. The purpose of the Career Day was to align with NSW celebrations in stimulating the interest of the public, learners and students in science subjects and encouraging them to pursue careers in STEMI. Thirty schools comprising 782 learners, 33 TUT students, 58 educators and two NGO representatives attended the sessions making a total of 875 attendees for both days.

Audit Committee report

We are pleased to present our report for the financial year that ended 31 March 2024.

Audit and Risk Committee responsibility

The Audit and Risk Committee reports that it has complied with its responsibilities arising from Section 77 of the Public Finance Management Act and Treasury Regulation 3.1.13. The Committee also reports that it has adopted appropriate formal Terms of Reference as its Charter, as approved by the Board. Accordingly, the Committee has regulated its affairs in compliance with this Charter and has discharged all its responsibilities as contained therein.

Committee members and attendance

The Audit and Risk Committee consists of members as stated on page 103 of this report. In terms of its Terms of Reference, the Committee convened at least four meetings for the period under review. The meetings and schedule of attendance are shown on pages 105 to 106 of this report.

The CEO, the executive management, and representatives of internal and external auditors attended committee meetings by invitation. The Committee also periodically meets separately with internal and external auditors. The internal and external auditors have unrestricted access to the Committee.

The effectiveness of internal control

The system of internal control that the CSIR applies over financial risk management is effective, efficient and transparent. In line with the Public Finance Management Act and King IV report, the internal audit function provides the Committee and management with assurance that the internal controls are appropriate and effective. This is achieved by means of the risk management process, as well as the identification of mitigating measures and an ongoing assessment thereof.

The following internal audit work was completed during the year under review:

- Key Performance Indicators
- Conferencing and accommodation – CSIR International Convention Centre
- Journals
- Property, plant and equipment
- Ad-hoc billing – Mining cluster
- Accounts receivables
- ICT – Information and Cyber security
- ICT – General controls
- Recruitment and appointments
- Salary payments and allowances
- Performance management and bonuses

From the reports of internal audit, the audit report on the annual financial statements and the management report of the Auditor-General of South-Africa, it was noted that no matters that include any material deficiencies in the system of internal control or any deviations therefrom were reported. Accordingly, the Committee can report that the system of risk management and internal control over financial reporting for the period under review was efficient and effective.

In-year management and quarterly reports

The Committee has noted and is satisfied with the content and quality of the reports prepared and issued by the CSIR during the year under review.

Evaluation of financial statements

We have reviewed the annual financial statements prepared by the CSIR for the year ended 31 March 2024. Based on the information provided, the Committee considers that it complies, in all material respects, with the requirements of the various Acts governing disclosure and reporting on the annual financial statements.

Auditor's report

We have reviewed the public entity's implementation plan for audit issues raised in the prior year and we are satisfied that the matters have been adequately resolved.

The Audit and Risk Committee concurs with and accepts the conclusions of the external auditor on the annual financial statements and is of the opinion that the audited annual financial statements should be accepted and read together with the report of the auditor.

Mike Mulcahy
Chairperson of the Audit and Risk Committee
CSIR
29 July 2024

B-BBEE compliance performance information

The following table has been completed in accordance with the compliance to the B-BBEE requirements of the B-BBEE Act of 2013 and as determined by the Department of Trade, Industry and Competition.

Has the department/public entity applied any relevant Code of Good Practice (B-BBEE Certificate Levels 1 – 8) with regards to the following:		
Criteria	**Response yes/no**	**Discussion**
Determining qualification criteria for the issuing of licences, concessions or other authorisations in respect of economic activity in terms of any law	No	The CSIR does not issue any licences, concessions or authorisations for economic activities under any law. Such responsibilities typically apply to entities that issue trade licences, mining/exploration licences and similar permits.
Developing and implementing a preferential procurement policy	Yes	We developed and implemented a procurement policy that incorporates preferential procurement, together with various templates, evaluation criteria, frameworks and so forth to ensure its effectiveness. This policy is monitored monthly.
Determining qualification criteria for the sale of state-owned enterprises	No	We do not generally engage in such sales, but when we do, criteria are developed on a case-by-case basis. These criteria align with the nature of the asset or technology being sold, the CSIR mandate and the goal of ensuring sustainable offerings in the interest of South Africa. For example, in the sale of laboratories, we set criteria to secure a buyer that ensures the service offering remains sustainable and available within the South African context.
Developing criteria for entering into partnerships with the private sector	No	Criteria are developed on a case-by-case basis to align with the objectives of the collaboration, the CSIR mandate and the goal of securing sustainable offerings and commercialisation of technology in the interest of South Africa. Where feasible and sustainable commercialisation through SMMEs is possible, criteria such as B-BBEE levels/status or black/female ownership may be included. There is no firm policy on this as the nature of the technology and available markets determine the feasibility of such criteria.
Determining criteria for the awarding of incentives, grants and investment schemes in support of Broad-Based Black Economic Empowerment	No	The award of grants, incentives and investments is not a core activity of the CSIR. We do not make material investments in this context, except for the YES Programme application, bursary awards and corporate social investment initiatives targeting previously disadvantaged individuals or institutions, such as schools, higher education institutions and so forth.

SECTION E
Human capital

SECTION E

Human capital

This section provides a detailed account of the strategies, programmes and interventions implemented in the year under review and the outcomes of these in the Human Capital (HC) portfolio.

Introduction

Recognising the importance of a skilled workforce to deliver on the CSIR's mandate and national strategic objectives, the CSIR prioritises the development of its staff in science, engineering and technology (SET) fields. This strategic investment cultivates a diverse and innovative talent pool dedicated to addressing South Africa's socioeconomic challenges through research and technological advancements. By empowering its workforce to actively contribute to national imperatives, the CSIR strengthens its role in driving a sustainable and prosperous future for the country.

The transformation of CSIR staff, particularly within the SET base, continues to be a priority and significant progress has been achieved in the last few years in terms of demographic diversity and strengthening the SET base. There has been notable advancement in the representation of transformed staff at the senior and middle management levels, along with an increase in the representation of female staff.

The benefits of implementing the talent reviews and succession planning for the 2023/24 financial year (FY) have been realised by the organisation. This positive step towards building a pool of suitably qualified employees has resulted in internal appointments at the top leadership level being filled by successors. Succession planning and review processes are currently underway for lower levels in different portfolios and divisions.

HC development remains a strategic priority, ensuring our workforce possesses the necessary skills to achieve our objectives. We have implemented pipeline development programmes to attract, retain and cultivate critical talent. These programmes provide access to a wider talent pool, including PhD graduates, which contributes to increasing the percentage of staff with doctoral qualifications.

Our commitment to pipeline development programmes strengthens our talent pool, ensuring we have the right skills in place to achieve long-term success.

In the 2022/23, the successful rollout of the first Leadership and Development Management Programme (LMDP) culminated in the graduation of 44 participants. In 2023/24, a second cohort of 137 employees has joined the programme, with 123 (88%) black South Africans and 77 (55%) being female staff. Additionally, the Executive Development Programme was launched in the FY, with 11 candidates set to graduate by April 2024. Other leadership programmes implemented in this FY include Executive Coaching and Mentorship Train-the-Trainer programmes.

Efficient HC systems play a crucial role in streamlining critical management tasks such as recruitment, performance reviews and administrative processes. With this in mind, HC continues to provide reliable people data and efficient HC systems, empowering managers and strengthening the organisation's overall effectiveness. This enables managers to dedicate more time to strategic initiatives and day-to-day operations. Moreover, these systems provide continuous and reliable tracking of key organisational metrics, allowing for simplified reporting and faster, data-driven decision-making.

Through strategic partnerships with relevant external stakeholders in the National Systems of Innovation, the organisation has managed to leverage support for skills development, innovation, youth unemployment and Corporate Social Investment (CSI). With the assistance of these strategic partners, approximately 200 internships have been facilitated for unemployed youth in South Africa through various programmes. The CSIR's self-funded flagship Youth Employment Services (YES) programme continues to offer unemployed youth opportunities to work in the organisation and its partnering SMMEs, with a particular focus on female candidates and people living with disabilities.

Staff and transformation profile

Total staff profile

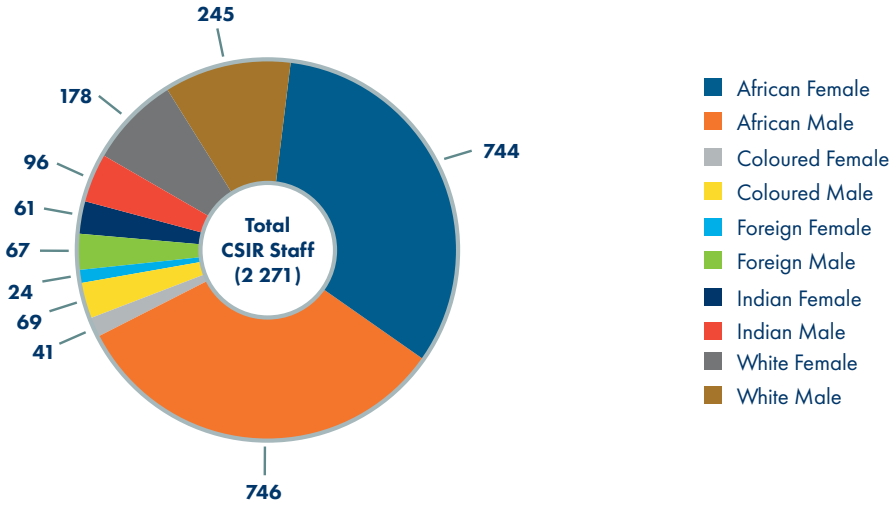


Figure 1: Staff profile

As of the end of the 2023/24 FY, the CSIR's total staff headcount stood at 2 271, reflecting an increase from 2 205 as of 31 March 2023; an increase of 66 for this FY. Of the 2023/24 headcount, 1 605 (71%) are in SET roles, while 666 (29%) are in support positions. The demographic breakdown includes 1 757 (77%) black South Africans and 1 024 (45%) female South Africans.

Table 1: CSIR staff profile as at 31 March 2023/24

Staff category	SET staff	SET staff as % of category total	Support staff	Support staff as % of category total	Total	%
Permanent	1 372	71.6%	543	28.4%	1 915	84.3%
Temporary*	83	78.3%	23	21.7%	106	4.7%
Pipeline: studentships	29	96.7%	1	3.3%	30	1.3%
Pipeline: GITs	18	100%	0	0%	18	0.8%
Pipeline: interns	74	69.2%	33	30.8%	107	4.7%
Pipeline: post doctorate	8	100%	0	0%	8	0.4%
Pipeline: YES programme	20	29.4%	48	70.6%	68	3.0%
Pipeline: WIL students	1	5.3%	18	94.7%	19	0.8%
Grand Total	**1 605**	**70.7%**	**666**	**29.3%**	**2 271**	**100.0%**

** Staff contracts less than 12 months*

SET and support staff profile

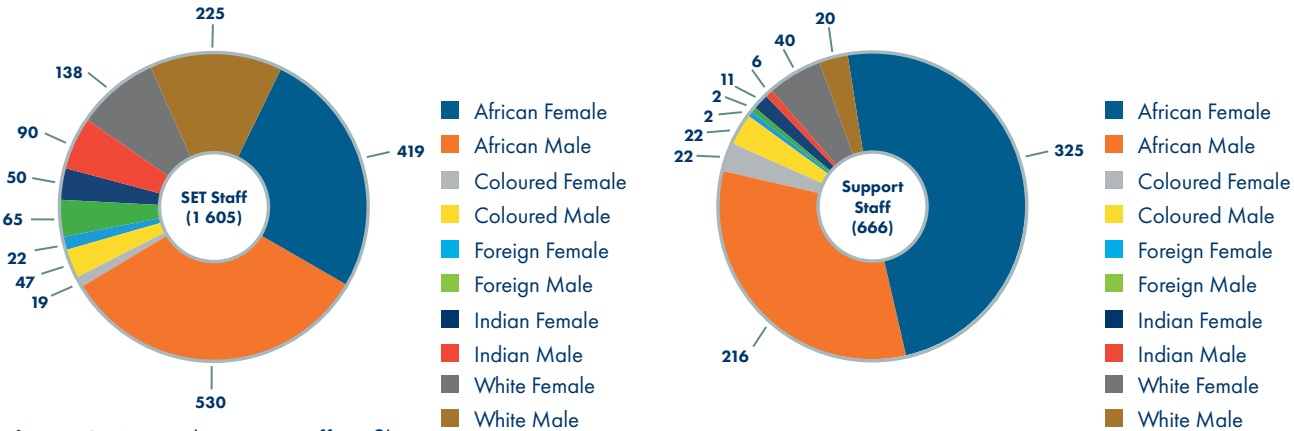


Figure 2: SET and support staff profile

CSIR employment equity performance against NEAP targets

As of 31 March 2024, the CSIR's employment equity performance against the National Economically Active Population (NEAP) targets has increased by 1.2% for black South Africans compared to FY 2022/23 as shown in the table below. When compared to four years ago (FY 2019/20), there has been an increase of 8.5% for black South Africans.

Table 2: Performance against NEAP targets

Performance	AM	AF	CM	CF	IM	IF	WM	WF	Total SA	FM	FF	Total foreign	Grand total
NEAP target %	42.7	35.8	5.2	4.4	1.7	1.1	5.1	4	100	0	0	0	100
FY19/20 average %	27.6	28.5	2.7	2.6	4.6	2.8	15.8	10.4	95	3.9	1.1	5	100
FY20/21 average %	29	28.7	2.9	2.4	4.5	2.9	14.5	10.2	95.1	3.9	1	4.9	100
FY21/22 average %	30.7	31.6	3	2.2	4.3	2.7	12.5	8.7	95.7	3.4	0.9	4.3	100
FY22/23 average %	32.1	32.1	3	2	4.4	2.5	11.5	8.4	96	3	1	4	100
FY23/24 average %	32.8	32.8	3	1.8	4.2	2.7	10.8	7.8	95.9	3	1.1	4.1	100
GAP % (FY23/24 Average vs NEAP target %)	**-9.9**	**-3**	**-2.2**	**-2.6**	**2.5**	**1.6**	**5.7**	**3.8**	**-4.1**	**3**	**1.1**	**4.1**	**0.0**

Number of staff with disabilities

As of 31 March 2024, the CSIR employed 60 staff members with disabilities, constituting 2.6% of the total staff. The CSIR's minimum target for staff members with disabilities is 2%.

A summary of the number of staff with disabilities per occupational category is provided in the table below.

Table 3: Staff with disability by occupational level

Occupational category	AM	CM	IM	WM	AF	CF	IF	WF	FM	Total	Total staff	%
Top management	0	0	0	0	0	0	0	0	0	0	21	0.00%
Senior management	0	0	0	1	0	0	0	1	0	2	95	0.09%
Middle management	2	0	0	6	0	0	1	1	1	11	859	0.48%
Skilled	1	0	2	3	0	0	1	1	0	8	970	0.35%
Semi-skilled	0	0	0	0	0	0	0	0	0	0	213	0.00%
Unskilled	12	0	0	0	27	0	0	0	0	39	113	1.72%
Total	**15**	**0**	**2**	**10**	**27**	**0**	**2**	**3**	**1**	**60**	**2 271**	**2.6%**

Staff movements

Appointments

From 1 April 2023 to 31 March 2024, a total of 377 employees were appointed, including 242 temporary employees. Among these appointments, 344 (91%) were black South Africans and 182 (48%) were female South Africans. This total number of appointments includes 135 permanent staff, of which 118 (87%) are black South Africans and 50 (37%) are female South Africans. Furthermore, 103 (76%) and 32 (24%) of the permanent appointments were in SET roles and support staff positions, respectively, for the FY 2023/24.

Table 4: Appointments by occupational level

Category	AM	AF	CM	CF	IM	IF	WM	WF	Total SA	FM	FF	Total foreign	Grand total
Top management	2	2	0	0	0	0	0	0	4	0	0	0	4
Senior management	2	1	0	0	1	0	0	1	5	1	0	1	6
Middle management	17	17	0	0	3	2	5	0	44	4	0	4	48
Skilled	36	20	2	0	3	3	4	1	69	0	1	1	70
Semi-skilled	3	3	1	0	0	0	0	0	7	0	0	0	7
Total permanent	**60**	**43**	**3**	**0**	**7**	**5**	**9**	**2**	**129**	**5**	**1**	**6**	**135**
Fixed-term contracts*	24	19	3	1	1	2	1	5	56	3	0	3	59
Pipeline: studentship	6	3	0	0	1	0	1	0	11	0	1	1	12
Pipeline: Graduates-In-Training (GIT)	1	2	0	0	0	0	0	1	4	0	0	0	4
Pipeline: Internships	31	35	1	0	1	3	1	0	72	0	0	0	72
Pipeline: post doctorate	2	2	0	0	0	0	0	1	5	1	1	2	7
Pipeline: YES programme	23	45	0	0	0	0	0	0	68	0	0	0	68
Pipeline: WIL students	7	13	0	0	0	0	0	0	20	0	0	0	20
Total temporary	94	119	4	1	3	5	3	7	236	4	2	6	242
Grand total	**154**	**162**	**7**	**1**	**10**	**10**	**12**	**9**	**365**	**9**	**3**	**12**	**377**

** Staff contracts less than 12 months*

CSIR staff exits

In the 2023/24 FY, a total of 310 employees exited the CSIR, including 141 temporary employees. Among these exits, 255 (82%) were black South Africans and 142 (46%) were female South Africans. Of the total exits, 205 (66%) were in SET roles, while support staff accounted for 105 (34%).

Table 5: Total Staff Exits

Occupational Category	AM	AF	CM	CF	IM	IF	WM	WF	Total SA	FM	FF	Total foreign	Grand total
Total permanent	66	43	4	2	6	1	23	14	159	9	1	10	169
Fixed-term contracts*	9	11	0	0	2	0	2	2	26	3	0	3	29
Pipeline	41	67	0	0	1	2	0	0	111	1	0	1	112
Total temporary	**50**	**78**	**0**	**0**	**3**	**2**	**2**	**2**	**137**	**4**	**0**	**4**	**141**
Grand total	**116**	**121**	**4**	**2**	**9**	**3**	**25**	**16**	**296**	**13**	**1**	**14**	**310**

** Staff contracts less than 12 months*

A total of 169 permanent staff have exited the CSIR since the beginning of the FY up to the end of March 2024. Among these exits, 122 (72%) were black South Africans and 60 (36%) were female South Africans. Out of the 169 permanent employees who exited, 128 (76%) were in SET roles, while 41 (24%) were support staff. The annualised turnover rate as of the end of March 2024 is 8.9% for total permanent staff and 9.4% for SET permanent staff.

Table 6: Permanent staff exits by occupational category

Occupational category	AM	AF	CM	CF	IM	IF	WM	WF	Total SA	FM	FF	Total foreign	Grand total
Top management	0	0	0	0	2	0	1	0	3	1	0	1	4
Senior management	0	1	0	0	0	0	2	1	4	1	0	1	5
Middle management	28	14	1	0	2	1	15	6	67	7	1	8	75
Skilled	28	24	3	2	2	0	5	6	70	0	0	0	70
Semi-skilled	10	4	0	0	0	0	0	1	15	0	0	0	15
Unskilled	0	0	0	0	0	0	0	0	0	0	0	0	0
Grand total	**66**	**43**	**4**	**2**	**6**	**1**	**23**	**14**	**159**	**9**	**1**	**10**	**169**

Table 7: Permanent staff exits by category

Permanent staff exits	AM	AF	CM	CF	IM	IF	WM	WF	Total SA	FM	FF	Total foreign	Grand total
Deceased	3	0	0	0	0	0	0	0	3	0	0	0	3
Dismissal	3	4	0	0	0	0	1	0	8	0	0	0	8
End of contract	0	0	0	0	0	0	0	0	0	1	0	1	1
No-fault dismissal: incapacity	1	0	0	0	0	0	0	0	1	0	0	0	1
Resignation	55	39	4	2	6	1	15	12	134	8	1	9	143
Retirement	4	0	0	0	0	0	7	2	13	0	0	0	13
Grand total	**66**	**43**	**4**	**2**	**6**	**1**	**23**	**14**	**159**	**9**	**1**	**10**	**169**

Table 8: Staff on fixed-term contracts exits

Staff on fixed-term contracts exits*	AM	AF	CM	CF	IM	IF	WM	WF	Total SA	FM	FF	Total foreign	Grand total
End of contract	50	78	0	0	3	2	2	2	137	4	0	4	141
Deceased	0	0	0	0	0	0	0	0	0	0	0	0	0
Grand total	**50**	**78**	**0**	**0**	**3**	**2**	**2**	**2**	**137**	**4**	**0**	**4**	**141**

**Staff contracts less than 12 months*

HC development

Student pipeline development

The number of students in the student pipeline programmes as of 31 March 2024, is illustrated in the following table, showing the demographics for the pipeline.

Table 9: Student pipeline programmes

Programme	AM	AF	CM	CF	IM	IF	WM	WF	Total SA	FM	FF	Total foreign	Grand total
CSIR bursary programme	40	40	1	1	3	0	2	2	89	0	0	0	89
IBS bursary programme	78	151	1	9	2	8	7	8	264	5	2	7	271
MerSETA bursaries	10	7	0	0	0	0	0	1	18	0	0	0	18
Studentships	14	11	0	0	1	0	2	0	28	1	1	2	30
GIT	7	8	0	0	0	1	0	2	18	0	0	0	18
Total	149	217	2	10	6	9	11	13	417	6	3	9	426
Percentage	**35%**	**50.9%**	**0.5%**	**2.4%**	**1.4%**	**2.1%**	**2.6%**	**3.1%**	**97.9%**	**1.4%**	**0.7%**	**2.1%**	**100.0%**

CSIR Bursary Programme

In 2024, the CSIR Bursary Programme awarded bursaries to seven students, bringing. the total number of currently funded bursary students to 89.

Inter-Bursary Support Bursary Programme

The Department of Science and Innovation (DSI) allocated a total of R44.7 million for the 2023/24 FY to support the 271 currently funded students. This cohort consists of 101 Doctoral, 94 Master's and 76 Honours students.

merSETA Bursary Programme

There are currently 18 students funded under this programme (13 undergraduates, two Master's and three Doctoral students).

Studentships

The number of studentships increased from 19 in the 2022/23 FY to 30 in the 2023/24 FY.

Staff dependents bursaries

As part of the CSIR's commitment to transforming human capital, enhancing the organisation's employee value proposition and remaining competitive, the CSIR Executive Committee (Exco) approved an initiative to provide bursaries for staff dependents.

A total of 154 applications for staff dependent bursaries were approved for staff dependents pursuing a tertiary education in the 2024 academic year.. After contract distribution, the number of applications amounted to 138, with 16 applicants having withdrawn due to various reasons. The allocation for each dependent is R35 400 before tax and any remaining amount will be deposited into the institution's account.

GIT Programme

In the 2023/24 FY, the Graduate-in-training (GIT) programme had 18 beneficiaries. Since its inception in 2019/20, the total number of graduates supported in the programme is 97. Additionally, 12 GITs have been absorbed into permanent positions, bringing the total number of graduates permanently appointed in various clusters to 57.

Unemployed youth development programmes

Table 10: Unemployed youth development programmes

Programme	AM	AF	CM	CF	IM	IF	WM	WF	Total SA	FM	FF	Total foreign	Grand total
YES	23	45	0	0	0	0	0	0	68	0	0	0	68
Internship	49	53	1	0	1	2	0	1	107	0	0	0	107
Work integrated learning (WIL)	6	13	0	0	0	0	0	0	19	0	0	0	19
Total	78	111	1	0	1	2	0	1	194	0	0	0	194
Percentage	**40.2%**	**57.2%**	**0.5%**	**0.0%**	**0.5%**	**1.0%**	**0.0%**	**0.5%**	**100.0%**	**0.0%**	**0.0%**	**0.0%**	**100.0%**

YES programme

The YES programme continues to assist the state with reducing youth unemployment. In the 2023/24 FY, a new cohort of 68 YES participants (comprising 66% female and 57% individuals with disabilities) has been appointed.

Work Integrated Learning programme

Currently, there are 19 students funded under the Manufacturing Engineering and Related Services Sector Education Training Authority (merSETA) Bursary Programme. Among them, there are 14 undergraduates, two Master's students and three doctoral students.

CSIR staff training

Technical training

During the 2023/2024 FY, the CSIR invested a total of R14 013 960 in training staff, with 1 927 employees enrolled for training: this included 19 training activities specifically designed for employees living with disabilities.

The continuation of the e-Learning platform in the 2023/24 FY allowed the organisation to complement traditional classroom-based training methods. Through this platform, CSIR employees were able to develop their capabilities by accessing behavioural, business, technical and leadership online short courses, all aimed at supporting organisational performance. As of 31 March 2024, a total of 2 203 courses and 59 108 videos have been completed online.

Leadership and management development training programmes

A graduation ceremony was held on 24 July 2023 for 44 CSIR staff members from the first cohort of the LMDP. The second LMDP cohort for FY 2023/24 commenced on 14 August 2023, with a total of 137 employees participating across different occupational levels. Among them, 123 (88%) were black South Africans and 77 (55%) were female staff. This programme is delivered in collaboration with Maccauvlei and Wits Business School.

Three new development programmes were introduced in the organisation for the 2023/24 FY:

- An **Executive Development Programme** commenced in mid-July 2023 and was delivered by the University of Cape Town Graduate School of Business (UCT GSB). The UCT GSB Executive Development Programme (EDP) is a high-impact programme designed to equip senior leaders with strategic thinking, an innovative mind-set and values-based leadership skills necessary for maintaining a long-term competitive advantage for the organisation. The EDP programme, which includes 11 delegates, is scheduled to conclude in April 2024, with a graduation ceremony planned for the same month.
- In the **Executive Coaching** programme, implemented in three phases, 18 employees were nominated to participate. The phases included coaching selection, coaching sessions and closeout. The programme spanned a maximum of nine months, with each session lasting 60 - 90 minutes and a set number of eight coaching sessions.
- The **Mentorship Train-the-Trainer** programme was launched on 16 August 2023 and sessions were conducted from 16 to 17 August 2023. A total of 20 delegates attended the training and successfully completed their portfolio of evidence in the third quarter of the FY.

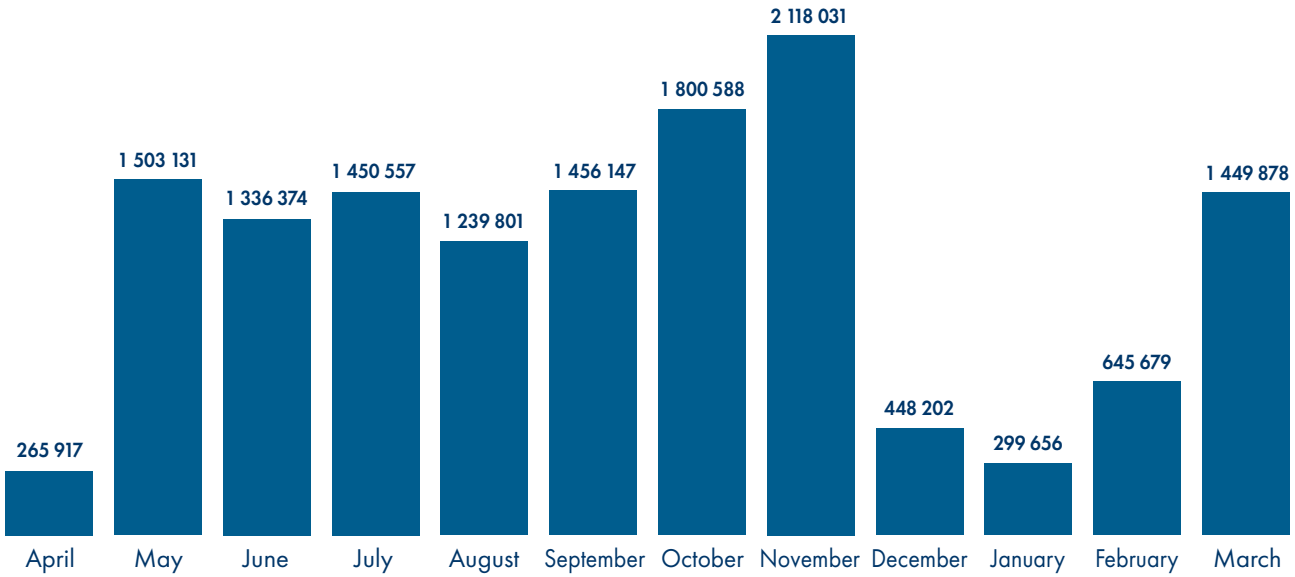


Figure 3: Summary of training costs by month

Table 11: Training costs by occupational category

Category	Number of staff	Rand	% of total
Top management	28	216 469	1.54%
Senior management	88	1 016 102	7.25%
Middle management	686	6 087 922	43.44%
Skilled	937	6 092 939	43.48%
Semi-skilled	149	521 458	3.72%
Unskilled	39	79 071	0.56%
Grand total	**1 927**	**14 013 960**	**100.00%**

Table 12: Training costs by event type

Training event	Number of staff	Amount
Computer-based training	193	1 645 334
Conferences	586	5 096 806
Seminars	1 148	7 271 820
Total	**1 927**	**14 013 960**

Table 13: Training provided by occupational categories, race and gender

Occupational Category	AM	AF	CM	CF	IM	IF	WM	WF	Total SA	FM	FF	Total foreign	Grand total
Top management	13	6	0	0	0	0	4	5	28	0	0	0	28
Senior management	27	15	8	0	8	0	25	5	88	0	0	0	88
Middle management	257	196	10	4	30	26	98	58	679	7	0	7	686
Skilled	385	382	22	10	35	11	37	55	937	0	0	0	937
Semi-skilled	95	35	15	2	1	0	0	0	148	1	0	1	149
Unskilled	26	13	0	0	0	0	0	0	39	0	0	0	39
Grand total	**803**	**647**	**55**	**16**	**74**	**37**	**164**	**123**	**1 919**	**8**	**0**	**8**	**1 927**

- **External stakeholder engagements on skills development**
  HC continues to engage relevant external stakeholders to establish strategic partnerships with key entities in the National System of Innovation, aimed at supporting skills development, innovation and Corporate Social Investment (CSI) initiatives. Through these partnerships, the CSIR secured R13 million from SETAs and R44.7 million from the DSI in the FY.

The CSIR has entered into a strategic partnership with the National Skills Fund (NSF) to advance skills development initiatives. Eight proposed programmes have been submitted to the NSF for funding consideration, marking the operationalisation of this partnership. Subsequently, a due diligence meeting was convened at the CSIR premises on 9 April 2024. The evaluation of these proposals is in its final stages, with the outcome anticipated in the first quarter of the next FY.

The CSIR is piloting an apprenticeship programme in partnership with merSETA. Workplace approval has been obtained for fitter and turner and machine and tool setter positions in Pretoria. Efforts to obtain workplace approval in Stellenbosch are ongoing, in coordination with merSETA's Western Cape regional office.

Talent management

Talent review

In the 2020/21 business plan, the CSIR committed to develop a Talent Management Framework to enhance the talent pipeline and succession plans. To this effect, the CSIR continued to implement talent reviews and succession planning reviews, assessments matrix and identified the succession pools at Executive level down to senior management level and scarce and critical roles in FY 2023/24. In the last quarter of FY 2023/24, succession planning and review processes began for lower levels in different portfolios and divisions within the organisation.

Career pathing

An experience navigator tool has been introduced in the CSIR to allow employees to identify gaps in their current profile and their desired future roles, enabling proactive

measures to address these gaps and prepare for the next role in their career path. The experience navigator has been extensively discussed and presented to line managers and employees across all portfolios during the 2023/24 FY and it is mainly targeted at employees that are considered as support within the organisation. Presentations to line managers included the process of linking career aspirations discussions with performance evaluations, aiming to develop comprehensive individual development plans for employees. The navigator tool is used to construct a profile of individual job experience to date and allows for an individual to correspond with their career aspiration within the CSIR.

Attraction and retention initiatives

The implementation of approved frameworks continued in the 2023/24 FY as part of the ongoing effort to attract and retain SET staff at identified levels:

- Attraction and retention of chief and principal researchers;
- Attraction and retention of SET females;
- The Accelerated Principal Researcher Programme; and
- The Capability Development Investment Programme aimed at attracting chief researchers from the external market.
- Staff dependents bursaries
    - As part of our commitment to transforming human capital, enhancing the organisation's employee value proposition and remaining competitive, the CSIR Executive Committee (Exco) approved an initiative to provide bursaries for staff dependents. This opportunity is available to all dependents of employees who are pursuing a tertiary education in the 2024 academic year.
    - A total of 154 applications for staff dependent bursaries were approved. After contract distribution, the number of applications amounted to 138, with 16 applicants having withdrawn due to various reasons. The allocation for each dependent is R35 400 before tax and any remaining amount will be deposited into the institution's account.

Performance management

The performance management system has been enhanced to align more closely with business requirements. Furthermore, staff members received training to augment their understanding of the performance management process. This training included informative videos explaining system processes, with links to these videos included in automated system emails for new employees. LinkedIn Learning training videos on conducting successful performance reviews were shared with the organisation as part of the communication regarding performance management. The performance management cycle achieved a 100% performance contracting of employees and 100% completed performance reviews for the FY 2023/24. The 360 feedback was rolled out once again and achieved an impressive usage rate of 67%.

Rewards and recognition

- **Excellence Awards**
  The CSIR will be hosting its Excellence Awards in November 2024 to recognise its employees in 21 categories. Various aspects of the Awards have been reviewed, with organisational-wide input. This review included various aspects such as award categories, monetary values of the awards and the terms of reference for the adjudication committees. Proposed changes and the nomination of panel members for adjudication will be presented to Exco in the first quarter of the next FY for approval.

- **New funeral scheme**
  As part of improving the employee benefits, the CSIR decided to consolidate its risk insurance product offerings and move the funeral cover policy to Sanlam. Negotiations have resulted in higher funeral cover amounts under the new policy, offered at a reduced monthly premium, benefiting CSIR employees.

- **Alumni Programme**
  Following the launch of the CSIR Alumni and Emeritus Programme in the previous FY, there has been a significant increase in former employees joining the programme in the 2023/24 FY. Currently, the programme has 1 085 members, with 50 of them volunteering to mentor the 22 aspiring entrepreneurs enrolled in the CSIR Entrepreneurship Development Programme.

- **CSIR staff bank preferential rates**
  As part of enhancing the staff benefits, the CSIR embarked on a project to support the financial well-being of its employees by inviting three major banks (First National Bank, Absa and Standard Bank) present CSIR employees with exclusive preferential rates. Additionally, to support the financial well-being of employees, these banks conducted a series of informative webinars.

Employee relations and transformation

The CSIR continues to see a sharp decline in the number of pending employee relations cases due to the capacity building of line managers and HC professionals in the organisation. The prompt handling and resolution of matters without compromising thoroughness and quality have contributed to this decline. Further capacity training initiatives were introduced in the FY aimed at identifying and training selected line managers to serve as initiators and chairpersons for employee relations processes.

Internal and external employee relations matters

Table 14: Summary of internal and external employee relations matters

Matters	Investigations	Disciplinary	Grievances	Incapacity	CCMA	Labour court	Total
Active	2	2	3	6*	3	0	16
Closed	14	14	10	8	3	1	50

** All six active incapacity cases are incapacity due to ill health or injury*

Employment Equity Report

The Employment Equity Report for 2023 was submitted to the Department of Employment and Labour on 8 December 2023.

Employee wellness

Psychosocial intervention

The Mental Health and Well-being programme for the current year concluded in the last week of November 2023 with notable improvements in webinar attendance of over 200 on average per session. Eight webinars covered a variety of topics, including "My purpose and career fulfilment", "My organisation, my purpose – the intersection", "My purpose, my well-being" and resilience and capacity building.

Climate Survey

With the completion of the climate survey conducted in the 2021/22 FY and the development of divisional/portfolio response plans in the 2022/23 FY, the focus shifted to implementing these plans in the 2023/24 FY. Various strategic initiatives and interventions such as executive coaching, management and leadership development, team cohesion interventions, talent management and employee value proposition were rolled out.

Additionally, the pulse survey was conducted during the FY to monitor progress against the response plans. The results demonstrated an increase in the participation rate from 51.6% in 2021 to 53.1% in 2023. A significant improvement of 10.6% was observed in the dimension of open and honest communication and a notable improvement of 11,4% was seen in the dimension of values modelling. This suggests that the programmes and interventions currently being rolled-out across the organisation are beginning to yield results.

Sports and recreation

The Comrades Marathon took place on 11 June 2023, with 26 runners from the CSIR Running Club and CSIR employees participating. Twenty-four of the runners reached the finish line, resulting in a successful completion rate of 92%.

The 30th CSIR Race was held on 21 October 2023, with over 290 running clubs participating. A total of 1 573 runners commenced the race, with 1 399 crossing the finish line. Among them, 799 completed the 10 km race, while 600 completed the 21 km race. The prominent sponsors of the race were VW, Sanlam and First National Bank.

HC system improvements

360° Performance Assessment tool

An enhanced 360 performance assessment tool was developed and implemented. The questionnaire for this assessment tool is aligned with CSIR values, reflecting the organisation's commitment to creating a values-based culture.

Automation of processes

To increase efficiency and maintain the integrity of HC-related services, the following processes were automated during the FY:

- The APEX annual increase system, facilitating accurate calculation of annual increases;
- The APEX bonus system, which was used to successfully calculate bonuses for employees;
- The Approval to Serve as a Director system;
- The Declaration of Interest process; and
- The Declaration of Private/Professional Extra Work process.

Human resource oversight statistics

Personnel related expenditure

Table 15: Personnel cost by programme/activity/objective

Programme/activity/objective	Total expenditure for the entity (R'000)	Personnel expenditure (R'000)	Personnel expenditure as a % of total exp.	No. of employees	Average personnel cost per employee (R'000)
CSIR Advanced Chemistry and Life Sciences Division	310 744	160 292	52%	232	690.91
CSIR Advanced Production and Security Division	877 231	531 535	61%	636	835.75
CSIR Smart Society Division	1 059 993	580 177	55%	736	788.28
Business Excellence and Integration Portfolio	177 914	70 869	40%	81	874.93
Chief Financial Officer Portfolio	173 618	126 461	73%	187	676.26
Human Capital and Communications Portfolio	156 269	81 912	52%	128	639.94
Legal Compliance and Business Enablement Portfolio	329 721	130 862	40%	242	540.75
CSIR Leadership and Governance	52 972	47 667	90%	29	1 643.64
Total	**3 138 462**	**1 729 775**	**55%**	**2 271**	**761.68**
Provision for STI 2023/24	73 007	73 007			
Post retirement benefit	1 029	1 029			
Total costs	**3 212 498**	**1 803 811**			

Table 16: Personnel cost by salary band

Level	Personnel expenditure (R'000)	% of personnel exp. to total personnel cost	No. of employees	Average personnel cost per employee (R'000)
Top management	65 962	3.81%	21	3 141
Senior management	189 386	10.95%	95	1 994
Professional qualified	938 529	54.26%	859	1 093
Skilled	470 810	27.22%	970	485
Semi-skilled	55 926	3.23%	213	263
Unskilled	9 162	0.53%	113	81
Total	**1 729 775**	**100.00%**	**2271**	**762**

Table 17: Performance rewards

Programme/activity/ objective	Performance rewards	Personnel expenditure (R'000)	% of performance rewards to total personnel cost
Top management	8 082	65 962	12%
Senior management	15 733	189 386	8%
Professional qualified	52 384	938 529	6%
Skilled	18 653	470 810	4%
Semi-skilled	2 351	55 926	4%
Unskilled	31	9 162	0%
Total	**97 234**	**1 729 775**	**6%**
Provision for STI 2023/24		73 007	
Post retirement benefit 2023/24		1 029	
Total employees remuneration		**1 803 811**	

Table 18: Performance rewards

Programme/activity/ objective	Personnel expenditure (R'000)	Training expenditure (R'000)	Training expenditure as a % of personnel cost.	No. of employees trained	Average training cost per employee
CSIR Advanced Chemistry and Life Sciences Division	160 292	764	0.5%	98	8
CSIR Advanced Production and Security Division	531 535	7 007	1.3%	347	20
CSIR Smart Society Division	580 177	3 868	0.7%	270	14
Business Excellence and Integration Portfolio	70 869	477	0.7%	39	12
Chief Financial Officer Portfolio	126 461	521	0.4%	71	7
Human Capital and Communications Portfolio	81 912	359	0.4%	24	15
Legal Compliance and Business Enablement Portfolio	130 862	863	0.7%	117	7
CSIR Leadership and Governance	47 666	155	0.3%	12	13
Total	**1 729 775**	**14 014**	**0.8%**	**978**	**14**
Provision for STI 2023/24	73 007				
Post retirement benefit	1 029				
Total costs	**1 803 811**				

Table 19: Employment and vacancies

Programme/activity/ objective	2022/23 No. of employees	2023/24 approved posts	2023/24 No. of employees	2023/24 vacancies	% of vacancies
CSIR Advanced Chemistry and Life Sciences Division	221	251	232	19	7.57%
CSIR Advanced Production and Security Division	618	684	636	48	7.02%
CSIR Smart Society Division	694	810	736	74	9.14%
Business Excellence and Integration Portfolio	81	87	81	6	6.90%
Chief Financial Officer Portfolio	192	197	187	10	5.08%
Human Capital and Communications Portfolio	129	133	128	5	3.76%
Legal Compliance and Business Enablement Portfolio	240	279	242	37	13.26%
CSIR Leadership and Governance	30	30	29	1	3.33%
Total	**2 205**	**2 471**	**2 271**	**200**	**8.09%**

Programme/activity/ objective	2022/23 No. of employees	2023/24 approved posts	2023/24 No. of employees	2023/24 vacancies	% of vacancies
Top Management	20	21	21	0	0%
Senior Management	91	105	95	10	9.52%
Professional qualified	858	934	859	75	8.03%
Skilled	929	1041	970	71	6.82%
Semi-skilled	208	229	213	16	6.99%
Unskilled	99	141	113	28	19.86%
Total	**2 205**	**2 471**	**2 271**	**200**	**8.09%**

Several attempts made in filling critical vacancies (senior management, and other hard-to-fill highly skilled positions) and as a result we engaged with the recruitment agencies, LinkedIn search and referrals which assisted in improving turnaround times and filled all Executive vacancies. Vacancies at these categories were filled in an average of +-150 days and this is due to scarcity of skills in the market, competition with private sector and multinational companies for skills in ICT and other critical science and engineering areas. Internal candidates were promoted where the pool existed but in instances where the pool is still developing, external candidates were considered. The CSIR has implemented a succession planning process, and this has resulted in succession pools of potential candidates with focused development plans. Some of the succession pool candidates have been appointed in executive positions.

The use of LinkedIn, referrals and active engagements and planning with hiring managers coupled with engagement of professional bodies, universities and other placement organisations (agencies and bootcamp organisations) have been engaged to improve the attractiveness of the organisation. For additional retention interventions, formalised organisational review platforms took place, as well as analysing data from survey outcomes to improve retention and attractiveness.

Table 20: Employment changes

Salary band	Employment at beginning of period	Appointments	Terminations	Internal movements (Promotions, type changes, renewal of contracts)	Employment at end of the period
Top Management	20	4	5	2	21
Senior Management	91	7	6	3	95
Professional qualified	858	71	93	23	859
Skilled	929	177	125	-11	970
Semi-skilled	208	27	26	4	213
Unskilled	99	91	61	-16	113
Total	**2 205**	**377**	**316**	**5**	**2 271**

Turnover Rate for Permanent employees = 8.9% and for Permanent SET employees = 9.4%

Table 21: Reasons for staff leaving

Reason	Number	% of total no. of staff leaving
Death	3	0.95%
Resignation	141	44.62%
Dismissal	9	2.85%
Retirement	9	2.85%
Ill health	1	0.32%
Expiry of contract	152	48.10%
Other	1	0.32%
Total	**316**	**100.00%**

Table 22: Labour Relations: Misconduct and disciplinary action

Nature of disciplinary Action	Number
Verbal Warning	13
Written Warning	10
Final Written warning	4
Dismissal	9

The main reasons for employees exiting the organisation were improved career development (41%) followed by employees looking for higher salaries and benefits (9%). Interventions to replace these staff members include recruitment from the market and also the absorption of the organisation's pipeline into those positions.

Table 23: Equity Target and Employment Equity Status

Levels	MALE							
	African		Coloured		Indian		White	
	Current	Target	Current	Target	Current	Target	Current	Target
Top Management	11	7	0	0	1	0	3	3
Senior Management	30	25	6	5	8	11	21	21
Professional qualified	213	189	24	26	58	43	177	258
Skilled	359	320	25	19	28	39	44	97
Semi-skilled	91	89	14	11	1	0	0	0
Unskilled	42	46	0	6	0	2	0	9
Total	**746**	**676**	**69**	**67**	**96**	**95**	**245**	**388**

Table 24: Equity Target and Employment Equity Status

Levels	FEMALE							
	African		Coloured		Indian		White	
	Current	Target	Current	Target	Current	Target	Current	Target
Top Management	3	4	0	1	0	0	2	1
Senior Management	8	14	0	2	0	2	9	8
Professional qualified	177	120	10	26	29	26	107	112
Skilled	394	320	21	29	30	39	56	107
Semi-skilled	91	85	10	17	2	2	4	6
Unskilled	71	38	0	2	0	2	0	8
TOTAL	**744**	**581**	**41**	**77**	**61**	**71**	**178**	**242**

Table 25: Equity Target and Employment Equity Status

Levels	DISABLED STAFF			
	Male		Female	
	Current	Target	Current	Target
Top Management	0	0%	0	0%
Senior Management	1	0%	1	0%
Professional qualified	9	0.30%	2	0.01%
Skilled	6	0.20%	2	0.01%
Semi-skilled	0	0%	0	0%
Unskilled	12	0.50%	27	0.98%
TOTAL	**28**	**1%**	**32**	**1%**

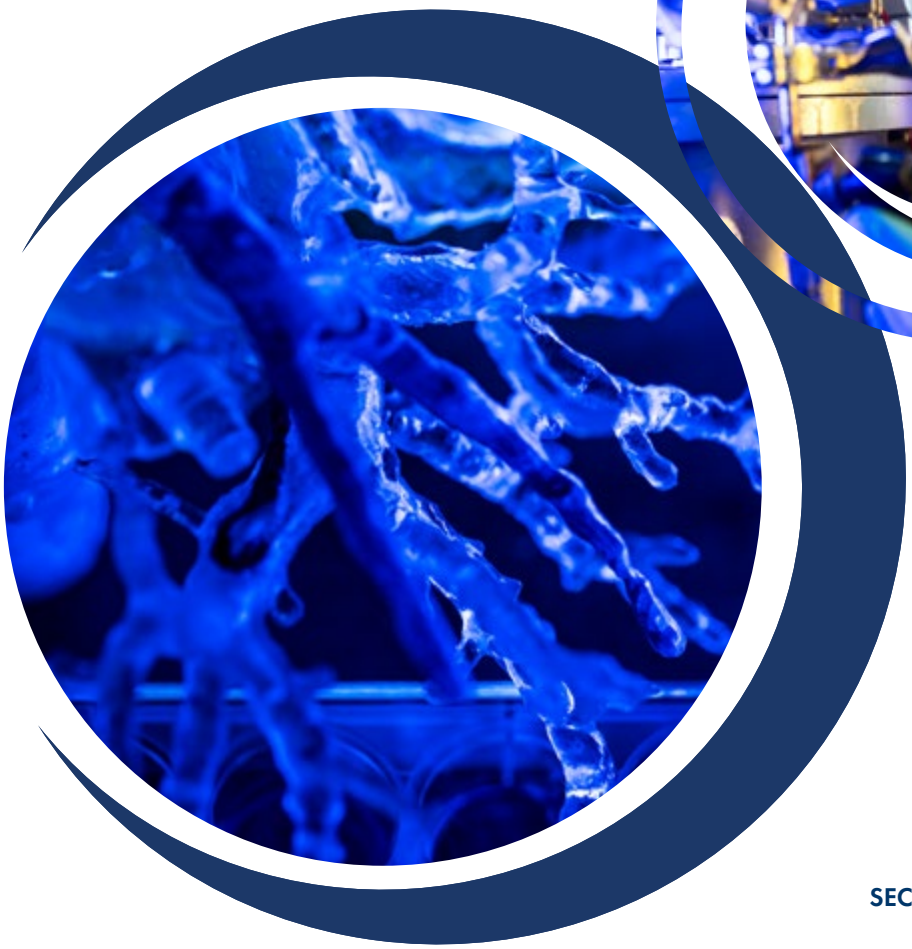
SECTION F

PFMA compliance report

SECTION F

PFMA compliance report

This section relates to information to be reported in the annual report pertaining to PFMA compliance requirements.



Irregular, fruitless and wasteful expenditure and material losses

Irregular expenditure

a) Reconciliation of irregular expenditure

Description	2023/24	2022/23
	R'000	R'000
Opening balance	12 530	11 799
Adjustment to opening balance	110	-
Opening balance as restated	12 640	-
Add: Irregular expenditure confirmed	-	841
Less: Irregular expenditure condoned	(162)	-
Less: Irregular expenditure not condoned and removed	(10 603)	-
Less: Irregular expenditure recoverable[1]	-	-
Less: Irregular expenditure not recoverable and written off	-	-
Add: Adjustment	73	-
Closing balance	**1 948**	**12 530**

1 Transfer to receivables

During the 2023/24 financial year, a casting error was identified in the closing balance of 2022/23. As a result, the opening balance was adjusted to correctly reflect R12 640 000.

A detailed review of the irregular expenditure register was performed during the year, resulting in several adjustments, with a cumulative effect of R73 000, to accurately disclose the irregular expenditure amount in accordance with relevant legislation.

During the financial year ended 31 March 2023, the PFMA Compliance and Reporting Framework introduced compliance reporting requirements effective on 3 January 2023, mandating that the amounts disclosed for irregular expenditure must be inclusive of VAT. As the reporting requirements only became effective on 3 January 2023, it should be noted that the amounts disclosed for irregular expenditure relating to the period before the effective date (included in the opening balances) are VAT exclusive.

Reconciling notes to the annual financial statement disclosure

Description	2023/24	2022/23
	R'000	R'000
Irregular expenditure that was under assessment in 2022/23	-	-
Irregular expenditure that relates to the prior year and identified in the current year	-	-
Irregular expenditure for the current year	-	841
Total	**-**	**841**

b) Details of irregular expenditure (under assessment, determination and investigation)

Description[2]	2023/24	2022/23
	R'000	R'000
Irregular expenditure under assessment	3 715	212
Irregular expenditure under determination	-	-
Irregular expenditure under investigation	-	-
Total	**3 715**	**212**

2 Group similar items

c) Details of irregular expenditure condoned

Description	2023/24	2022/23
	R'000	R'000
Irregular expenditure condoned	162	-
Total	**162**	**-**

d) Details of irregular expenditure removed (not condoned)

Description	2023/24	2022/23
	R'000	R'000
Irregular expenditure NOT condoned and removed	10 603	-
Total	**10 603**	**-**

Irregular expenditure of R10.603 million relating to prior years was considered and approved by the CSIR Board for removal in line with the relevant National Treasury Instruction Notes.

e) Details of irregular expenditure recoverable

Description	2023/24	2022/23
	R'000	R'000
Irregular expenditure recoverable	-	-
Total	**-**	**-**

f) Details of current and previous year irregular expenditure written off (irrecoverable)

Description	2023/24	2022/23
	R'000	R'000
Irregular expenditure written off	-	-
Total	**-**	**-**

Additional disclosure relating to inter-institutional arrangements

g) Details of non-compliance cases where an institution is involved in an inter-institutional arrangement (where such institution is not responsible for the non-compliance)

Description
None
Total

h) Details of irregular expenditure where an institution is involved in an inter-institutional arrangement (where such institution is responsible for the non-compliance)[3]

Description	2023/24	2022/23
	R'000	R'000
None	-	-
Total	**-**	**-**

3 Refer to paragraphs 3.12, 3.13 and 3.14 of Annexure A (PFMA Compliance and Reporting Framework) to National Treasury Instruction No. 4 of 2022/23

i) Details of disciplinary or criminal steps taken as a result of irregular expenditure

Disciplinary steps taken
In the previous financial year 2022/23, consequence management in progress amounted to R 771 000 and consequence management implemented amounted to R 879 000.
In the current year 2023/24, there is no consequence management in progress, but consequence management implemented amounted to R 269 000.

Fruitless and wasteful expenditure

a) Reconciliation of fruitless and wasteful expenditure

Description	2023/24	2022/23
	R'000	R'000
Opening balance	191	191
Adjustment to opening balance	-	-
Opening balance as restated	-	-
Add: Fruitless and wasteful expenditure confirmed	-	-
Less: Fruitless and wasteful expenditure recoverable[4]	-	-
Less: Fruitless and wasteful expenditure not recoverable and written off	-	-
Closing balance	**191**	**191**

4 Transfer to receivables

During the financial year ended 31 March 2023, the PFMA Compliance and Reporting Framework introduced compliance reporting requirements effective on 3 January 2023, mandating that the amounts disclosed for fruitless and wasteful expenditure must be inclusive of VAT. As the reporting requirements only became effective on 3 January 2023, it should be noted that the amounts disclosed for fruitless and wasteful expenditure relating to the period before the effective date (included in the opening balances) are VAT exclusive.

Reconciling notes to the annual financial statement disclosure

Description	2023/24	2022/23
	R'000	R'000
Fruitless and wasteful expenditure that was under assessment in 2022/23	-	-
Fruitless and wasteful expenditure that relates to the prior year and identified in the current year	-	-
Fruitless and wasteful expenditure for the current year	-	-
Total	**-**	**-**

b) Details of fruitless and wasteful expenditure (under assessment, determination and investigation)

Description[5]	2023/24	2022/23
	R'000	R'000
Fruitless and wasteful expenditure under assessment	24	-
Fruitless and wasteful expenditure under determination	-	-
Fruitless and wasteful expenditure under investigation	-	-
Total	**24**	**-**

5 Group similar items

c) Details of fruitless and wasteful expenditure recoverable

Description	2023/24	2022/23
	R'000	R'000
Fruitless and wasteful expenditure recoverable	-	-
Total	**-**	**-**

d) Details of fruitless and wasteful expenditure not recoverable and written off

Description	2023/24	2022/23
	R'000	R'000
Fruitless and wasteful expenditure written off	-	-
Total	**-**	**-**

e) Details of disciplinary or criminal steps taken as a result of fruitless and wasteful expenditure

Disciplinary steps taken
N/A

Additional disclosure relating to material losses in terms of PFMA Section 55(2)(b)(i) & (iii)[6]

6 Information related to material losses must also be disclosed in the annual financial statements.

a) Details of material losses through criminal conduct

Material losses through criminal conduct	2023/24	2022/23
	R'000	R'000
Theft	-	-
Other material losses	-	-
Less: Recoverable	-	-
Less: Not recoverable and written off	-	-
Total	**-**	**-**

b) Details of other material losses

Nature of other material losses	2023/24	2022/23
	R'000	R'000
None	-	-
Total	**-**	**-**

c) Other material losses recoverable

Nature of losses	2023/24	2022/23
	R'000	R'000
None	-	-
Total	**-**	**-**

d) Other material losses not recoverable and written off

Nature of losses	2023/24	2022/23
	R'000	R'000
None	-	-
Total	**-**	**-**

Late and/or non-payment of suppliers

Description	Number of invoices	Consolidated value R'000
Valid invoices received	55 427	1 581 402
Invoices paid within 30 days or agreed period	53 553	1 543 979
Invoices paid after 30 days or agreed period	866	23 213
Invoices older than 30 days or agreed period (unpaid and without dispute)	35	9 858
Invoices older than 30 days or agreed period (unpaid and in dispute)	41	138

The CSIR's standard contractually agreed payment terms are 45 days from the invoice date, except where explicitly agreed otherwise. Invoices not settled within the agreed period are primarily due to the supplier's tax status changing to non-compliant, preventing the CSIR from processing the invoice.

Supply chain management

Procurement by other means: Format of disclosure

Project description	Name of supplier	Type of procurement by other means	Contract number	Value of contract R'000
Provision of LinkedIn e-learning subscription	LinkedIn Ireland Unlimited Company	Single source procurement	SIN 238	R2 552
Bulk argon gas	Air Products South Africa (Pty) Ltd	Single source procurement	SIN 239	R3 744
Bulk procurement of reagents	Merck Life Sciences (PTY) Ltd	Single source procurement	SIN 260	R1 500
Annual renewal of PBSPro Resource Manager Software Licenses and Support, for the HPC system	Eclipse Holdings (Pty) Ltd	Single source procurement	SIN 244	R9 200
The provision of BIOVIA Materials Studio for Non-Profit Research	Dassault Systems South Africa (Pty) Ltd	Single source procurement	SIN 245A	R2 792
Development of an interface mechanism	Midnite Aerospace Solutions (Pty) Ltd	Single source procurement	SSP 3576	R6 880
Mamba Steel Rims and Tyres	Global Wheel (Pty) Ltd	Single source procurement	SSP 3579	R1 604
Microsoft Enterprise Agreement renewal 1 Feb 2024 - 31 March 2026	Microsoft Ireland Operations limited	Single source procurement	SSP 3598	R31 275
Baseline 1: Test and Evaluation: Development of user stories, Systems Engineering, Pre-Mission planning user stories development, User Interface/ Frontend, Pre-Mission planning design and development Backend, Application architecture, Data model design	Midnite Aerospace Solutions (Pty) Ltd	Single source procurement	SSP 3623	R2 422

Project description	Name of supplier	Type of procurement by other means	Contract number	Value of contract R'000
Procurement of Hardware Maintenance and Software Support Services for the NICIS Cloud Production Platform (Sebowa)	Linomtha ICT (Pty) Ltd.	Single source procurement	SSP 3627	R7 121
The supply of Inductively Coupled Plasma Optical Emission Spectrometer	Anatech Instruments (Pty) Ltd	Single source procurement	SSP 3632	R2 247
Maintenance of Siemens Software Licenses	Siemens Industry Software (Pty) Ltd	Single source procurement	SSP 3679	R2 237
YLS-2000-SM feeding fiber	Olicasize (Pty) Ltd	Single source procurement	SSP 3706A	R3 369
Renewal Of Oracle Agreement 1954192	Oracle Corporation (South Africa) (Pty) Ltd	Single source procurement	SSP 3720	R2 006
Renewal Of Oracle Agreement 3010252	Oracle Corporation (South Africa) (Pty) Ltd	Single source procurement	SSP 3721	R2 070
Annual Subscription for One [1] STAR-CCM+ Power Session (unlimited Cores)	Aerotherm Computational Dynamics CC	Single source procurement	SSP 3723	R1 673
Laser cladding nozzle	Anatech Instruments (Pty) Ltd	Single source procurement	SSP 3729	R1 552
Once-off servicing of the Millipore and MilliQ used in the bioprocessing department to purify the water	Esri South Africa (Pty) Ltd	Single source procurement	SSP 3748	R1 670
CSIR participation at the Smarter Mobility Africa Summit 1 - 3 October 2023	ECM Technologies (Pty) Ltd	Single source procurement	SSP 3752	R1 638
Renewal of Quantec EasyData Annual Subscription (01 September 2023 – 31 August 2024)	AV Simulation SAS	Single source procurement	SSP 3755	R3 782
Advertising space for an article for the Municipal Capability and Partnership Programme in the *Municipal Focus* Magazine	Bruker South Africa (Pty) Ltd	Single source procurement	SSP 3762	R4 037
Talkwalker platform for open-source intelligence in the National Policy Data Observatory	Oracle Corporation (South Africa) (Pty) Ltd	Single source procurement	SSP 3781	R2 100
Analog module faulty channel	Global Wheel (Pty) Ltd	Single source procurement	SSP 3786	R1 604
HEPA exhaust filters for biosafety cabinet	Underwater Surveys (Pty) Ltd	Single source procurement	SSP 3789	R10 946
SA Profile Magazine	MicroSep (Pty) Ltd	Single source procurement	SSP 3796	R3 000
Tyre testing and parametrisation in accordance with RSA-MIL-HDBK-62	Oracle Corporation (South Africa) (Pty) Ltd	Single source procurement	SSP 3811	R1 560

Project description	Name of supplier	Type of procurement by other means	Contract number	Value of contract R'000
Procurement of a torsion vibration damper for a Deutz F6L912 engine number 6373967	ECM Technologies (Pty) Ltd	Single source procurement	SSP 3822	R1 718
Renewal of SuperPro Designer license	TENET	Single source procurement	SSP 3824	R10 608
Annual renewal of business licences (SimaPro Compact, Analyst, Developer)	EBSCO International Inc	Single source procurement	SSP 3826	R2 135
TWP2M2-NIR Broadband electro-optic phase modulator	Elsevier B.V	Single source procurement	SSP 3853	R2 750
Credit Card: Audio Recorder	Oracle Corporation SA	Single source procurement	SSP 3911	R5 489
Renewal of the Springer Transformative Agreement subscription for 2024	Microsoft SA	Single source procurement	SSP 3912	R2 369
Repairs and factory calibration of Scanivalve ZOC33 Module (miniature pressure scanning instrument)	Management Planning Systems (Pty) Ltd	Single source procurement	SSP 3938	R1 500
Matlab commercial license renewal	Oracle Corporation South Africa (Pty) Ltd	Single source procurement	SSP 3989A	R1 998
IMAGINE Software Maintenance Renewal	Opti-Num Solutions (Pty) Ltd	Single source procurement	SSP 3996	R3 450
Bursary Application System Subscription Renewal 2024-2025	Elsevier B.V	Single source procurement	SSP 4007	R2 015
American Chemical Society (ACS) - Subscription Renewal (2024)	Oracle Corporation South Africa (Pty) Ltd	Single source procurement	SSP 4037	R4 951
The provision of Oracle Software Update License & Support annual renewal	Bentley Systems International Limited	Single source procurement	SSP 4042	R1 519
14-004-1-WC Altium Designer Commercial Subscription Renewal.	Ekasilam Technologies (Pty) Ltd	Single source procurement	SSP 4048	R3 000
Bentley AssetWise ALIM Renewal Subscription for 2024	Gartner South Africa (Pty) Ltd	Single source procurement	SSP 4050	R2 310
Geographic Information System and Sensor Fusion Support	Axiz (Pty) Ltd	Single source procurement	SSP 4055	R3 918
Transblot Turbo Starter System	Promolab (Pty) Ltd	Single source procurement	SSP3545	R1 945
Servicing of the Chromatography instruments	Promolab (Pty) Ltd	Single source procurement	SSP3546	R2 412

Contract variations and expansions: Format of disclosure

Project description	Name of supplier	Contract modification type (Expansion or Variation)	Contract number	Original contract value	Value of previous contract expansion/s or variation/s (if applicable)	Value of current contract expansion or variation
				R'000	R'000	R'000
CTFL Waste Disposal	Rag Clean CC	Variation	PO1000820237	R2 990	N/A	R777
Guarding Security Services	G4S Secure Solutions SA Pty Ltd	Expansion	PO1000827079	R70 890	R6 467	R10 942
Fortigate Firewall License renewal for 6 months	Securicom (Pty) Ltd	Variation	PO1000749230	R7 174	N/A	R1 322
Legal services for a pending case	Lusenga Attorneys	Variation	PO1000795468	R53	0	R52
TENET Expansion	Tertiary Education & Research Network of South Africa	Expansion	PO1000831240	R8 525	N/A	R1 768
Provision of cleaning services to the CSIR Kwa-Zulu Natal and Western Cape Region	Monabo Hygiene Services (Pty) Ltd	Expansion	PO1000837863	R5 963	0	R1 455
Provision of cleaning services to the CSIR Gauteng Region	Quatro Cleaning Services	Expansion	PO1000842512	R49 843	0	R11 944
One year renewal of Dassault Biovia Materials Studio software license for CHPC users	Dassault Systèmes South Africa (Pty) Ltd.	Variation	PO1000830874	R1 299	N/A	R1 299
Appointment of professional electrical engineering services consultant for the design and implementation of back-up generator and upgrade of the existing MLV distribution board.	PLP Consulting Engineers (Pty) Ltd	Variation	PO1000782389	R416	0	R379

Project description	Name of supplier	Contract modification type (Expansion or Variation)	Contract number	Original contract value	Value of previous contract expansion/s or variation/s (if applicable)	Value of current contract expansion or variation
				R'000	R'000	R'000
The provision of seasonal casual labour/temporary staffing solutions to the CSIR International Convention Centre	SD Recruitment (Pty) Ltd	Variation	PO1000828063	R1 500	N/A	R1 500
Solar PV Installations	K2022774548 South Africa (Pty) Ltd	Variation	PO1000839018	R496	N/A	R129
Solar PV Installations	Liswoga enterprise Holding (Pty) Ltd	Variation	PO1000838790	R1 194	N/A	R232
The supply of Fortigate firewall license renewal, support and maintenance for period of six (6) months	Securicom (Pty) Ltd	Variation	PO1000749230	R7 174	R1 322	R1 666
Dynamic and Static Shear Modulus tests on Aseismic bearing samples	Investmech (Pty) Ltd	Variation	PO1000842989	R601	N/A	R148
The support, maintenance, and software assurance of critical network equipment	AE Soft (Pty) Ltd	Variation	PO1000789126	R3 170	N/A	R1 415
The support, maintenance, and software assurance of critical network equipment	21st Century Pay Solutions Company (Pty) Ltd	Variation	PO1000826293	R372	N/A	R82
Removal and repacking of Gabion walls to the T1 and T7 at the DBEL Facility in Paardefontein	Bajadi Investments and Projects 133 CC	Variation	PO1000837634	R149	N/A	R29

Project description	Name of supplier	Contract modification type (Expansion or Variation)	Contract number	Original contract value	Value of previous contract expansion/s or variation/s (if applicable)	Value of current contract expansion or variation
				R'000	R'000	R'000
The Provision of seasonal causal labour/temporary staffing solutions to the CSIR International Convention Centre	SD Recruitment (Pty) Ltd	Variation	PO1000828063	R1 500	R1 500	R1 000
The Provision of seasonal casual labour/temporary staffing solutions to the CSIR International Convention Centre (ICC).	SD Recruitment (Pty) Ltd	Variation	PO1000828063	R1 500	R2 500	R1 000
Provision of security systems maintenance to the CSIR Gauteng sites for a period of 24 months	Moribula Investment Solutions (Pty) Ltd	Variation	PO1000801102	R2 000	N/A	R624
Licence, support and maintenance of the CSIR NuQ payroll system.	PAY SQUAD CC	Variation	PO1000815440	R1 944	N/A	R2 098
Expansion of an existing contract for SANReN Backbone Extension Project: Signing of Addendum 3 to the Solutions Agreement 1A with Openserve (Pty) Ltd	Openserve (Pty) Ltd	Variation	PO1000850536	R35 277	N/A	R10 890
Provision of exhibition stand design and construction at the Mining Indaba 2024 Conference	Synergy Business Events (Pty) Ltd	Variation	PO1000846437	R471	R321	R151
Roller Blinds	Umakho Construction CC	Variation	PO1000847358	R351	N/A	R70

SECTION G

Annual financial statements

SECTION G

Annual financial statements

The consolidated financial statements set out on pages 150 to 197, which have been prepared on the going concern basis, were approved by the CSIR Board on 30 May 2024.

Report of the Auditor-General to Parliament on the Council for Scientific and Industrial Research

Report on the audit of the consolidated and separate financial statements

Opinion

1. I have audited the consolidated and separate financial statements of the Council for Scientific and Industrial Research (CSIR) and its subsidiary (the group) set out on pages 150 to 197, which comprise the consolidated and separate statement of financial position as at 31 March 2024, consolidated and separate statement of profit or loss and other comprehensive income, statement of changes in equity and statement of cash flows for the year then ended, as well as notes to the consolidated and separate financial statements, including material accounting policy information.

2. In my opinion, the consolidated and separate financial statements present fairly, in all material respects, the financial position of the group as at 31 March 2024 and their financial performance and cash flows for the year then ended in accordance with the International Financial Reporting Standards (IFRS) and the requirements of the Public Finance Management Act 1 of 1999 (PFMA).

Basis for opinion

3. I conducted my audit in accordance with the International Standards on Auditing (ISAs). My responsibilities under those standards are further described in the responsibilities of the Auditor-General for the audit of the consolidated and separate financial statements section of my report.

4. I am independent of the group in accordance with the International Ethics Standards Board for Accountants' International code of ethics for professional accountants (including International Independence Standards) (IESBA code) as well as other ethical requirements that are relevant to my audit in South Africa. I have fulfilled my other ethical responsibilities in accordance with these requirements and the IESBA code.

5. I believe that the audit evidence I have obtained is sufficient and appropriate to provide a basis for my opinion.

Emphasis of matter

6. I draw attention to the matter below. My opinion is not modified in respect of this matter.

Restatement of corresponding figures

7. As disclosed in note 34 to the financial statements, the corresponding figures for 2022-23 were restated as a result of a change in accounting policy in the financial statements of the entity at, and for the year ended, 2023-24.

Responsibilities of the accounting authority for the consolidated and separate financial statements

8. The accounting authority is responsible for the preparation and fair presentation of the consolidated and separate financial statements in accordance with the IFRS and the requirements of the PFMA; and for such internal control as the accounting authority determines is necessary to enable the preparation of consolidated and separate financial statements that are free from material misstatement, whether due to fraud or error.

9. In preparing the consolidated and separate financial statements, the accounting authority is responsible for assessing the group's ability to continue as a going concern; disclosing, as applicable, matters relating to going concern; and using the going concern basis of accounting unless the appropriate governance structure either intends to liquidate the group or to cease operations, or has no realistic alternative but to do so.

Responsibilities of the Auditor-General for the audit of the consolidated and separate financial statements

10. My objectives are to obtain reasonable assurance about whether the consolidated and separate financial statements as a whole are free from material misstatement, whether due to fraud or error; and to issue an auditor's report that includes my opinion. Reasonable assurance is a high level of assurance but is not a guarantee that an audit conducted in accordance with the ISAs will always detect a material

misstatement when it exists. Misstatements can arise from fraud or error and are considered material if, individually or in aggregate, they could reasonably be expected to influence the economic decisions of users taken on the basis of these consolidated and separate financial statements.

11. A further description of my responsibilities for the audit of the consolidated and separate financial statements is included in the annexure to this auditor's report. This description, which is located at page number 147 of this auditor's report, forms part of our auditor's report.

Report on the annual performance report

12. In accordance with the Public Audit Act 25 of 2004 (PAA) and the general notice issued in terms thereof, I must audit and report on the usefulness and reliability of the reported performance information against predetermined objectives for the selected material performance indicators presented in the annual performance report. The accounting authority is responsible for the preparation of the annual performance report.

13. I selected the following material performance indicators related to strategic objective (SO)1: Conduct research, development and innovation of transformative technologies and accelerate their diffusion presented in the annual performance report for the year ended 31 March 2024. I selected those indicators that measure the entity's performance on its primary mandated functions and that are of significant national, community or public interest.
    - Publication equivalents
    - New priority patent applications filed
    - New patents granted
    - New technology demonstrators
    - Number of technology license agreements signed.

14. I evaluated the reported performance information for the selected material performance indicators against the criteria developed from the performance management and reporting framework, as defined in the general notice. When an annual performance report is prepared using these criteria, it provides useful and reliable information and insights to users on the entity's planning and delivery on its mandate and objectives.

15. I performed procedures to test whether:
    - the indicators used for planning and reporting on performance can be linked directly to the entity's mandate and the achievement of its planned objectives
    - all the indicators relevant for measuring the entity's performance against its primary mandated and prioritised functions and planned objectives are included
    - the indicators are well defined to ensure that they are easy to understand and can be applied consistently, as well as verifiable so that I can confirm the methods and processes to be used for measuring achievements
    - the targets can be linked directly to the achievement of the indicators and are specific, time bound and measurable to ensure that it is easy to understand what should be delivered and by when, the required level of performance as well as how performance will be evaluated
    - the indicators and targets reported on in the annual performance report are the same as those committed to in the approved initial or revised planning documents
    - the reported performance information presented in the annual performance report in the prescribed manner
    - there is adequate supporting evidence for the achievements reported and for the reasons provided for any over- or underachievement of targets.

16. I performed the procedures to report material findings only and not to express an assurance opinion or conclusion.
17. I did not identify any material findings on the reported performance information for the selected indicators.

Other matter

18. I draw attention to the matter below.

Achievement of planned targets

19. The annual performance report includes information on reported achievements against planned targets and provides explanations for over- or underachievements.

20. The table that follows provides information on the achievement of planned targets and lists the key indicators that were not achieved as reported in the annual performance report. The reasons for any underachievement of targets are included in the annual performance report on pages 79 to 88.

S01: Conduct research, development and innovation of transformative technologies and accelerate their diffusion

The budget spent per strategic objective could not be determined as the entity do not budget per strategic objective.

Key indicator not achieved	Planned target	Reported achievement
KPI 02: New priority patent applications filed	8	5
KPI 05: Number of technology licence agreements signed	18	13

Report on compliance with legislation

21. In accordance with the PAA and the general notice issued in terms thereof, I must audit and report on compliance with applicable legislation relating to financial matters, financial management and other related matters. The accounting authority is responsible for the entity's compliance with legislation.

22. I performed procedures to test compliance with selected requirements in key legislation in accordance with the findings engagement methodology of the Auditor-General of South Africa (AGSA). This engagement is not an assurance engagement. Accordingly, I do not express an assurance opinion or conclusion.

23. Through an established AGSA process, I selected requirements in key legislation for compliance testing that are relevant to the financial and performance management of the entity, clear to allow consistent measurement and evaluation, while also sufficiently detailed and readily available to report in an understandable manner. The selected legislative requirements are included in the annexure to this auditor's report.

24. I did not identify any material non-compliance with the selected legislative requirements.

Other information in the annual report

25. The accounting authority is responsible for the other information included in the annual report. The other information referred to does not include the consolidated and separate financial statements, the auditor's report and those selected material indicators in the scoped-in strategic objective presented in the annual performance report that have been specifically reported on in this auditor's report.

26. My opinion on the consolidated and separate financial statements, the report on the audit of the annual performance report and the report on compliance with legislation do not cover the other information included in the annual report and I do not express an audit opinion or any form of assurance conclusion on it.

27. My responsibility is to read this other information and, in doing so, consider whether it is materially inconsistent with the consolidated and separate financial statements and the selected material indicators in the scoped-in objective presented in the annual performance report or my knowledge obtained in the audit, or otherwise appears to be materially misstated.

28. If, based on the work I have performed, I conclude that there is a material misstatement in this other information, I am required to report that fact.

29. I have nothing to report in this regard.

Internal control deficiencies

30. I considered internal control relevant to my audit of the consolidated and separate financial statements, annual performance report and compliance with applicable legislation; however, my objective was not to express any form of assurance on it.

31. I did not identify any significant deficiencies in internal control.

Auditor-General

Pretoria
31 July 2024

AUDITOR-GENERAL
SOUTH AFRICA

Auditing to build public confidence

Annexure to the auditor's report

The annexure includes the following:
- The Auditor-General's responsibility for the audit
- The selected legislative requirements for compliance testing

Auditor-General's responsibility for the audit

Professional judgement and professional scepticism

As part of an audit in accordance with the ISAs, I exercise professional judgement and maintain professional scepticism throughout my audit of the consolidated and separate financial statements and the procedures performed on reported performance information for selected material performance indicators and on the entity's compliance with selected requirements in key legislation.

Financial statements

In addition to my responsibility for the audit of the consolidated and separate financial statements as described in this auditor's report, I also:
- identify and assess the risks of material misstatement of the consolidated and separate financial statements, whether due to fraud or error; design and perform audit procedures responsive to those risks; and obtain audit evidence that is sufficient and appropriate to provide a basis for my opinion. The risk of not detecting a material misstatement resulting from fraud is higher than for one resulting from error, as fraud may involve collusion, forgery, intentional omissions, misrepresentations, or the override of internal control
- obtain an understanding of internal control relevant to the audit in order to design audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on the effectiveness of the entity's internal control
- evaluate the appropriateness of accounting policies used and the reasonableness of accounting estimates and related disclosures made
- conclude on the appropriateness of the use of the going concern basis of accounting in the preparation of the consolidated and separate financial statements. I also conclude, based on the audit evidence obtained, whether a material uncertainty exists relating to events or conditions that may cast significant doubt on the ability of the entity and its subsidiaries to continue as a going concern. If I conclude that a material uncertainty exists, I am required to draw attention in my auditor's report to the related disclosures in the consolidated and separate financial statements about the material uncertainty or, if such disclosures are inadequate, to modify my opinion on the consolidated and separate financial statements. My conclusions are based on the information available to me at the date of this auditor's report. However, future events or conditions may cause an entity to cease operating as a going concern
- evaluate the overall presentation, structure and content of the consolidated and separate financial statements, including the disclosures, and determine whether the consolidated and separate financial statements represent the underlying transactions and events in a manner that achieves fair presentation
- obtain sufficient appropriate audit evidence regarding the financial information of the entities or business activities within the group to express an opinion on the consolidated financial statements. I am responsible for the direction, supervision and performance of the group audit. I remain solely responsible for my audit opinion.

Communication with those charged with governance

I communicate with the accounting authority regarding, among other matters, the planned scope and timing of the audit and significant audit findings, including any significant deficiencies in internal control that I identify during my audit.

I also provide the accounting authority with a statement that I have complied with relevant ethical requirements regarding independence and communicate with them all relationships and other matters that may reasonably be thought to bear on my independence and, where applicable, actions taken to eliminate threats or safeguards applied.

Report of the Auditor-General

for the year ended 31 March 2024

Compliance with legislation - selected legislative requirements

The selected legislative requirements are as follows:

Legislation	Sections or regulations
Public Finance Management Act 1 of 1999	Section 50(3)(b); 51(1)(a)(iii); 51(1)(b)(i); Section 51(1)(b)(ii); 51(1)(e)(iii); 52(b); Section 54(2)(c); 54(2)(d); 55(1)(a); 55(1)(b); Section 55(1)(c)(i); 56; 57(b); 57(d)
Treasury Regulations, 2005	Regulation 29.1.1; 29.1.1(a); 29.1.1(c); 29.2.1; Regulation 29.2.2; 29.3.1; 31.1.2(c) Regulation 33.1.1; 33.1.3
Construction Industry Development Board Act 38 of 2000	Section 18(1)
Construction Industry Development Board Regulations, 2004	Regulation 17; 25(7A)
Erratum National Treasury Instruction No. 5 of 2020/21	Paragraph 1
Erratum National Treasury Instruction No. 5 of 2020/21	Paragraph 2
National Treasury Instruction No. 4 of 2015/16	Paragraph 3.4
National Treasury Instruction No. 5 of 2020/21	Paragraph 4.8; 4.9; 5.3
National Treasury SCM Instruction No. 03 of 2021/22	Paragraph 4.2
National Treasury SCM Instruction No. 11 of 2020/21	Paragraph 3.1; 3.4(b); 3.9
Preferential Procurement Policy Framework Act 5 of 2000	Section 1; 2.1(a); 2.1(f)
Preferential Procurement Regulations 2022	Regulation 4.1; 4.2; 4.3; 4.4; 5.1; 5.2; 5.3; 5.4
Preferential Procurement Regulations, 2017	Regulation 4.1; 4.2; 5.1; 5.3; 5.6; 5.7; 6.1; 6.2; Regulation 6.3; 6.5; 6.6; 6.8; 7.1; 7.2; 7.3; 7.5; Regulation 7.6; 7.8; 8.2; 8.5; 9.1; 10.1; 10.2; Regulation 11.1; 11.2
Prevention and Combating of Corrupt Activities Act 12 of 2004	Section 34(1)

Statements of Profit or Loss and other Comprehensive Income

for the year ended 31 March 2024

	Note	GROUP 2024 R '000	GROUP 2023 R '000	CSIR 2024 R '000	CSIR 2023 R '000
Revenue	2	**3,150,678**	2,819,197	**3,150,678**	2,819,197
Other income	3	**28,061**	41,776	**28,061**	41,776
Total operating income		**3,178,739**	2,860,973	**3,178,739**	2,860,973
Expenses					
Employees' remuneration		**(1,803,811)**	(1,710,353)	**(1,803,811)**	(1,710,353)
Depreciation		**(45,701)**	(42,459)	**(45,701)**	(42,459)
Operating expenses		**(1,361,373)**	(1,119,103)	**(1,362,986)**	(1,119,209)
Operating loss	4	**(32,146)**	(10,942)	**(33,759)**	(11,048)
Finance income	5	**71,675**	55,367	**71,114**	55,037
Finance expense	6	**(887)**	(422)	**(887)**	(422)
Share of loss of joint ventures and associates		**(1,668)**	(151)	**-**	-
Profit for the year		**36,974**	43,852	**36,468**	43,567
Other comprehensive income:					
Items that will not be reclassified to profit or loss:					
Remeasurement of post-retirement medical benefit obligation		**1,182**	1,246	**1,182**	1,246
Items that may be reclassified to profit or loss:					
Gains on valuation of investments in debt instruments		**2,746**	16,111	**2,746**	16,111
Other comprehensive income for the year net of taxation		**3,928**	17,357	**3,928**	17,357
Total comprehensive income for the year		**40,902**	**61,209**	**40,396**	**60,924**

Statements of Financial Position

as at 31 March 2024

	Note	GROUP 2024 R '000	GROUP 2023 Restated R '000	CSIR 2024 R '000	CSIR 2023 Restated R '000
ASSETS					
Non-Current Assets					
Property, plant and equipment	8	**808,228**	786,623	**808,228**	786,623
Right-of-use assets	9	**7,978**	8,031	**7,978**	8,031
Interest in subsidiaries	10	**-**	-	**4,650**	4,650
Interests in joint venture and associate	11	**-**	-	**-**	-
		816,206	**794,654**	**820,856**	**799,304**
Current Assets					
Inventories	12	**737**	639	**737**	639
Other receivables from contracts with customers	13	**193,329**	203,503	**193,329**	203,503
Trade and other receivables	14	**402,486**	446,832	**402,461**	446,802
Contract assets	15	**4,856**	2,871	**4,856**	2,871
Investments at fair value through profit or loss	16	**-**	134,487	**-**	134,487
Investments at fair value through other comprehensive income	17	**587,752**	739,942	**587,752**	739,942
Cash and cash equivalents	18	**737,291**	500,039	**728,143**	491,414
		1,926,451	**2,028,313**	**1,917,278**	**2,019,658**
TOTAL ASSETS		**2,742,657**	**2,822,967**	**2,738,134**	**2,818,962**
EQUITY AND LIABILITIES					
EQUITY					
Reserves		**152,428**	149,682	**152,428**	149,682
Retained income		**1,170,605**	1,132,449	**1,166,068**	1,128,418
		1,323,033	**1,282,131**	**1,318,496**	**1,278,100**
LIABILITIES					
Non-Current Liabilities					
Lease liabilities	9	**5,447**	5,720	**5,447**	5,720
Post-retirement medical benefits	19	**9,770**	10,028	**9,770**	10,028
		15,217	**15,748**	**15,217**	**15,748**
Current Liabilities					
Lease liabilities	9	**2,817**	2,244	**2,817**	2,244
Post-retirement medical benefits	19	**2,055**	1,950	**2,055**	1,950
Trade and other payables	20	**350,629**	357,316	**350,643**	357,342
Advances from customers	21	**974,410**	1,064,856	**974,410**	1,064,856
Provisions	22	**74,496**	98,722	**74,496**	98,722
		1,404,407	**1,525,088**	**1,404,421**	**1,525,114**
TOTAL LIABILITIES		**1,419,624**	**1,540,836**	**1,419,638**	**1,540,862**
TOTAL EQUITY AND LIABILITIES		**2,742,657**	**2,822,967**	**2,738,134**	**2,818,962**

Statements of Changes In Equity

for the year ended 31 March 2024

	Revaluation reserve	Reserve for valuation of investments	Total reserves	Retained income	Total equity
	R '000	R '000	R '000	R '000	R '000
GROUP					
Balance at 1 April 2022	**133,571**	**-**	**133,571**	**1,087,351**	**1,220,922**
Profit for the year	-	-	-	43,852	43,852
Other comprehensive income	-	16,111	16,111	1,246	17,357
Total comprehensive income for the year	**-**	**16,111**	**16,111**	**45,098**	**61,209**
Balance at 1 April 2023	**133,571**	**16,111**	**149,682**	**1,132,449**	**1,282,131**
Profit for the year	-	-	-	36,974	36,974
Other comprehensive income	-	2,746	2,746	1,182	3,928
Total comprehensive income for the year	**-**	**2,746**	**2,746**	**38,156**	**40,902**
Balance at 31 March 2024	**133,571**	**18,857**	**152,428**	**1,170,605**	**1,323,033**
CSIR					
Balance at 1 April 2022	**133,571**	**-**	**133,571**	**1,083,605**	**1,217,176**
Profit for the year	-	-	-	43,567	43,567
Other comprehensive income	-	16,111	16,111	1,246	17,357
Total comprehensive income for the year	**-**	**16,111**	**16,111**	**44,813**	**60,924**
Balance at 1 April 2023	**133,571**	**16,111**	**149,682**	**1,128,418**	**1,278,100**
Profit for the year	-	-	-	36,468	36,468
Other comprehensive income	-	2,746	2,746	1,182	3,928
Total comprehensive income for the year	**-**	**2,746**	**2,746**	**37,650**	**40,396**
Balance at 31 March 2024	**133,571**	**18,857**	**152,428**	**1,166,068**	**1,318,496**

Statements of Cash Flows

for the year ended 31 March 2024

	Note	GROUP 2024 R '000	GROUP 2023 Restated R '000	CSIR 2024 R '000	CSIR 2023 Restated R '000
Cash flows from operating activities					
Cash receipts from external customers		**2,443,356**	2,024,093	**2,443,356**	2,024,111
Parliamentary Grant received		**714,308**	741,615	**714,308**	741,615
Cash paid to suppliers and employees		**(3,230,350)**	(2,798,142)	**(3,230,335)**	(2,798,150)
Cash utilised in operating activities	23	**(72,686)**	(32,434)	**(72,671)**	(32,424)
Finance income received		**25,544**	33,243	**25,006**	32,913
Finance expense paid		**-**	(284)	**-**	(284)
Net cash (out)/in flow from operating activities		**(47,142)**	**525**	**(47,665)**	**205**
Cash flows from investing activities					
Acquisition of property, plant and equipment	8	**(66,439)**	(88,256)	**(66,439)**	(88,256)
Proceeds on disposal of property, plant and equipment	8	**1,680**	4,698	**1,680**	4,698
Movement in investments at fair value through profit and loss		**152,129**	(125,000)	**152,129**	(125,000)
Movement in debt investments at fair value through other comprehensive income		**200,000**	35,451	**200,000**	35,451
Loan repayment from Sera (Pty) Ltd		**-**	1,950	**-**	1,950
Net cash in/(out) flow from investing activities		**287,370**	**(171,157)**	**287,370**	**(171,157)**
Cash flows from financing activities					
Payment on lease liabilities		**(2,440)**	(1,854)	**(2,440)**	(1,854)
Net cash out flow from financing activities		**(2,440)**	**(1,854)**	**(2,440)**	**(1,854)**
Unrealised exchange losses on foreign cash balances		**(536)**	(270)	**(536)**	(270)
Net increase/(decrease) in cash and cash equivalents		**237,252**	**(172,756)**	**236,729**	**(173,076)**
Cash and cash equivalents at the beginning of the year		**500,039**	672,795	**491,414**	664,490
Cash and cash equivalents at the end of the year	18	**737,291**	**500,039**	**728,143**	**491,414**

Notes to the Consolidated Financial Statements

for the year ended 31 March 2024

Entity information

The CSIR is a national government business enterprise (enacted by The Scientific Research Council Act, 1988 (Act 46 of 1988 as amended by Act 71 of 1990) domiciled in the Republic of South Africa. The address of the CSIR's principal place of business is Meiring Naudé Road, Brummeria, Pretoria. The CSIR undertakes directed and particularly multi-disciplinary research and technological innovation, to foster, in the national interest and in fields which in its opinion should receive preference, industrial and scientific development, either by itself or in co-operation with principals from the private or public sectors, and thereby to contribute to the improvement of the quality of life of the people of the Republic.

The consolidated annual financial statements of the Group as at and for the year ended 31 March 2024 comprise the entity and its subsidiaries (together referred to as the Group) and the Group's interest in associates and jointly controlled entities.

1. Significant accounting policies

The principal accounting policies applied in the preparation of these consolidated and separate financial statements are set out below.

1.1 Basis of preparation

The consolidated and separate financial statements have been prepared on the going concern basis in accordance with, and in compliance with, International Financial Reporting Standards ("IFRS") and International Financial Reporting Interpretations Committee ("IFRIC") interpretations issued and effective at the time of preparing these consolidated financial statements and the Public Finance Management Act, 1999 (Act 1 of 1999) as amended by Act 29 of 1999.

These consolidated financial statements comply with the requirements of the South African Institute of Chartered Accountants Financial Reporting Guides as issued by the Accounting Practices Committee and the Financial Reporting Pronouncements as issued by the Financial Reporting Standards Council.

The consolidated financial statements have been prepared on the historic cost convention, unless otherwise stated. They are presented in Rands, which is the Group and entity's functional currency.

The Group has consistently applied the following accounting policies to all periods presented in these consolidated financial statements, except if mentioned otherwise.

Certain comparative amounts in the statements of financial position, and the statements of cash flows have been reclassified, as a result of a change in accounting policy (see Note 34).

1.2 Consolidation

Basis of consolidation

The consolidated financial statements incorporate the separate financial statements of the CSIR and all subsidiaries. Subsidiaries are entities (including structured entities) which are controlled by the Group.

The Group has control of an entity when it is exposed to or has rights to variable returns from involvement with the entity and it has the ability to affect those returns through the use of its power over the entity.

The results of subsidiaries are included in the consolidated financial statements from the effective date of acquisition to the effective date of disposal.

All inter-company transactions, balances, and unrealised gains on transactions between Group companies are eliminated in full on consolidation. Unrealised losses are also eliminated unless the transaction provides evidence of an impairment of the asset transferred.

1.2 Consolidation (continued)

Investments in subsidiaries in the separate financial statements

In the CSIR's separate financial statements, investments in subsidiaries are carried at cost less any accumulated impairment losses.

1.3 Joint arrangements

A joint arrangement is an arrangement where two or more parties have joint control. Joint control is the contractually agreed sharing of control of an arrangement, which exists only when decisions about the relevant activities require the unanimous consent of the parties sharing control. A joint arrangement is either a joint operation or a joint venture.

A joint operation is a joint arrangement whereby the parties that have joint control of the arrangement have rights to the assets, and obligations for the liabilities, relating to the arrangement. A joint venture is a joint arrangement whereby the parties that have joint control of the arrangement have rights to the net assets of the arrangement. The Group has assessed the nature of its joint arrangements and determined them to be joint ventures.

Joint ventures

An interest in a joint venture is accounted for using the equity method. Under the equity method, interests in joint ventures are carried in the statements of financial position at cost, adjusted for post-acquisition changes in the CSIR's share of net assets of the joint venture, less any impairment losses.

The Group's share of post-acquisition profit or loss is recognised in profit or loss, and its share of movements in other comprehensive income is recognised in other comprehensive income with a corresponding adjustment to the carrying amount of the investment. Losses in a joint venture in excess of the Group's interest in that joint venture, including any other unsecured losses, are recognised only to the extent that the Group has incurred a legal or constructive obligation to make payments on behalf of the joint venture.

Profits or losses on transactions between the Group and a joint venture are eliminated to the extent of the Group's interest therein. Unrealised losses are eliminated unless the transaction provides evidence of an impairment of the asset transferred. Accounting policies of joint ventures have been changed where necessary to ensure consistency with the policies adopted by the Group.

Investments in joint ventures in the separate financial statements

In the company's separate financial statements, investments in joint ventures are carried at cost less any accumulated impairment losses.

1.4 Investments in associates

An associate is an entity over which the Group has significant influence, and which is neither a subsidiary nor a joint arrangement. Significant influence is the power to participate in the financial and operating policy decisions of the investee but has no control or joint control over those policies. It generally accompanies a shareholding of between 20% and 50% of the voting rights.

Investments in associates are accounted for using the equity method. Under the equity method, investments in associates are carried in the Statements of Financial Position at cost adjusted for post-acquisition changes in the Group's share of net assets of the associate, less any impairment losses.

The Group's share of post-acquisition profit or loss is recognised in profit or loss, and its share of movements in other comprehensive income is recognised in other comprehensive income with a corresponding adjustment to the carrying amount of the investment. Losses in an associate in excess of the Group's interest in that associate, including any other unsecured losses, are recognised only to the extent that the Group has incurred a legal or constructive obligation to make payments on behalf of the associate.

1.4 Investments in associates (continued)

Profits or losses on transactions between the Group and an associate are eliminated to the extent of the Group's interest therein. Unrealised losses are eliminated unless the transaction provides evidence of an impairment of the asset transferred. Accounting policies of associates have been changed where necessary to ensure consistency with the policies adopted by the Group.

1.5 Significant judgements and sources of estimation uncertainty

The preparation of consolidated financial statements in conformity with IFRS requires management, from time to time, to make judgements, estimates and assumptions that affect the application of policies and reported amounts of assets, liabilities, income and expenses. These estimates and associated assumptions are based on experience and various other factors that are believed to be reasonable under the circumstances. Actual results may differ from these estimates. The estimates and underlying assumptions are reviewed on an ongoing basis. Revisions to accounting estimates are recognised in the period in which the estimates are revised and in any future periods affected.

Critical judgements in applying accounting policies

The critical judgements made by management in applying accounting policies, apart from those involving estimations, that have the most significant effect on the amounts recognised in the financial statements, are outlined as follows:

Revenue recognition

The nature of the CSIR's business is varied, in that there are contracts with customers which give rise to single performance obligations, and others which give rise to multiple performance obligations. Judgement is applied in the determination of distinct performance obligations, as well as to when transfer of control of the identified performance obligations is satisfied.

In identifying distinct performance obligations, judgement was applied in assessing whether certain deliverables are separately identifiable from other items to be transferred to the customer in terms of the contract.

Key sources of estimation uncertainty

Impairment of financial assets
The allowance for doubtful accounts in trade and other receivables is based on assumptions about risk of default and expected loss rates. The Group uses judgement in making these assumptions and selecting the inputs to the calculation of the allowance for doubtful accounts, based on the expected credit loss model (used in IFRS 9).

Impairment testing

Impairment of property, plant and equipment
At each reporting date, property, plant and equipment in use are assessed for impairment. To assess whether any impairment exists, estimates of expected future cash flows are used. Actual outcomes could vary significantly from such estimates. Factors such as changes in discount rates, the planned use of buildings, machinery or equipment or closure of facilities and technical obsolescence could lead to shorter useful lives or impairment.

Useful lives of property, plant and equipment
Management assesses the appropriateness of the useful lives of property, plant and equipment at the end of each reporting period. The useful lives of vehicles, furniture and fixtures, IT equipment and equipment are determined based on Group replacement policies for the various assets.

When the estimated useful life of an asset differs from previous estimates, the change is applied prospectively in the determination of the depreciation charge.

1.5 Significant judgements and sources of estimation uncertainty (continued)

Provisions

Provisions are inherently based on assumptions and estimates using the best information available. Additional disclosure of these estimates of provisions are included in note 22.

Estimates of post-retirement medical benefit liabilities

An actuarial valuation is carried out at the end of each financial year for the post-retirement liabilities of the Group. Key assumptions used to determine the net assets and liabilities of these obligations and their sensitivities are set out in note 19.

1.6 Property, plant and equipment

Property, plant and equipment are tangible assets which the Group holds for its own use or for rental to others and which are expected to be used for more than one year.

An item of property, plant and equipment is recognised as an asset when it is probable that future economic benefits associated with the item will flow to the Group, and the cost of the item can be measured reliably.

Property, plant and equipment is initially measured at cost. Cost includes all of the expenditure which is directly attributable to the acquisition or construction of the asset.

Expenditure incurred subsequently for major services, additions to or replacements of parts of property, plant and equipment are capitalised if it is probable that future economic benefits associated with the expenditure will flow to the Group and the cost can be measured reliably. Day-to-day servicing costs are included in profit or loss in the year in which they are incurred.

Major inspection costs which are a condition of continuing use of an item of property, plant and equipment and which meet the recognition criteria are included as a replacement in the cost of the item of property, plant and equipment. Any remaining inspection costs from the previous inspection are derecognised.

Major spare parts and standby equipment which are expected to be used for more than one year are included in property, plant and equipment.

Property, plant and equipment is subsequently stated at cost less accumulated depreciation and any accumulated impairment losses, except for land which is stated at revalued amount less any accumulated impairment losses.

Depreciation of an asset commences when the asset is available for use as intended by management. Depreciation is charged to write off the asset's carrying amount over its estimated useful life to its estimated residual value, using a method that best reflects the pattern in which the asset's economic benefits are consumed by the Group. Leased assets are depreciated in a consistent manner over the shorter of their expected useful lives and the lease term. Depreciation is not charged to an asset if its estimated residual value exceeds or is equal to its carrying amount. Depreciation of an asset ceases at the earlier of the date that the asset is classified as held for sale, or derecognised.

The useful lives of items of property, plant and equipment have been assessed as follows:

Item	Depreciation method	Average useful life
Buildings	Straight line	90 years
Furniture and fixtures	Straight line	3 to 20 years
Vehicles	Straight line	10 years
Equipment	Straight line	3 to 20 years
IT equipment	Straight line	3 to 5 years
Land	Straight line	Indefinite

1.6 Property, plant and equipment (continued)

The residual value, useful life and depreciation method of each asset are reviewed at the end of each reporting year. If the expectations differ from previous estimates, the change is accounted for prospectively as a change in accounting estimate.

Each part of an item of property, plant and equipment with a cost that is significant in relation to the total cost of the item is depreciated separately.

The depreciation charge for each year is recognised in profit or loss unless it is included in the carrying amount of another asset.

Impairment tests are performed on property, plant and equipment when there is an indicator that they may be impaired. When the carrying amount of an item of property, plant and equipment is assessed to be higher than the estimated recoverable amount, an impairment loss is recognised immediately in profit or loss to bring the carrying amount in line with the recoverable amount.

An item of property, plant and equipment is derecognised upon disposal or when no future economic benefits are expected from its continued use or disposal. Any gain or loss arising from the derecognition of an item of property, plant and equipment, determined as the difference between the net disposal proceeds, if any, and the carrying amount of the item, is included in profit or loss when the item is derecognised.

Capital commitments
Capital commitments disclosed in the financial statements represent amounts associated with binding agreements that the Group has entered into with other parties for the acquisition of property, plant and equipment, that will be incurred in periods after the current reporting date.

Capital commitments are disclosed but not recognised as liabilities in the current reporting period.

1.7 Financial instruments

Financial instruments held by the Group are classified in accordance with the provisions of IFRS 9 Financial Instruments.

Broadly, the applicable classification possibilities, which are adopted by the Group, are as follows:

Financial assets that are debt instruments:
- Amortised cost. (This classification applies only when the contractual terms of the instrument give rise, on specified dates, to cash flows that are solely payments of principal and interest on principal, and where the instrument is held under a business model whose objective is met by holding the instrument to collect contractual cash flows).
- Fair value through other comprehensive income. (This classification applies only when the contractual terms of the instrument give rise, on specified dates, to cash flows that are solely payments of principal and interest on principal, and the instrument is held under a business model whose objective is achieved by both collecting contractual cash flows and selling the instruments).
- Fair value through profit or loss. (This classification automatically applies to all debt instruments that do not qualify as at amortised cost or at fair value through other comprehensive income).

Financial liabilities:
- Amortised cost

Note 26 Financial instruments and risk management presents the financial instruments held by the Group based on their specific classifications.

All regular way purchases or sales of financial assets are recognised and derecognised on a trade date basis. Regular way purchases or sales are purchases or sales of financial assets that require the delivery of assets within the time frame established by regulation or convention in the marketplace.

The specific accounting policies for the classification, recognition and measurement of each type of financial instrument held by the Group are presented on the next page:

1.7 Financial instruments (continued)

Debt instruments at fair value through other comprehensive income

Classification
Certain investments in debt instruments are classified as at fair value through other comprehensive income. This classification applies when the debt instrument meets both the following conditions and is not designated as at fair value through profit or loss:

- it is held within a business model whose objective is achieved by both collecting contractual cash flows and selling financial assets; and
- its contractual terms give rise on specified dates to cash flows that are solely payments of principal and interest on the principal amount outstanding.

The Group holds investments in debt instruments (flexible income fund) which are classified as at fair value through other comprehensive income (note 17).

Recognition and measurement
These debt instruments are recognised when the Group becomes a party to the contractual provisions. They are measured, at initial recognition, at fair value plus transaction costs, if any.

They are subsequently measured at fair value.

Even though they are measured at fair value, the Group determines the amortised cost of each instrument as if they were measured at amortised cost. The difference, at reporting date, between the amortised cost and the fair value of the debt instruments, is recognised in other comprehensive income and accumulated in equity in the reserve for valuation of investments.

The amortised cost is the amount recognised on the instrument initially, minus principal repayments, plus cumulative amortisation (interest) using the effective interest method of any difference between the initial amount and the maturity amount, adjusted for any loss allowance.

Impairment
The Group assesses on a forward-looking basis the expected credit losses associated with its debt instruments carried at fair value through other comprehensive income. The impairment methodology applied depends on whether there has been a significant increase in credit risk.

At each reporting date, the Group assesses whether debt instruments at fair value through other comprehensive income are credit-impaired. A financial asset is "credit-impaired" when one or more events that have a detrimental impact on the estimated future cash flows of the financial asset have occurred.

The loss allowance is charged to profit or loss.

If the financial instrument is determined to have low credit risk at the reporting date, the Group assumes that the credit risk on a financial instrument has not increased significantly since initial recognition.

Derecognition
Refer to the derecognition section of the accounting policy for the policies and processes related to derecognition.

1.7 Financial instruments (continued)

Trade and other receivables

Classification
Trade and other receivables, excluding, when applicable, VAT and prepayments, are classified as financial assets subsequently measured at amortised cost (note 14).

They have been classified in this manner because their contractual terms give rise, on specified dates to cash flows that are solely payments of principal and interest on the principal outstanding. The Group's business model is to collect the contractual cash flows on trade and other receivables.

Recognition and measurement
Trade and other receivables are recognised when the Group becomes a party to the contractual provisions of the receivables. They are measured, at initial recognition, at transaction price.

They are subsequently measured at amortised cost.

The amortised cost is the amount recognised on the receivable initially, minus principal repayments, plus cumulative amortisation (interest) using the effective interest method of any difference between the initial amount and the maturity amount, adjusted for any loss allowance.

Impairment
The Group recognises a loss allowance for expected credit losses on trade and other receivables, excluding VAT and prepayments. The amount of expected credit losses is updated at each reporting date.

The Group measures the loss allowance for trade and other receivables at an amount equal to lifetime expected credit losses (lifetime ECL), which represents the expected credit losses that will result from all possible default events over the expected life of the receivable.

Measurement and recognition of expected credit losses
The Group applies the simplified approach to trade receivables, contract assets and lease receivables of measuring the loss allowance at an amount equal to lifetime expected credit losses in terms of IFRS 9. The Group applies the ECL valuation model as follows:

- It rebuts the more than 30 days past due presumption. Instead, the CSIR presumes that there is a significant increase in credit risk when payments are more than 90 days outstanding from dates of invoices. Based on historical experience for most of the CSIR's debtors if contractual payments become more than 30 days past due, this does not represent a significant increase in the credit risk of a financial instrument. It is rather due to their extensive administrative systems for local debtors, or timing differences in moving money outside of the borders of their countries for international customers instead of financial difficulty of the debtors.
- When a receivable (i.e. an invoice) is more than 90 days outstanding, an allowance for loss is raised for 100% of the outstanding amount excluding VAT (thus a 100% loss probability is assumed). However, no allowance is raised when there is a firm commitment by the debtor that they will settle the amount due even if the receivable is more than 90 days outstanding.
- An allowance for loss is raised even if a receivable (invoice) is less than 90 days outstanding when there is evidence indicating a significant increase in credit risk of a debtor.

Write off policy
The Group writes off a receivable when there is information indicating that the counterparty is in severe financial difficulty and there is no realistic prospect of recovery, e.g. when the counterparty has been placed under liquidation or has entered into bankruptcy proceedings. Receivables written off may still be subject to enforcement activities under the Group recovery procedures, taking into account legal advice where appropriate. Any recoveries made are recognised in profit or loss.

Credit risk
Details of credit risk are included in the trade and other receivables note (note 14) and the financial instruments and risk management note (note 26).

1.7 Financial instruments (continued)

Derecognition
Refer to the derecognition section of the accounting policy for the policies and processes related to derecognition.

Investments in debt instruments at fair value through profit or loss

Classification
Certain investments in debt instruments are classified as mandatorily at fair value through profit or loss. These investments do not qualify for classification at amortised cost or at fair value through other comprehensive income because either the contractual terms of these instruments do not give rise, on specified dates to cash flows that are solely payments of principal and interest on the principal outstanding, or the objectives of the Group's business model are met by selling the instruments rather than holding them to collect the contractual cash flows. The Group holds investments in Index Linked Notes (note 16), which are at fair value through profit or loss.

Recognition and measurement
Investments in debt instruments at fair value through profit or loss are recognised when the Group becomes a party to the contractual provisions of the instrument. The investments are measured, at initial recognition and subsequently, at fair value. Transaction costs are recognised in profit or loss.

Fair value gains or losses are included in other income (note 3).

Impairment
Investments in debt instruments at fair value through profit or loss are not subject to impairment provisions.

Derecognition
Refer to the derecognition section of the accounting policy for the policies and processes related to derecognition.

Trade and other payables

Classification
Trade and other payables (note 20), excluding VAT and amounts received in advance, are classified as financial liabilities subsequently measured at amortised cost.

Recognition and measurement
They are recognised when the Group becomes a party to the contractual provisions, and are measured, at initial recognition, at fair value plus transaction costs, if any.

Trade and other payables expose the Group to liquidity risk and possibly to interest rate risk. Refer to note 26 for details of risk exposure and management thereof.

Trade and other payables denominated in foreign currencies
When trade payables are denominated in a foreign currency, the carrying amount of the payables is determined in the foreign currency. The carrying amount is then translated to the Rand equivalent using the spot rate at the end of each reporting period. Any resulting foreign exchange gains or losses are recognised in profit or loss.

Details of foreign currency risk exposure and the management thereof are provided in the financial instruments and risk management note (note 26).

Derecognition
Refer to the derecognition section of the accounting policy for the policies and processes related to derecognition.

Financial guarantee contracts

A financial guarantee contract is a contract that requires the issuer to make specified payments to reimburse the holder for a loss it incurs because a specified debtor fails to make payments when due in accordance with the terms of a debt instrument.

1.7 Financial instruments (continued)

Financial guarantee contracts issued by the Group are initially measured at their fair values and, if not designated as at fair value through profit or loss and do not arise from a transfer of a financial asset, are subsequently measured at the higher of:

- The amount of the loss allowance determined in accordance with IFRS 9; and
- The amount initially recognised less, where appropriate, cumulative amount of income recognised in accordance with the revenue recognition policies.

Refer to note 32 for details of financial guarantee contracts.

Cash and cash equivalents

Cash and cash equivalents comprise cash on hand and demand deposits, and other short-term highly liquid investments that are readily convertible to a known amount of cash, are subject to an insignificant risk of changes in value, and are held for the purpose of meeting short-term cash commitments rather than for investment or other purposes.

Cash and cash equivalents are initially and subsequently recorded at amortised cost, which approximates fair value.

Derecognition

Financial assets

The Group derecognises a financial asset only when the contractual rights to the cash flows from the asset expire, or when it transfers the financial asset and substantially all the risks and rewards of ownership of the asset to another party. If the Group neither transfers nor retains substantially all the risks and rewards of ownership and continues to control the transferred asset, the Group recognises its retained interest in the asset and an associated liability for amounts it may have to pay. If the Group retains substantially all the risks and rewards of ownership of a transferred financial asset, the Group continues to recognise the financial asset and also recognises a collateralised borrowing for the proceeds received.

On derecognition of a financial asset in its entirety, the difference between the carrying amount (measured at the date of derecognition) and the consideration received, is recognised in profit or loss.

On derecognition of a debt instrument at fair value through other comprehensive income, the cumulative gain or loss on that instrument which was previously accumulated in equity in the reserve for valuation of investments is reclassified to profit or loss.

Financial liabilities

The Group derecognises financial liabilities when, and only when, the Group's obligations are discharged, cancelled or they expire. The difference between the carrying amount of the financial liability derecognised and the consideration paid and payable, including any non-cash assets transferred or liabilities assumed, is recognised in profit or loss.

1.8 Income tax

The CSIR is exempt from South African income tax in terms of section 10 (1) (t) (i) of the Income Tax Act, 1962 (Act 58 of 1962).

1.9 Leases

The Group assesses whether a contract is, or contains a lease, at the inception of the contract.

A contract is, or contains, a lease if the contract conveys the right to control the use of an identified asset for a period of time in exchange for consideration.

In order to assess whether a contract is, or contains a lease, management determines whether the asset under consideration is "identified", which means that the asset is either explicitly or implicitly specified in the contract and that the supplier does not have a substantial right of substitution throughout the period of use. Once management has concluded that the contract deals with an identified asset, the right to control the use thereof is considered. To this end, control over the use of an identified asset only exists when the Group has the right to substantially all of the economic benefits from the use of the asset as well as the right to direct the use of the asset.

1.9 Leases (continued)

In circumstances where the determination of whether the contract is or contains a lease requires significant judgement, the relevant disclosures are provided in the significant judgments and sources of estimation uncertainty section of these accounting policies.

Group as lessee

A lease liability and corresponding right-of-use asset are recognised at the lease commencement date, for all lease agreements for which the Group is a lessee, except for short-term leases of 12 months or less, or leases of low value assets. For these leases, the Group recognises the lease payments as an operating expense on a straight-line basis over the term of the lease unless another systematic basis is more representative of the time pattern in which economic benefits from the leased asset are consumed.

The various lease and non-lease components of contracts containing leases are accounted for separately, with consideration being allocated to each lease component on the basis of the relative stand-alone prices of the lease components and the aggregate stand-alone price of the non-lease components (where non-lease components exist).

However, as an exception to the preceding paragraph, the Group has elected not to separate the non-lease components for leases of land and buildings.

Details of leasing arrangements where the Group is a lessee are presented in note 9 Leases (Group as lessee).

Lease liability

The lease liability is initially measured at the present value of the lease payments that are not paid at the commencement date, discounted by using the rate implicit in the lease. If this rate cannot be readily determined, the Group uses its incremental borrowing rate.

Lease payments included in the measurement of the lease liability comprise the following:
- Fixed lease payments, including in-substance fixed payments, less any lease incentives;
- Variable lease payments that depend on an index or rate, initially measured using the index or rate at the commencement date;
- The amount expected to be payable by the Group under residual value guarantees;
- The exercise price of purchase options, if the Group is reasonably certain to exercise the option;
- Lease payments in an optional renewal period if the Group is reasonably certain to exercise an extension option; and
- Penalties for early termination of a lease, if the lease term reflects the exercise of an option to terminate the lease.

Variable rents that do not depend on an index or rate are not included in the measurement of the lease liability (or right-of-use asset). The related payments are recognised as an expense in the period incurred and are included in operating expenses.

The lease liability is presented as a separate line item in the Statements of Financial Position.

The lease liability is subsequently measured by increasing the carrying amount to reflect interest on the lease liability (using the effective interest method) and by reducing the carrying amount to reflect lease payments made. Interest charged on the lease liability is included in finance expense (note 6).

The Group remeasures the lease liability (and makes a corresponding adjustment to the related right-of-use asset) when:
- There has been a change to the lease term, in which case the lease liability is remeasured by discounting the revised lease payments using a revised discount rate;
- There has been a change in the assessment of whether the Group will exercise a purchase, termination or extension option, in which case the lease liability is remeasured by discounting the revised lease payments using a revised discount rate;
- There has been a change to the lease payments due to a change in an index or a rate, in which case the lease liability is remeasured by discounting the revised lease payments using the initial discount rate (unless the lease payments change is due to a change in a floating interest rate, in which case a revised discount rate is used);

1.9 Leases (continued)

- There has been a change in expected payment under a residual value guarantee, in which case the lease liability is remeasured by discounting the revised lease payments using the initial discount rate;
- A lease contract has been modified and the lease modification is not accounted for as a separate lease, in which case the lease liability is remeasured by discounting the revised payments using a revised discount rate.

When the lease liability is remeasured in this way, a corresponding adjustment is made to the carrying amount of the right-of-use asset, or is recognised in profit or loss if the carrying amount of the right-of-use asset has been reduced to zero.

Right-of-use assets

Right-of-use assets are presented as a separate line item in the Statements of Financial Position.

Lease payments included in the measurement of the right-of-use assets comprise the following:
- The initial amount of the corresponding lease liability;
- Any lease payments made at or before the commencement date;
- Any initial direct costs incurred;
- Any estimated costs to dismantle and remove the underlying asset or to restore the underlying asset or the site on which it is located, when the Group incurs an obligation to do so, unless these costs are incurred to produce inventories; and
- Less any lease incentives received.

Right-of-use assets are subsequently measured at cost less accumulated depreciation and impairment losses.

Right-of-use assets are depreciated over the shorter period of the lease term and useful life of the underlying asset. However, if a lease transfers ownership of the underlying asset or the cost of the right-of-use asset reflects that the Group expects to exercise a purchase option, the related right-of-use asset is depreciated over the useful life of the underlying asset. Depreciation starts at the commencement date of a lease.

For right-of-use assets which are depreciated over their useful lives, the useful lives are determined consistently with items of the same class of property, plant and equipment. Refer to the accounting policy for property, plant and equipment for details of useful lives.

The residual value, useful life and depreciation method of each asset are reviewed at the end of each reporting year. If the expectations differ from previous estimates, the change is accounted for prospectively as a change in accounting estimate. Each part of a right-of-use asset with a cost that is significant in relation to the total cost of the asset is depreciated separately.

The depreciation charge for each year is recognised in profit or loss unless it is included in the carrying amount of another asset.

Group as lessor

Leases for which the Group is a lessor are classified as finance or operating leases. Whenever the terms of the lease transfer substantially all the risks and rewards of ownership to the lessee, the contract is classified as a finance lease. All other leases are classified as operating leases. Lease classification is made at inception and is only reassessed if there is a lease modification.

When the Group is an intermediate lessor, it accounts for the head lease and the sublease as two separate contracts. The sublease is classified as a finance or operating lease by reference to the right-of-use asset arising from the head lease. If the head lease is a short-term lease to which the Group applies the exemption described previously, then it classifies the sub-lease as an operating lease.

The various lease and non-lease components of contracts containing leases are accounted for separately, with consideration being allocated by applying IFRS 15.

1.10 Inventories

Inventories are measured at the lower of cost and net realisable value on the weighted average method.

Net realisable value is the estimated selling price in the ordinary course of business less the estimated costs of completion and the estimated costs necessary to make the sale.

The cost of inventories comprises of all costs of purchase, costs of conversion and other costs incurred in bringing the inventories to their present location and condition.

1.11 Other receivables from contracts with customers

This accounting policy needs to be read in conjunction with the accounting policies for revenue from contracts with customers, contract assets and advances on contracts with customers. The Group presents as an asset the gross amount due from customers for contract work for all contracts in progress for which costs incurred plus recognised profits (less recognised losses) exceed progress billings. These are included in other receivables from contracts with customers under current assets. Progress billings that are invoiced but not yet paid by customers are included in trade and other receivables.

1.12 Impairment of assets

The Group assesses at each end of the reporting period whether there is any indication that an asset may be impaired. If any such indication exists, the Group estimates the recoverable amount of the asset.

If there is any indication that an asset may be impaired, the recoverable amount is estimated for the individual asset. If it is not possible to estimate the recoverable amount of the individual asset, the recoverable amount of the cash-generating unit to which the asset belongs is determined.

The recoverable amount of an asset or a cash-generating unit is the higher of its fair value less costs to sell and its value in use.

If the recoverable amount of an asset is less than its carrying amount, the carrying amount of the asset is reduced to its recoverable amount. That reduction is an impairment loss.

An impairment loss of assets carried at cost less any accumulated depreciation is recognised immediately in profit or loss.

An entity assesses at each reporting date whether there is any indication that an impairment loss recognised in prior periods for assets may no longer exist or may have decreased. If any such indication exists, the recoverable amounts of those assets are estimated.

The increased carrying amount of an asset attributable to a reversal of an impairment loss does not exceed the carrying amount that would have been determined had no impairment loss been recognised for the asset in prior periods.

A reversal of an impairment loss of assets carried at cost less accumulated depreciation is recognised immediately in profit or loss. Any reversal of an impairment loss of a revalued asset is treated as a revaluation increase.

1.13 Employee benefits

Short-term employee benefits

The cost of short-term employee benefits, (those payable within 12 months after the service is rendered, such as paid vacation leave and sick leave, bonuses, and non-monetary benefits such as medical care), are recognised in the period in which the service is rendered and are not discounted.

The expected cost of compensated absences is recognised as an expense as the employees render services that increase their entitlement or, in the case of non-accumulating absences, when the absence occurs.

1.13 Employee benefits (continued)

Defined contribution plans

Payments to defined contribution retirement benefit plans are charged as an expense as they fall due.

Pension fund

The Group operates a defined contribution plan, the assets of which are held in a separate trustee-administered fund. The benefits payable by the fund in the future, due to retirements and withdrawals from the fund, are contributions to the fund together with fund interest at a rate determined by the valuator with the consent of the trustees. The rate is so determined that the value of the total of the fund shall not exceed the value of the total assets of the fund.

Defined benefit plans

Post-retirement medical benefits
The Group provides post-retirement medical benefits to qualifying employees, which is deemed to be a defined benefit plan. Contributions were made to the relevant funds over the expected service lives of the employees entitled to those funds. The estimated cost of providing such benefits was charged to profit or loss on a systematic basis over the employees' working lives within the Group.

For defined benefit plans the cost of providing the benefits is determined using the projected unit credit method. Actuarial valuations are conducted on an annual basis by independent actuaries separately for each plan. Consideration is given to any event that could impact the funds up to the end of the reporting period where the interim valuation is performed at an earlier date.

Past service costs are recognised immediately to the extent that the benefits are already vested, and are otherwise amortised on a straight-line basis over the average period until the amended benefits become vested.

To the extent that, at the beginning of the financial year, any cumulative unrecognised actuarial gain or loss exceeds ten percent of the greater of the present value of the projected benefit obligation and the fair value of the plan assets (the corridor), that portion is recognised in profit or loss over the expected average remaining service lives of participating employees. Actuarial gains or losses within the corridor are not recognised.

Actuarial gains and losses are recognised in the year in which they arise, in other comprehensive income. Gains or losses on the curtailment or settlement of a defined benefit plan is recognised when the Group is demonstrably committed to curtailment or settlement.

When it is virtually certain that another party will reimburse some or all of the expenditure required to settle a defined benefit obligation, the right to reimbursement is recognised as a separate asset. The asset is measured at fair value. In all other respects, the asset is treated in the same way as plan assets. In profit or loss, the expense relating to a defined benefit plan is presented as the net of the amount recognised for a reimbursement.

The amount recognised in the statements of financial position represents the present value of the defined benefit obligation as adjusted for unrecognised actuarial gains and losses and unrecognised past service costs, and reduces by the fair value of plan assets.

Any asset is limited to unrecognised actuarial losses and past service costs, plus the present value of available refunds and reduction in future contributions to the plan.

1.14 Provisions and contingencies

Provisions are recognised when:
- The Group has a present obligation as a result of a past event;
- It is probable that an outflow of resources embodying economic benefits will be required to settle the obligation; and
- A reliable estimate can be made of the obligation.

1.14 Provisions and contingencies (continued)

The amount of a provision is the present value of the expenditure expected to be required to settle the obligation.

Contingent assets and contingent liabilities are not recognised. Contingencies are disclosed in note 25.

1.15 Government grants

Government grants are recognised when there is reasonable assurance that:
- The Group will comply with the conditions attached to them; and
- The grants will be received.

Government grants are recognised as income over the periods necessary to match them with the related costs that they are intended to compensate.

A government grant that becomes receivable as compensation for expenses or losses already incurred or for the purpose of giving immediate financial support to the entity with no future related costs is recognised as income for the period in which it becomes receivable.

Government grants related to assets, including non-monetary grants at fair value, are presented in the statements of financial position by deducting the grant to arrive at the carrying amount of the asset.

Grants related to income are presented as a credit in the statements of profit or loss and other comprehensive income (separately).

1.16 Revenue from contracts with customers

The Group derives revenue from contracts with customers for the following:
- Contract income, including CSIR International Convention Centre revenue
- Operating leases
- Royalty income

The Group measures and accounts for revenue based on the specifications of each individual contract with a customer, excluding any amounts received on behalf of third parties, and based on the contractual obligations either accounts for the revenue at a specific point in time or over time as control of the goods or services are transferred to the customer.

The Group recognises revenue over time if a customer simultaneously receives and consumes all of the benefits provided by the Group. The Group recognises revenue at a point in time if the over time criteria is not met. Revenue is recognised when control is transferred to the customer which is usually when legal title passes to the customer and the business has the right to payment. Refer below for further explanation of the different products and services and when control is transferred to the customer and when the Group has right to payment.

Contract income (including CSIR International Convention Centre revenue)

Contract income comprises the consideration received or receivable on contracts entered into with customers in the ordinary course of the CSIR's activities. Revenue is shown net of amounts collected on behalf of third parties (e.g. VAT). Revenue is recognised at the amount of the transaction price that is allocated to each performance obligation, determined at an amount that depicts the consideration to which CSIR expects to be entitled in exchange for transferring the goods and services promised to the customer. Where a contract contains multiple performance obligations, the transaction price is allocated to each performance obligation based on their relative stand-alone selling prices.

Contract income is recognised when the transfer of control of the identified performance obligation(s) has been satisfied. In term contracts, where milestones and invoicing dates are not aligned, revenue is recognised according to the stage of completion. Stage of completion is measured based on costs incurred as a percentage of total estimated costs required to satisfy the performance obligation.

1.16 Revenue from contracts with customers (continued)

Operating leases

Contract income from operating leases is recognised on a straight-line basis over the lease term.

Royalty income

Royalty income is recognised when the underlying transactions triggering their payment occurs. Royalty income is measured at the rate per customer contract.

1.17 Contract assets and advances on contracts with customers

The accounting policy for contract assets needs to be read in conjunction with the accounting policy for revenue from contracts with customers. Contract assets arise on the basis that costs are incurred to satisfy performance obligations. The related payment timing is determined based on each individual contract. These costs include costs to fulfil a contract and includes costs such as direct labour, materials, professional/consulting services and allocation of overhead costs which relate directly to satisfy performance obligations of the contract.

Contract assets are recovered from the customer when the relevant performance obligations are completed and payment can be obtained from the customer. If costs are incurred on a contract without a corresponding payment received it is shown as contract assets at the reporting period.

If the customer has paid in advance for performance obligations to be satisfied it is shown as advances from customers within current liabilities. The Group presents as a liability the gross amount due to customers for contract work for all contracts in progress for which progress billings exceed costs incurred plus recognised profits (less recognised losses).

1.18 Related parties

A related party is a person or an entity with the ability to control or jointly control the other party, or exercise significant influence over the other party, or vice versa, or an entity that is subject to common control, or joint control.

Control is the power to govern the financial and operating policies of an entity so as to obtain benefits from its activities.

A related party transaction is a transfer of resources, services or obligations between the reporting entity and a related party, regardless of whether a price is charged.

Significant influence is the power to participate in the financial and operating policy decisions of an entity but is not control over those policies.

Key management are those persons responsible for planning, directing and controlling the activities of the entity, including those charged with the governance of the entity in accordance with legislation, in instances where they are required to perform such functions. All individuals from the level of executive management up to the Board of Directors are regarded as key management.

Close family members of a person are those family members who may be expected to influence or be influenced by that person in their dealings with the entity.

The entity is exempt from disclosure requirements in relation to related party transactions if that transaction occurs within normal supplier and/or client/recipient relationships on terms and conditions no more or less favourable than those which it is reasonable to expect the entity to have adopted if dealing with that individual entity or person in the same circumstances and terms and conditions are within the normal operating parameters established by that reporting entity's legal mandate.

Where the entity is exempt from the disclosures in accordance with the above, the entity discloses narrative information about the nature of the transactions and the related outstanding balances, to enable users of the entity's financial statements to understand the effect of related party transactions on its annual financial statements.

The entity operates in an economic sector currently dominated by entities directly or indirectly owned by the South African Government. As a consequence of the constitutional independence of the three spheres of government in South Africa, only entities within the national sphere of government are considered to be related parties.

Notes to the Consolidated Financial Statements

for the year ended 31 March 2024

2. Revenue	GROUP 2024 R '000	GROUP 2023 R '000	CSIR 2024 R '000	CSIR 2023 R '000
Revenue				
Parliamentary Grant	**729,724**	738,476	**729,724**	738,476
Contract income	**2,019,523**	1,765,536	**2,019,523**	1,765,536
Royalty income	**1,986**	1,645	**1,986**	1,645
Other government grants	**399,445**	313,540	**399,445**	313,540
	3,150,678	**2,819,197**	**3,150,678**	**2,819,197**
The group disaggregates revenue from customers as follows:				
Parliamentary Grant				
Parliamentary Grant received	**714,308**	741,615	**714,308**	741,615
Less:				
Grant received for projects started before year-end but not completed	**(41,228)**	(56,644)	**(41,228)**	(56,644)
Add:				
Grant received in prior year for projects completed in this year	**56,644**	53,505	**56,644**	53,505
	729,724	**738,476**	**729,724**	**738,476**
Contract income				
Local private sector	**225,006**	263,216	**225,006**	263,216
Local public sector	**1,481,831**	1,259,619	**1,481,831**	1,259,619
International sector (including Africa)	**312,686**	242,701	**312,686**	242,701
	2,019,523	**1,765,536**	**2,019,523**	**1,765,536**
Royalty income				
Royalty income	**1,986**	1,645	**1,986**	1,645
Other government grants				
Other government grants	**399,445**	313,540	**399,445**	313,540
Total revenue	**3,150,678**	**2,819,197**	**3,150,678**	**2,819,197**

2. Revenue (continued)

	GROUP		CSIR	
	2024 %	2023 %	2024 %	2023 %
Parliamentary Grant				
Parliamentary Grant received	**23.16%**	26.19%	**23.16%**	26.19%
Contract income				
Local private sector	**7.14%**	9.34%	**7.14%**	9.34%
Local public sector	**47.03 %**	44.68%	**47.03%**	44.68%
International sector (including Africa)	**9.93 %**	8.61%	**9.93%**	8.61%
Other government grants				
Other government grants	**12.68 %**	11.12%	**12.68%**	11.12%
Royalty income				
Royalty income	**0.06 %**	0.06%	**0.06%**	0.06%
	100.00 %	**100.00%**	**100.00%**	**100.00%**

Included in other government grants is R144 million (2023: R110 million) ring-fenced allocation from the Department of Science and Innovation for specific initiatives managed through memorandums of agreement.

Included in contract income is rental income amounting to R64,3 million (2023: R59,9 million) and revenue of R39 million (2023: R29 million) earned by the CSIR International Convention Centre.

Estimates on Parliamentary Grant recognition are based on cost to completion, budgets and percentage of completion.

Other government grants relate to income from contracts with government that impose specified performance conditions on the CSIR.

3. Other income	GROUP		CSIR	
	2024 R '000	2023 R '000	2024 R '000	2023 R '000
Bad debts recovered	**1,680**	53	**1,680**	53
Compensation from insurance claims	**-**	28,855	**-**	28,855
Other recoveries	**4,062**	3,440	**4,062**	3,440
Profit/(loss) on disposal of property, plant and equipment	**642**	(59)	**642**	(59)
Foreign exchange gains	**3,389**	-	**3,389**	-
Gain on fair value adjustment of investment at fair value through profit or loss	**-**	9,487	**-**	9,487
Realised gain on investment at fair value through profit or loss	**17,642**	-	**17,642**	-
Realised gain on investment at fair value through other comprehensive income	**646**	-	**646**	-
	28,061	**41,776**	**28,061**	**41,776**

Notes to the Consolidated Financial Statements

for the year ended 31 March 2024

	GROUP		CSIR	
4. Operating loss				
Operating loss for the year is arrived at after taking the following items, amongst others, into account:	**2024 R '000**	**2023 R '000**	**2024 R '000**	**2023 R '000**
Depreciation				
Depreciation of property, plant and equipment	**43,561**	41,059	**43,561**	41,059
Depreciation of right-of-use assets	**2,140**	1,400	**2,140**	1,400
Total depreciation	**45,701**	**42,459**	**45,701**	**42,459**
Movement in credit loss allowances				
Trade and other receivables	**6,619**	(6,452)	**6,619**	(6,452)
Other				
Bad debts written off	**2,069**	13,139	**2,057**	13,139
Gain on fair value adjustment of investment at fair value through profit or loss	**-**	(9,487)	**-**	(9,487)
Foreign exchange gains	**(3,389)**	-	**(3,389)**	-
(Reversal of impairment)/impairment on investments in joint venture and associate	**(1,668)**	342	**-**	493
Impairment of property, plant and equipment	**-**	23,452	**-**	23,452
(Profit)/loss on disposal of property, plant and equipment	**(642)**	59	**(642)**	59
5. Finance income				
Interest income				
Investments in financial assets:				
Finance income	**71,675**	55,367	**71,114**	55,037
Finance income				
Interest on bank balances	**27,256**	11,094	**26,695**	10,764
Other investment income	**44,419**	44,273	**44,419**	44,273
Total	**71,675**	**55,367**	**71,114**	**55,037**
6. Finance expense				
Finance leases	**887**	422	**887**	422
7. Taxation				
Opening balance	**5,745**	6,030	**-**	-
Assessed tax loss utilised for the year	**(522)**	(285)	**-**	-
Assessed tax loss carried forward	**5,223**	**5,745**	**-**	-

A subsidiary in the Group (CSIR C3 SOC Ltd) is in an assessed loss position and no deferred tax was raised for the assessed loss due to the uncertainty of the recoverability in future periods in respect of the carry forward of unused tax losses.

The CSIR is exempt from South African income tax in terms of section 10(1)(t)(i) of the Income Tax Act, Act No 58 of 1962.

8. Property, plant and equipment

GROUP	2024			2023		
	Cost or revaluation R '000	Accumulated depreciation R '000	Carrying value R '000	Cost or revaluation R '000	Accumulated depreciation R '000	Carrying value R '000
Land	**138,400**	**-**	**138,400**	138,400	-	138,400
Buildings	**592,416**	**(110,382)**	**482,034**	583,784	(103,088)	480,696
Furniture and fixtures	**16,690**	**(13,571)**	**3,119**	15,306	(13,531)	1,775
Vehicles	**7,074**	**(6,071)**	**1,003**	7,197	(6,023)	1,174
Equipment	**554,034**	**(433,305)**	**120,729**	544,569	(429,408)	115,161
IT equipment	**242,594**	**(179,651)**	**62,943**	222,549	(173,132)	49,417
Total	**1,551,208**	**(742,980)**	**808,228**	**1,511,805**	**(725,182)**	**786,623**

CSIR	2024			2023		
	Cost or revaluation R '000	Accumulated depreciation R '000	Carrying value R '000	Cost or revaluation R '000	Accumulated depreciation R '000	Carrying value R '000
Land	**138,400**	**-**	**138,400**	138,400	-	138,400
Buildings	**592,416**	**(110,382)**	**482,034**	583,784	(103,088)	480,696
Furniture and fixtures	**16,690**	**(13,571)**	**3,119**	15,306	(13,531)	1,775
Vehicles	**7,074**	**(6,071)**	**1,003**	7,197	(6,023)	1,174
Equipment	**554,034**	**(433,305)**	**120,729**	544,569	(429,408)	115,161
IT equipment	**242,594**	**(179,651)**	**62,943**	222,549	(173,132)	49,417
Total	**1,551,208**	**(742,980)**	**808,228**	**1,511,805**	**(725,182)**	**786,623**

Reconciliation of property, plant and equipment - Group - 2024					
	Opening balance R '000	Additions R '000	Disposals and write-offs R '000	Depreciation R '000	Closing balance R '000
Land	**138,400**	**-**	**-**	**-**	**138,400**
Buildings	**480,696**	**8,696**	**(58)**	**(7,300)**	**482,034**
Furniture and fixtures	**1,775**	**1,912**	**(8)**	**(560)**	**3,119**
Vehicles	**1,174**	**-**	**(3)**	**(168)**	**1,003**
Equipment	**115,161**	**23,749**	**(647)**	**(17,534)**	**120,729**
IT equipment	**49,417**	**32,082**	**(557)**	**(17,999)**	**62,943**
	786,623	**66,439**	**(1,273)**	**(43,561)**	**808,228**

8. Property, plant and equipment (continued)

Reconciliation of property, plant and equipment - Group - 2023					
	Opening balance R '000	Additions R '000	Other changes, movements R '000	Depreciation R '000	Closing balance R '000
Land	138,400	-	-	-	138,400
Buildings	440,597	46,433	(340)	(5,994)	480,696
Furniture and fixtures	2,160	301	(93)	(593)	1,775
Vehicles	1,382	-	-	(208)	1,174
Equipment	111,232	19,703	2,697	(18,471)	115,161
IT equipment	43,862	21,819	(471)	(15,793)	49,417
	737,633	**88,256**	**1,793**	**(41,059)**	**786,623**

Reconciliation of property, plant and equipment - CSIR - 2024					
	Opening balance R '000	Additions R '000	Disposals and write-offs R '000	Depreciation R '000	Closing balance R '000
Land	**138,400**	**-**	**-**	**-**	**138,400**
Buildings	**480,696**	**8,696**	**(58)**	**(7,300)**	**482,034**
Furniture and fixtures	**1,775**	**1,912**	**(8)**	**(560)**	**3,119**
Vehicles	**1,174**	**-**	**(3)**	**(168)**	**1,003**
Equipment	**115,161**	**23,749**	**(647)**	**(17,534)**	**120,729**
IT equipment	**49,417**	**32,082**	**(557)**	**(17,999)**	**62,943**
	786,623	**66,439**	**(1,273)**	**(43,561)**	**808,228**

Reconciliation of property, plant and equipment - CSIR - 2023					
	Opening balance R '000	Additions R '000	Other changes, movements R '000	Depreciation R '000	Closing balance R '000
Land	138,400	-	-	-	138,400
Buildings	440,597	46,433	(340)	(5,994)	480,696
Furniture and fixtures	2,160	301	(93)	(593)	1,775
Vehicles	1,382	-	-	(208)	1,174
Equipment	111,232	19,703	2,697	(18,471)	115,161
IT equipment	43,862	21,819	(471)	(15,793)	49,417
	737,633	**88,256**	**1,793**	**(41,059)**	**786,623**

8. Property, plant and equipment (continued)

Revaluations

The Group's land is stated at revalued amounts, being the fair value at the date of revaluation, less any subsequent accumulated impairment losses. Revaluations are performed every five years and in intervening years if the carrying amount of the land differs materially from their fair value.

The fair value measurements as of 31 March 2020 were performed by Potela Peter Mabelane, an independent valuer not related to the Group. Mabelane is a member of the South African Council for the Property Valuers Profession and has the appropriate qualifications and recent experience in the fair value measurement of properties in the relevant locations.

The carrying value of the revalued assets under the cost model would have been:

	GROUP		CSIR	
	2024 R '000	2023 R '000	2024 R '000	2023 R '000
Land	**4,829**	4,829	**4,829**	4,829

Details of properties

Land and buildings are unencumbered and full details of the titles are available at the registered office of the CSIR.

A change in the depreciation estimate due to a change in the useful lives of equipment, ICT equipment, furniture and fixtures and vehicles resulted in a R2,4 million (2023: R4,4 million) decrease in the depreciation amount for the current financial year.

During the current financial year, assets to the value of R197 million (2023: R78,7 million) were purchased with government grant funds. At year-end, the cumulative value of assets purchased with government grant funds and shown at a nil cost is R1,1 billion (2023: R927,8 million).

9. Leases (Group as lessee)

The Group leases several assets, including buildings, motor vehicles and office equipment. The average lease term is four years.

Details pertaining to leasing arrangements, where the Group is lessee are presented below:

Net carrying amounts of right-of-use assets

The carrying amounts of right-of-use assets are included in the following line items:

	GROUP		CSIR	
	2024 R '000	2023 R '000	2024 R '000	2023 R '000
Buildings	**3,562**	4,870	**3,562**	4,870
Motor vehicles	**4,416**	3,161	**4,416**	3,161
	7,978	**8,031**	**7,978**	**8,031**
Additions to right-of-use assets				
Buildings	**-**	5,043	**-**	5,043
Motor vehicles	**2,996**	3,061	**2,996**	3,061
	2,996	**8,104**	**2,996**	**8,104**
Depreciation recognised on right-of-use assets				
Depreciation recognised on each class of right-of-use assets, is presented below:				
Buildings	**758**	921	**758**	921
Motor vehicles	**1,382**	442	**1,382**	442
Office equipment	**-**	37	**-**	37
	2,140	**1,400**	**2,140**	**1,400**
Other disclosures				
Interest expense on lease liabilities	**887**	422	**887**	422
Lease liabilities				
The maturity analysis of lease liabilities is as follows:				
Within one year	**2,817**	2,664	**2,817**	2,664
Two to five years	**4,784**	5,517	**4,784**	5,517
More than five years	**663**	527	**663**	527
	8,264	**8,708**	**8,264**	**8,708**
Non-current liabilities	**5,447**	5,720	**5,447**	5,720
Current liabilities	**2,817**	2,244	**2,817**	2,244
	8,264	**7,964**	**8,264**	**7,964**

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for the year ended 31 March 2024

10. Interest in subsidiaries	GROUP		CSIR	
	2024 R '000	2023 R '000	2024 R '000	2023 R '000
Shares at cost less impairment losses	-	-	4,650	4,650
Indebtedness				
- by subsidiaries	-	-	-	-
- impairment of loans	-	-	-	-
	-	-	4,650	4,650

The following table provides details of the entity which is controlled directly by the CSIR, and the carrying amount of the investment in the CSIR's separate financial statements.

CSIR						
Name of company	% voting power 2024	% voting power 2023	% holding 2024	% holding 2023	Carrying amount 2024 R '000	Carrying amount 2023 R '000
CSIR C3 SOC Ltd	100%	100%	100%	100%	4,650	4,650

CSIR C3 SOC Ltd was previously known as Technifin SOC Ltd. The change of name took effect in July 2023.

11. Interests in joint venture and associate

GROUP				
Name of company	% ownership interest 2024	% ownership interest 2023	Carrying amount 2024 R '000	Carrying amount 2023 R '000
Joint venture				
Sera (Pty) Ltd - South Africa	50.00%	50.00%	-	-
Associate				
Persomics AB - Sweden	35.03%	35.03%	19,786	21,454
			19,786	21,454
Impairment			(19,786)	(21,454)
			-	-

CSIR				
Name of company	% ownership interest 2024	% ownership interest 2023	Carrying amount 2024 R '000	Carrying amount 2023 R '000
Joint venture				
Sera (Pty) Ltd - South Africa	50.00%	50.00%	-	16,166
Associate				
Persomics AB - Sweden	35.03%	35.03%	26,325	-
			26,325	16,166
Impairment			(26,325)	(16,166)
			-	-

11. Interests in joint venture and associate (continued)

Sera (Pty) Ltd is in the process of deregistration.

The investment in Persomics AB has been fully impaired at CSIR and Group level as at 31 March 2024. Persomics AB has reached an agreement with its largest creditor, enabling a liquidation of the business, which is expected to be completed during the 2024/25 financial year.

The following are details of the significant joint venture's and associate's assets, liabilities, income and expenses:

	GROUP JOINT VENTURE		GROUP ASSOCIATE	
	2024 R '000	2023 R '000	2024 R '000	2023 R '000
Current assets	**-**	465	**707**	68
Non-current assets	**-**	-	**-**	8,630
Current liabilities	**-**	11	**-**	1,464
Income	**-**	37	**-**	-
Expenses	**-**	339	**4,763**	467

12. Inventories	GROUP		CSIR	
	2024 R '000	2023 R '000	2024 R '000	2023 R '000
Finished goods	**737**	639	**737**	639

The cost of inventories recognised as an expense for the year amounted to R20,86 million (2023: R18,82 million).

13. Other receivables from contracts with customers

Contracts in progress at the end of the reporting period				
Other receivables from contracts with customers	**193,329**	203,503	**193,329**	203,503

Other receivables from contracts with customers arise as result of the time lag between customer billing and revenue recognition. Contract assets (refer to note 15) constitute capitalised costs on point in time contracts with customers. Advances received in excess of work completed are included in advances from customers under current liabilities.

14. Trade and other receivables	GROUP		CSIR	
	2024 R '000	2023 R '000	2024 R '000	2023 R '000
Financial instruments:				
Trade receivables	**327,533**	354,886	**327,531**	354,872
Accrued income	**-**	16	**-**	-
Trade receivables loss allowance	**(33,699)**	(28,070)	**(33,699)**	(28,070)
Trade receivables at amortised cost	**293,834**	326,832	**293,832**	326,802
Deposits	**1,190**	60	**1,190**	60
Other receivables	**9,566**	6,196	**9,543**	6,196
Other receivables loss allowance	**(5,033)**	(4,043)	**(5,033)**	(4,043)
Non-financial instruments:				
Prepayments	**102,929**	117,787	**102,929**	117,787
Total trade and other receivables	**402,486**	**446,832**	**402,461**	**446,802**

15. Contract assets

Contract assets	**4,856**	2,871	**4,856**	2,871
Reconciliation of contract assets				
Opening balance	**2,871**	4,315	**2,871**	4,315
Increase in contract assets	**3,778**	-	**3,778**	-
Transfers of contract assets to receivables	**(1,793)**	(1,444)	**(1,793)**	(1,444)
	4,856	**2,871**	**4,856**	**2,871**

16. Investments at fair value through profit or loss

Investments held by the Group which are measured at fair value, excluding debt instruments measured at fair value through other comprehensive income, are as follows:

Designated at fair value through profit or loss:				
Index-Linked Notes	**-**	134,487	**-**	134,487
	-	**134,487**	**-**	**134,487**

This investment was a structured financial instrument issued by First Rand Bank Limited. It was in the form of listed registered notes, and it matured on 22 December 2023.

17. Investments at fair value through other comprehensive income	GROUP		CSIR	
	2024 R '000	2023 Restated R '000	2024 R '000	2023 Restated R '000
Investments in debt instruments	**587,752**	739,942	**587,752**	739,942
Split between non-current and current portions				
Current assets	**587,752**	739,942	**587,752**	739,942

The amount represents the Group's interest in Stanlib's Flexible Income fund, which is designed to take advantage of exposure to income generating investments through various interest-rate environments. The fund invests mainly in South African investment markets (but may allocate capital to foreign markets) and is benchmarked against the Alexander Forbes Short-Term Fixed Interest (STeFI) Composite Index.

Interest distributions from the fund are made quarterly.

18. Cash and cash equivalents

Cash and cash equivalents consist of:				
Cash on hand	**92**	97	**92**	97
Bank balances	**136,139**	97,442	**135,384**	96,695
Short-term deposits	**601,060**	402,500	**592,667**	394,622
	737,291	**500,039**	**728,143**	**491,414**

Cash on hand comprises petty cash.

19. Post-retirement medical benefits

CSIR Pension Fund

The fund is registered in terms of the Pension Funds Act, 1956 (Act 24 of 1956), and is a defined contribution plan. The CSIR's liability to the fund was limited to paying the employer contributions up until 29 February 2016. The impact of the tax reform effective from 1 March 2016 is that the CSIR package structure was changed to reflect all retirement fund contributions as employee contributions. All permanent CSIR employees are members of the fund.

Employee contributions of R209 million (2023: R194 million) were expensed during the year.

Post-retirement medical benefits

The CSIR has a post-retirement medical benefit obligation to certain qualifying retired CSIR employees (pensioners) who joined the CSIR prior to 30 September 1996. An offer was made to qualifying pensioners in December 2005 to accept an annuity, payable from an independent source, equivalent to the value of their medical subsidy. The pensioners who accepted the offer are no longer entitled to a subsidy from the CSIR.

The accumulated benefit obligation and the annual cost of accrual of benefits are assessed by independent, qualified actuaries using the projected unit credit method. The estimated present value of the anticipated expenditure for the remaining 18 continuation members (2023: 18 continuation members) was recalculated by the actuaries as at 31 March 2024 and will be funded through cash and cash equivalents. These cash and cash equivalents have not been set aside specifically for this benefit.

The amount included in the statement of financial position arising from the CSIR's obligation in respect of post-retirement medical benefits is as follows:

	GROUP		CSIR	
	2024 R '000	**2023 R '000**	**2024 R '000**	**2023 R '000**
Carrying value				
Present value of the defined benefit obligation - wholly unfunded	**11,825**	11,978	**11,825**	11,978
Non-current liabilities	**9,770**	10,028	**9,770**	10,028
Current liabilities	**2,055**	1,950	**2,055**	1,950
	11,825	**11,978**	**11,825**	**11,978**

Amounts recognised in the statement of profit or loss and other comprehensive income in respect of the scheme are as follows:

Net amount recognised				
Interest cost	**1,029**	1,020	1,029	1,020
Actuarial gain	**(1,182)**	(1,246)	(1,182)	(1,246)
	(153)	**(226)**	**(153)**	**(226)**

Movement in the net liability recognised in the statement of financial position is as follows:

Net liability at the beginning of the year	**11,978**	12,204	**11,978**	12,204
Net income recognised in the statement of profit or loss and other comprehensive income	**(153)**	(226)	**(153)**	(226)
Net liability at the end of the year	**11,825**	**11,978**	**11,825**	**11,978**

19. Post-retirement medical benefits (continued)

	GROUP		CSIR	
	2024 %	2023 %	2024 %	2023 %
Principal actuarial assumptions at the reporting date:				
Discount rate	**10.45%**	9.33%	**10.45%**	9.33%
CPI inflation rate	**5.23%**	4.73%	**5.23%**	4.73%

The above results are sensitive to changes in the discount rate and the CPI inflation rate.

	GROUP		CSIR	
	2024 R '000	2023 R '000	2024 R '000	2023 R '000
The effect of a one percent increase in the assumed discount rate would have the following effects:				
Effect on defined benefit obligation	**(514)**	(553)	**(514)**	(553)
The effect of a one percent decrease in the assumed discount rate would have the following effects:				
Effect on defined benefit obligation	**562**	609	**562**	609
The effect of a one percent increase in the assumed CPI inflation rate would have the following effects:				
Effect on defined benefit obligation	**557**	600	**557**	600
The effect of a one percent decrease in the assumed CPI inflation rate would have the following effects:				
Effect on defined benefit obligation	**(516)**	(553)	**(516)**	(553)

The above sensitivity analyses are based on a change in an assumption while all other assumptions are assumed to remain unchanged. This may not always be realistic as some of the assumptions tend to be correlated. When calculating the sensitivity of the defined benefit obligation to significant actuarial assumptions, the same method (present value of the defined benefit obligation calculated with the projected unit credit method at the end of the reporting period) has been applied as when calculating the liability recognised within the statement of financial position.

	2024 R '000	2023 R '000	2022 R '000	2021 R '000	2020 R '000
Historical information					
Present value of the defined benefit obligation	11,825	11,978	12,204	12,881	11,800

The average term (undiscounted) of the defined benefit obligation is 7.75 years (2023: 8.4 years) and the average duration (discounted) of the defined benefit obligation is 5 years (2023: 5.25 years).

20. Trade and other payables

	GROUP		CSIR	
	2024 R '000	2023 R '000	2024 R '000	2023 R '000
Financial instruments:				
Trade payables	**226,058**	248,596	**226,072**	248,622
Salary related payables	**89,482**	86,540	**89,482**	86,540
Non-financial instruments:				
VAT	**35,089**	22,180	**35,089**	22,180
Total trade and other payables	**350,629**	**357,316**	**350,643**	**357,342**

21. Advances from customers

Advances from customers	**974,410**	1,064,856	**974,410**	1,064,856

Advances from customers constitute income received from customers in advance.

22. Provisions

Reconciliation of provisions - Group - 2024					
	Opening balance R '000	Additions R '000	Utilised during the year R '000	Reversed during the year R '000	Closing balance R '000
Other provisions	**98,722**	**74,496**	**(97,252)**	**(1,470)**	**74,496**

Reconciliation of provisions - Group - 2023				
	Opening balance R '000	Additions R '000	Utilised during the year R '000	Closing balance R '000
Other provisions	87,990	98,722	(87,990)	98,722

Reconciliation of provisions - CSIR - 2024					
	Opening balance R '000	Additions R '000	Utilised during the year R '000	Reversed during the year R '000	Closing balance R '000
Other provisions	**98,722**	**74,496**	**(97,252)**	**(1,470)**	**74,496**

Reconciliation of provisions - CSIR - 2023				
	Opening balance R '000	Additions R '000	Utilised during the year R '000	Closing balance R '000
Other provisions	87,990	98,722	(87,990)	98,722

Other provisions comprise of provision for short-term employees' performance incentives. The provision was based on the approved Short-Term Incentive (STI) guideline and was estimated based on past established practice.

23. Reconciliation of operating profit to cash utilised in operating activities	GROUP		CSIR	
	2024 R '000	2023 Restated R '000	2024 R '000	2023 Restated R '000
Profit for the year	**36,974**	43,852	**36,468**	43,567
Adjusted for:				
Depreciation	**45,701**	42,459	**45,701**	42,459
Profit on disposal and write-off of property, plant and equipment	**(642)**	(5,344)	**(642)**	(5,344)
Net unrealised foreign exchange gains	**(4,782)**	(19,751)	**(4,782)**	(19,751)
Bad debts written off	**2,069**	13,139	**2,057**	13,139
Finance income	**(71,675)**	(55,367)	**(71,114)**	(55,037)
Finance expense	**887**	422	**887**	422
Impairments	**4,951**	6,945	**6,619**	6,945
Movement in post-retirement medical benefits	**1,029**	1,020	**1,029**	1,020
Movements in provisions	**(24,226)**	10,732	**(24,226)**	10,732
Leave accrual	**14,593**	19,133	**14,593**	19,133
Share of losses from joint venture and associate	**1,668**	151	**-**	-
Profit on disposal and remeasurement of fair value investments	**(17,642)**	(9,487)	**(17,642)**	(9,487)
Profit on disposal of investment at fair value through other comprehensive income	**(646)**	-	**(646)**	-
Other non-cash items	**16**	3,975	**-**	4,142
Changes in working capital:				
Inventories	**(98)**	(34)	**(98)**	(34)
Trade and other receivables	**37,247**	(120,575)	**37,231**	(120,578)
Contract assets	**(1,985)**	1,444	**(1,985)**	1,444
Other receivables from contracts with customers	**14,759**	(31,392)	**14,759**	(31,392)
Trade and other payables	**(21,296)**	(35,474)	**(21,292)**	(35,522)
Advances from customers	**(89,588)**	101,718	**(89,588)**	101,718
Cash utilised in operating activities	**(72,686)**	**(32,434)**	**(72,671)**	**(32,424)**

24. Board members, Directors and Executive Management's remuneration

2024	Emoluments R '000	Directors' fees R '000	Total R '000
Board members and Executive Directors			
Dr TH Dlamini	7,814	-	7,814
Non-executive Board members			
Prof. A Van Zyl	-	198	198
M Govender	-	132	132
Dr C Render	-	126	126
Prof. Y Ballim	-	145	145
M Matolong	-	121	121
Dr V Mthethwa	-	151	151
V Jarana	-	144	144
M Fakir	-	144	144
J Newton	-	147	147
M Mulcahy (from 12 July 2023)	-	92	92
Executive Management			
MA Dindar (until 30 June 2023)	2,825	-	2,825
E Opperman	2,739	-	2,739
Dr K Naidoo	3,502	-	3,502
Dr RK Chikwamba	4,579	-	4,579
Dr MS Maserumule	4,977	-	4,977
MC Mabindisa	3,477	-	3,477
Adv. E Kennedy	3,837	-	3,837
Dr S Malinga	4,211	-	4,211
	37,961	**1,400**	**39,361**

24. Board members, Directors and Executive Management's remuneration (continued)

2023	Emoluments R '000	Directors' fees R '000	Total R '000
Board members and Executive Directors			
Dr TH Dlamini	7,191	-	7,191
Non-executive Board members			
Prof. T Majozi (until 31 December 2022)	-	251	251
Prof. A Van Zyl	-	36	36
M Govender	-	18	18
Prof. AR Childs (until 31 December 2022)	-	82	82
Dr C Render	-	134	134
S Masie (until 31 December 2022)	-	117	117
Prof. Y Ballim	-	20	20
M Matolong	-	18	18
Dr R Masango (until 31 December 2022)	-	93	93
J Netshitenzhe (until 31 December 2022)	-	71	71
Dr V Mthethwa	-	123	123
C Shariff (until 31 December 2022)	-	117	117
V Jarana	-	17	17
M Fakir	-	20	20
J Newton	-	19	19
Executive Management			
MA Dindar	4,408	-	4,408
E Opperman (acting from 17 January 2023)	474	-	474
Dr K Naidoo	3,078	-	3,078
Dr RK Chikwamba	4,302	-	4,302
Dr MS Maserumule	4,614	-	4,614
MC Mabindisa	3,270	-	3,270
Adv. E Kennedy	3,616	-	3,616
Dr S Malinga (from 1 August 2022)	2,496	-	2,496
	33,449	**1,136**	**34,585**

25. Contingencies

In the nature of the CSIR's business, agreements with complex deliverables may be entered into. All necessary steps are taken to manage the risks inherent to these transactions. If and when it is evident that there is a reasonable probability that a dispute on a transaction could lead to costs against the CSIR, such costs will be disclosed. Refer to note 32 for financial guarantees issued by the CSIR.

26. Financial instruments and risk management

Financial risk management

Overview

The Group is exposed to the following risks from its use of financial instruments:
- Market risk (currency risk, interest rate risk and price risk);
- Credit risk; and
- Liquidity risk

This note presents information about the Group's exposure to each of the above risks and the Group's objectives, policies and processes for measuring and managing risk. Further quantitative disclosures are included throughout these consolidated financial statements.

The Board has overall responsibility for the establishment and oversight of the Group's risk management framework.

The Group's risk management policies are established to identify and analyse the risks faced by the Group, to set appropriate risk limits and controls, and to monitor risks and adherence to limits. Risk management policies and systems are reviewed regularly to reflect changes in market conditions and the Group's activities. The Group, through its training and management standards and procedures, aims to develop a disciplined and constructive control environment in which all employees understand their roles and obligations.

The Audit and Risk Committee oversees how management monitors compliance with the Group's risk management policies and procedures and reviews the adequacy of the risk management framework in relation to the risks faced by the Group. The Group Audit and Risk Committee is assisted in its oversight role by internal audit. Internal audit undertakes both regular and ad hoc reviews of risk management controls and procedures, the results of which are reported to the Audit and Risk Committee.

26.1 Market risk

Market risk is the risk that changes in market prices, such as foreign exchange rates and interest rates will affect the Group's income or the value of its holdings of financial instruments. The objective of market risk management is to manage and control market risk exposures within acceptable parameters, while optimising the return.

Foreign currency risk

The Group is exposed to currency risk on sales and purchases that are denominated in a currency other than the respective functional currency of the Group entities.

The Group enters into forward exchange contracts to buy specified amounts of foreign currencies in the future at a predetermined exchange rate.

Forward exchange contracts are entered into mainly to cover import orders. The Group has no policy to enter into forward exchange contracts for anticipated foreign receipts. The Group does not use derivative financial instruments for speculative purposes.

26. Financial instruments and risk management (continued)

The Group's exposure to foreign currency risk was as follows:

31 March 2024	ZAR R '000	EURO R '000	USD R '000	GBP R '000	Other R '000	Total R '000
Trade receivables	269,687	4,099	17,529	1,370	1,149	293,834
Bank accounts	63,170	6,378	60,923	5,668	-	136,139
Trade and other payables	(314,879)	(135)	(268)	(2)	(256)	(315,540)
Gross statement of financial position exposure	17,978	10,342	78,184	7,036	893	114,433
Net exposure	**17,978**	**10,342**	**78,184**	**7,036**	**893**	**114,433**

31 March 2023	ZAR R '000	EURO R '000	USD R '000	GBP R '000	Other R '000	Total R '000
Trade receivables	339,359	-	7,909	7,543	577	355,388
Bank accounts	47,806	5,422	37,811	6,351	54	97,444
Trade and other payables	(333,770)	(1,224)	-	(17)	(125)	(335,136)
Gross statement of financial position exposure	53,395	4,198	45,720	13,877	506	117,696
Net exposure	**53,395**	**4,198**	**45,720**	**13,877**	**506**	**117,696**

The following closing exchange rates were applied at reporting date:

	GROUP		CSIR	
	2024 R	2023 R	2024 R	2023 R
Rand per unit of foreign currency:				
USD	**19.003**	17.895	**19.003**	17.895
Euro	**20.608**	19.554	**20.608**	19.554
GBP	**24.031**	22.210	**24.031**	22.210

Sensitivity analysis

A 10% strengthening of the rand against the following currencies at 31 March would have decreased profit or loss by the amounts shown below. This analysis assumes that all other variables remain constant. The analysis is performed on the same basis for 2023.

	GROUP		CSIR	
	2024 R '000	2023 R '000	2024 R '000	2023 R '000
Euro	**(1,034)**	(665)	**(1,034)**	(665)
USD	**(7,818)**	(4,572)	**(7,818)**	(4,572)
GBP	**(704)**	(1,391)	**(704)**	(1,391)
Other	**(89)**	(76)	**(89)**	(76)

A 10% weakening of the rand against the above currencies at 31 March would have had the equal but opposite effect on the above currencies to the amounts shown above, on the basis that all other variables remain constant.

26. Financial instruments and risk management (continued)

Interest rate risk
Interest rate exposure and investment strategies are evaluated by management on a regular basis. Interest-bearing investments are held with several reputable banks and financial institutions in order to minimise exposure.

At the reporting date the interest rate profile of the Group's interest-bearing financial instruments was as follows:

	GROUP		CSIR	
	2024 R '000	2023 R '000	2024 R '000	2023 R '000
Fixed rate instruments: Carrying amount				
Financial assets: Fixed deposits and Index-Linked Notes	**6,240**	140,273	**-**	134,487

The Group does not designate derivatives as hedging instruments under a fair value hedge accounting model. Therefore, a change in interest rates at the reporting date would not affect profit or loss.

	GROUP		CSIR	
	2024 R '000	2023 Restated R '000	2024 R '000	2023 Restated R '000
Variable rate instruments: Carrying amount				
Financial assets: Call deposits	**594,820**	396,714	**592,667**	394,622
Financial assets: Bank balances	**136,139**	97,442	**135,384**	96,695
Financial assets: Investments at fair value through other comprehensive income	**587,752**	739,942	**587,752**	739,942
	1,318,711	**1,234,098**	**1,315,803**	**1,231,259**

Sensitivity analysis

The Group does not account for any fixed rate financial assets and liabilities at fair value through profit or loss, therefore a change in interest rates at the reporting date would not affect profit or loss.

26.2 Credit risk

Credit risk is the risk of financial loss to the Group if a customer or counterparty to a financial instrument fails to meet its contractual obligations. It arises principally from the Group's bank balances and deposits, trade and other receivables and loans to joint ventures, associates and subsidiaries.

Trade and other receivables and loans to joint ventures, associates and subsidiaries
Trade and other receivables and loans to joint ventures, associates and subsidiaries are presented net of impairment losses. Credit risk with respect to trade receivables is limited due to the large number of customers comprising the Group's customer base and their dispersion across different industries and geographical areas.

Bank balances and deposits
The Group's bank balances and cash are placed with high credit, quality financial institutions with no significant exposure to any one financial institution.

26. Financial instruments and risk management (continued)

Guarantees
Refer to note 32 for details on bank guarantees issued with respect to facilities.

Exposure to credit risk
The carrying amount of financial assets represents the maximum credit exposure.

The maximum exposure to credit risk at the reporting date was:

	GROUP		CSIR	
	2024 R '000	2023 Restated R '000	2024 R '000	2023 Restated R '000
Fixed deposits and Index-Linked Notes	**6,240**	140,273	**-**	134,487
Call deposits	**594,820**	396,714	**592,667**	394,622
Bank balances	**136,139**	97,442	**135,384**	96,695
Cash on hand	**92**	97	**92**	97
Trade and other receivables	**299,557**	446,772	**299,532**	446,742
Other receivables from contracts with customers	**193,329**	203,503	**193,329**	203,503
	1,230,177	**1,284,801**	**1,221,004**	**1,276,146**

The maximum exposure to credit risk for trade receivables at the reporting date by type of customer was:

	GROUP		CSIR	
	2024 R '000	2023 R '000	2024 R '000	2023 R '000
Local public sector	**191,190**	235,267	**191,188**	235,267
Local private sector	**80,897**	73,743	**80,897**	73,743
International sector	**21,747**	18,311	**21,747**	18,311
	293,834	**327,321**	**293,832**	**327,321**

The Group's most significant customers are various local public sector customers.

The aging of the Group's trade receivables at the reporting date was:	2024 Gross R '000	2024 Impairment R '000	2023 Gross R '000	2023 Impairment R '000
Not past due	**239,204**	1,444	**259,400**	-
Past due 0 – 30 days	**32,408**	1,934	**40,495**	1,682
Past due 31 – 120 days	**24,412**	3,593	**23,762**	2,666
Past due more than 120 days	**31,509**	26,728	**31,734**	23,722
	327,533	**33,699**	**355,391**	**28,070**

26. Financial instruments and risk management (continued)

The movement in the allowance for impairment in respect of trade receivables during the year was as follows:

	GROUP	
	2024 R '000	**2023 R '000**
Balance at 1 April	**28,070**	38,566
Movement for the year		
Recoveries	**(9,035)**	-
Reversals and write-off	**(3,122)**	(12,363)
New impairment allowances	**17,786**	1,867
Balance at 31 March	**33,699**	**28,070**

The allowance account in respect of trade receivables is used to record impairment losses unless the Group is satisfied that no recovery of the amount owing is possible; at that point the amount considered irrecoverable is written off against the financial asset directly.

The fully performing trade receivables are considered to be of high credit quality.

26.3 Liquidity risk

Liquidity risk is the risk that the Group will not be able to meet its financial obligations as these fall due. The Group's approach to managing liquidity is to ensure, as far as possible, that it will always have sufficient liquidity to meet its liabilities when due, under both normal and stressed conditions, without incurring unacceptable losses or risking damage to the Group's reputation.

The Group monitors its cash flow on a daily basis. Typically, the Group ensures that it has sufficient cash on demand to meet expected operational expenses for a period of 60 days, including the servicing of financial obligations; this excludes the potential impact of extreme circumstances that cannot be predicted reasonably, such as natural disasters.

The following are the contractual maturities of financial liabilities, including interest payments but excluding the impact of netting agreements for the Group:

	2024 Contractual cash flows			**2023 Contractual cash flows**		
	Carrying amount R '000	**6 months or less R '000**	**6 - 12 months R '000**	**Carrying amount R '000**	**6 months or less R '000**	**6 - 12 months R '000**
Non-derivative financial liabilities						
Trade and other payables	**(315,540)**	**(315,540)**	**-**	(330,136)	(330,136)	-
	(315,540)	**(315,540)**	**-**	**(330,136)**	**(330,136)**	**-**

26. Financial instruments and risk management (continued)

Fair values

The estimated net fair values, as at the reporting date, have been determined using available market information and appropriate valuation methodologies as outlined below. This value is not necessarily indicative of the amounts that the Group could realise in the normal course of business. The fair values of the financial assets and financial liabilities are sensitive to exchange rate movements. A sensitivity analysis of a 10% increase/decrease in exchange rate fluctuation on the balances held in foreign currency as at 31 March 2024 is performed.

As at 31 March 2024 the carrying amount of bank balances and cash, deposits, trade and other receivables, contracts in progress and trade and other payables approximated their fair values due to the short-term maturities of these assets and liabilities.

Basis for determining fair values

Trade and other receivables and trade and other payables

The fair value of trade and other receivables and trade and other payables is calculated based on the present value of future cash flows, discounted at the average return on investment rate at the reporting date.

Forward exchange contracts

The fair value of forward exchange contracts is determined using forward exchange rates at the Statement of Financial Position date, with the resulting value discounted back to present value.

27. Changes in liabilities arising from financing activities	**GROUP**		**CSIR**	
	2024 R '000	**2023 R '000**	**2024 R '000**	**2023 R '000**
Finance leases				
Opening balance	**7,964**	**11,326**	**7,964**	**11,326**
New leases	**2,996**	8,104	**2,996**	8,104
Other non-cash movements	**(256)**	(9,612)	**(256)**	(9,612)
Total non-cash movements	**2,740**	**(1,508)**	**2,740**	**(1,508)**
Cash flows	**(2,440)**	(1,854)	**(2,440)**	(1,854)
Closing balance	**8,264**	**7,964**	**8,264**	**7,964**

28. Fair value information

Fair value hierarchy

The table below analyses assets and liabilities carried at fair value. The different levels are defined as follows:

Level 1: Quoted unadjusted prices in active markets for identical assets or liabilities that the Group can access at measurement date.

Level 2: Inputs other than quoted prices included in level 1 that are observable for the asset or liability either directly or indirectly.

Level 3: Unobservable inputs for the asset or liability.

		GROUP		CSIR	
	Notes	2024 R '000	2023 Restated R '000	2024 R '000	2023 Restated R '000
Levels of fair value measurements					
Level 1: Recurring fair value measurements					
Assets					
Financial instruments					
Index-Linked Notes	16	-	134,487	-	134,487
Investments in debt instruments	17	**587,752**	739,942	**587,752**	739,942
Total		**587,752**	**874,429**	**587,752**	**874,429**

29. Related parties

Relationships

Minister	Dr Blade Nzimande
Holding entity	Department of Science and Innovation
Subsidiaries	CSIR C3 SOC Ltd (100%). Refer to note 10.
Joint ventures	Sera (Pty) Ltd (50%). Refer to note 11.
Associates	Persomics AB (35.03%). Refer to note 11.
Entities in Ministerial Portfolio	Department of Higher Education and Training and other related entities under the holding entity.
National Government	All national government departments and their related entities.
Directors and key management	Directors and key management. Refer to note 24.

The CSIR is a schedule 3B National Government Business Enterprise in terms of the Public Finance Management Act, 1999 (Act 1 of 1999) as amended by Act 29 of 1999, and therefore falls within the national sphere of government. As a consequence, the CSIR has a significant number of related parties, being entities that fall within the national sphere of government. Amounts due from/to these entities are subject to the same terms and conditions as normal trade receivables and trade payables.

In addition, the CSIR has a related party relationship with its subsidiaries and joint ventures and associates (see notes 10 and 11). Unless specifically disclosed, these transactions are concluded at arm's length and the Group is able to transact with any entity.

29. Related parties (continued)

	GROUP		CSIR	
	2024 R '000	2023 R '000	2024 R '000	2023 R '000
Transactions with related parties				
Constitutional institutions				
Services rendered	**2,837**	1,668	**2,837**	1,668
Services received	**-**	3	**-**	3
Amount due from	**2,315**	1,533	**2,315**	1,533
Major public entities				
Services rendered	**339,379**	187,887	**339,379**	187,887
Services received	**47,888**	64,147	**47,888**	64,147
Amount due from	**56,864**	15,928	**56,864**	15,928
National public entities				
Services rendered	**115,469**	94,079	**115,469**	94,079
Services received	**24,227**	25,313	**24,227**	25,313
Amount due from	**15,034**	17,405	**15,034**	17,405
National government business enterprises				
Services rendered	**4,525**	7,662	**4,525**	7,662
Services received	**2,075**	570	**2,075**	570
Amount due from	**4,530**	5,254	**4,530**	5,254
Government departments				
Services rendered	**2,063,263**	1,916,513	**2,063,263**	1,916,513
Services received	**10,463**	8,388	**10,463**	8,388
Amount due from	**114,758**	149,613	**114,758**	149,613
Subsidiaries				
Amount due to	**-**	**-**	**(13)**	(13)

The above is a summary of transactions with related parties during the year and balances due at year-end.

Transactions with key management

Total remuneration of key management is included in employees' remuneration (refer to note 24 for Executive Management's remuneration).

30. Irregular and fruitless and wasteful expenditure	GROUP		CSIR	
	2024 R '000	2023 R '000	2024 R '000	2023 R '000
Irregular expenditure	-	841	-	841
Fruitless and wasteful expenditure	-	-	-	-
Total (inclusive of VAT)	**-**	**841**	**-**	**841**

There is irregular expenditure of R3,715 million and fruitless and wasteful expenditure of R24,000 that is under assessment for the 2023/2024 financial year.

31. Capital commitments

Property, plant and equipment	**470,203**	118,359	**470,203**	118,359

Included in capital commitments is an amount of R302,36 million for a high performance computing system on a 5 year lease-to-own agreement.

32. Financial guarantees

Local and foreign payments and performance guarantees issued as at 31 March	**19,827**	39,088	**19,827**	39,088

33. New Standards and Interpretations

33.1 Standards and interpretations effective and adopted in the current year

In the current year, the Group has adopted the following standards and interpretations that are effective for the current financial year and that are relevant to its operations:

Standard/ Interpretation:	**Effective date:** Financial years beginning on or after
Disclosure of accounting policies: Amendments to IAS 1 and IFRS Practice Statement 2	1 January 2023
In February 2021, the IASB issued Disclosure of Accounting Policies (Amendments to IAS 1 and IFRS Practice Statement 2). The amendments provide guidance to help entities apply materiality judgments to accounting policy disclosures and distinguish changes in accounting estimates from changes in accounting policies.	
These amendments have not affected the Group's results.	
Definition of accounting estimates: Amendments to IAS 8	1 January 2023
In February 2021, the IASB issued Definition of Accounting Estimates, which amended IAS 8 Accounting Policies, Changes in Accounting Estimates and Errors.	
The amendments introduced the definition of accounting estimates and included other amendments to IAS 8 to help entities distinguish changes in accounting estimates from changes in accounting policies.	
These amendments have not affected the Group's results.	

33. New Standards and Interpretations (continued)

33.2 Standards and interpretations not yet effective

The Group has chosen not to early adopt the following standards and interpretations, which have been published and are mandatory for the Group's accounting periods beginning on or after 1 April 2024 or later periods:

Standard/ Interpretation:	**Effective date:** Financial years beginning on or after
Supplier finance arrangements: Amendments to IAS 7 and IFRS 7 Supplier Finance Arrangements: The amendment supplements existing disclosure requirements by requiring a company to disclose specific information about its supplier finance arrangements that enables users of financial statements to assess the effects of those arrangements on the company's liabilities and cash flows and on the company's exposure to liquidity risk. This amendment is not expected to affect the Group's results, however additional disclosures may be required.	1 January 2024
Lease liability in a sale and leaseback: Amendment to IFRS 16 Lease Liability in a Sale and Leaseback: The narrow-scope amendment requires a seller-lessee in a sale and leaseback transaction to determine 'lease payments' or 'revised lease payments' in a way that the seller-lessee would not recognise any amount of a gain or loss relating to the right of use retained by the seller-lessee. The new requirement does not prevent the seller-lessee from recognising in profit or loss any gain or loss relating to the partial or full termination of a lease. This amendment is not expected to affect the Group's results.	1 January 2024
Classification of Liabilities as Current or Non-Current: Amendment to IAS 1 The amendment clarifies that only covenants with which an entity is required to comply on or before the reporting date affect the classification of a liability as current or non-current, with additional guidance to explain how an entity should disclose information in the notes to understand the risk that non-current liabilities with covenants could become repayable within twelve months. This amendment is not expected to affect the Group's results.	1 January 2024
Lack of exchangeability: Amendments to IAS 21 Lack of Exchangeability: The amendments require an entity to apply a consistent approach to assessing whether a currency is exchangeable into another currency and, when it is not, to determining the exchange rate to use and the disclosures to provide. This amendment is not expected to affect the Group's results.	1 January 2025

34. Change in accounting policy

During the 2024 financial year, the CSIR performed a detailed review of the various classes of financial instruments held by it. The practical implementation of the investment in the Stanlib Flexible Income Fund since inception was considered.

Due to the investment being held for longer than originally anticipated and the movement in the fair value being more significant than originally anticipated, it was deemed more appropriate to reclassify this investment as a financial instrument at fair value through other comprehensive income (OCI) rather than cash and cash equivalents.

The investment is short term in nature, has no fixed maturity date and is redeemable on demand. It is thus highly liquid in nature. The Group will continue to classify the investment under Current Assets in the Statement of Financial Position.

The following table summarises the impact on the affected financial statement line items for the prior periods:

GROUP

Statement of Financial Position	2023		
	Previously reported R '000	Adjustments R '000	Restated R '000
Current assets			
Cash and cash equivalents	1,239,981	(739,942)	500,039
Investment at fair value through other comprehensive income	-	739,942	739,942
	1,239,981	**-**	**1,239,981**

Statement of Cash Flows	2023		
	Previously reported R '000	Adjustments R '000	Restated R '000
Cash flows from investing activities			
Remeasurement of debt investments at fair value through other comprehensive income	16,111	(16,111)	-
Movement in debt investments at fair value through other comprehensive income	-	35,451	35,451
Net cash outflow from investing activities	(190,497)	19,340	(171,157)
Net increase/(decrease) in cash and cash equivalents	(192,096)	19,340	(172,756)
Cash and cash equivalents at the beginning of the year	1,432,077	(759,282)	672,795
Cash and cash equivalents at the end of the year	**1,239,981**	**(739,942)**	**500,039**

34. Change in accounting policy (continued)

CSIR

Statement of Financial Position	2023		
	Previously reported R '000	Adjustments R '000	Restated R '000
Current assets			
Cash and cash equivalents	1,231,356	(739,942)	491,414
Investment at fair value through other comprehensive income	-	739,942	739,942
	1,231,356	**-**	**1,231,356**

Statement of Cash Flows	2023		
	Previously reported R '000	Adjustments R '000	Restated R '000
Cash flows from investing activities			
Remeasurement of debt investments at fair value through other comprehensive income	16,111	(16,111)	-
Movement in debt investment at fair value through other comprehensive income	-	35,451	35,451
Net cash outflow from investing activities	(190,497)	19,340	(171,157)
Net increase/(decrease) in cash and cash equivalents	(192,416)	19,340	(173,076)
Cash and cash equivalents at the beginning of the year	1,423,772	(759,282)	664,490
Cash and cash equivalents at the end of the year	**1,231,356**	**(739,942)**	**491,414**

SECTION H

CSIR publications

SECTION H

CSIR publications

This section provides a detailed account of the CSIR's publication equivalents. These include accredited journal articles, conference papers, books and book chapters.

Journal articles (240)

Maodzeka, DK, Olakanmi, EO, Mosalagae, M, Hagedorn-Hansen, D, Pityana, Sisa L. 2023. *Hybrid optimisation studies on the microstructural properties and wear resistance of maraging steel 1.2709 parts produced by laser powder bed fusion.* Optics & Laser Technology, 159(4), pp 51pp.

De Saxe, CC, Van Eeden, J, Kemp, Lana, Steenkamp, Anton J, Cowper, J. 2023. *High-capacity coal trucks to reduce costs and emissions at South Africa's power utility.* Research in Transportation Business & Management, 48, pp 12pp.

Ngwangwa, H, Pandelani, Thanyani A, Nemavhola, F. 2023. *The application of standard nonlinear solid material models in modelling the tensile behaviour of the supraspinatus tendon.* Engineering Solid Mechanics, 11(1), pp 63-74.

Li, X, Wessels, K, Armston, J, Hancock, S, Mathieu, R, Main, Russell S, Naidoo, L, Erasmus, B, Scholes, R. 2023. *First validation of GEDI canopy heights in African savannas.* Remote Sensing of Environment, 285, pp 17pp.

Raw, JL, Van Niekerk, Lara, Chauke, O, Riddin, T, Adams, JB. 2023. *Blue carbon sinks in South Africa and the need for restoration to enhance carbon sequestration.* Science of the Total Environment, 859(Part 1), pp 12pp.

Bolokang, Amogelang S, Mathabathe, Maria N, Motaung, DE, Arendse, CJ, Swart, HC. 2023. *Grain structure orientational change in Ti6Al4V alloys induced by sea water quenching and novel stress relief annealing process.* Materials Chemistry and Physics, 297, pp 10pp.

Pratt, Lawrence E, Matheus, Jana, Klein, R. 2023. *A benchmark dataset for defect detection and classification in electroluminescence images of PV modules using semantic segmentation.* Systems and Soft Computing, 5, pp 8pp.

Ryan-Keogh, Thomas J, Bone, EL, Thomalla, Sandy J, Lain, Elizabeth J, Smith, Marie E, Bernard, S, Vichi, M. 2023. *Spatial and temporal drivers of fluorescence quantum yield variability in the Southern Ocean.* Limnology and Oceanography, 68(3), pp 569-582.

Mugwanda, Kanganwiro, Hamese, Saltiel, Van Zyl, Winschau F, Prinsloo, E, Du Plessis, M, Dicks, L, Thimiri Govindaraj, Deepak B. 2023. *Recent advances in genetic tools for engineering probiotic lactic acid bacteria.* Bioscience Reports, 43(1), pp 27pp.

Goga, T, Harding, K, Russo, Valentina, Von Blottnitz, H. 2023. *A lifecycle-based evaluation of greenhouse gas emissions from the plastics industry in South Africa.* South African Journal of Science, 119(1-2), pp 63-68.

Smith, Tanya, O'Kennedy, Martha M, Ross, CS, Lewis, NS, Abolnik, C. 2023. *The production of Newcastle disease virus-like particles in Nicotiana benthamiana as potential vaccines.* Frontiers in Plant Science, 14, pp 13pp.

Ryan-Keogh, Thomas J, Thomalla, Sandy J, Scheel Monteiro, Pedro M, Tagliabue, A. 2023. *Multidecadal trend of increasing iron stress in Southern Ocean phytoplankton.* Science, 379(6634), pp 834-840.

Maponya, TG, Makgopa, K, Somo, TR, Tshwane, David M, Modibane, KD. 2023. *Highly adsorptive removal of palladium and platinum ions from wastewater using novel ethylenediamine-glutaraldehyde-grafted metal organic framework.* Environmental Nanotechnology, Monitoring and Management, 20, pp 14pp.

Baichan, P, Naicker, Previn, Augustine, TN, Smith, M, Candy, G, Devar, J, Nweke, EE. 2023. *Proteomic analysis identifies dysregulated proteins and associated molecular pathways in a cohort of gallbladder cancer patients of African ancestry.* Clinical Proteomics, 20(8), pp 14pp.

Kgaphola, Motsoko J, Ramoelo, A, Odindi, J, Mwenge Kahinda, Jean-Marc, Seetal, Ashwin R. 2023. *Apportioning human-induced and climate-induced land degradation: A Case of the Greater Sekhukhune District Municipality.* Applied Sciences, 13(6), pp 18pp.

Gulumian, M, Thwala, Melusi, Makhoba, X, Wepener, V. 2023. *Current situation and future prognosis of health, safety and environment risk assessment of nanomaterials in South Africa.* South African Journal of Science, 119(1/2), pp 7pp.

Kgaphola, Motsoko J, Ramoelo, A, Odindi, J, Mwenge Kahinda, Jean-Marc, Seetal, Aswin R, Musvoto, Constansia D. 2023. *Social-ecological system understanding of land degradation in response to land use and cover changes in the Greater Sekhukhune District Municipality.* Sustainability, 15(4), pp 19pp.

Fisher, JA, Schneider, L, Fostier, A-H, Guerrero, S, Guimaraes, JD, Labuschagne, Casper, Leaner, JJ, Martin, Lynwill G, Mason, RP, Walters, Chavon R. 2023. *A synthesis of mercury research in the Southern Hemisphere, part 2: Anthropogenic perturbations.* Ambio, 52(5), pp 918-937.

Masindi, Vhahangwele, Mbhele, Nkhangweleni R, Foteinis, Spyros. 2023. *Sustainable co-management of acid mine drainage with struvite synthesis effluent: Pragmatic synergies in circular economy.* Environments, 10(4), pp 14pp.

Mtibe, Asanda, Mokhena, TC, Mathew, Maya J. 2023. *Sustainable valorization and conversion of e-waste plastics into value-added products.* Current Opinion in Green and Sustainable Chemistry, 40, pp 7pp.

Skhosana, Felix V, Thenga, Humbelani F, Mateyisi, Mohau J, Von Maltitz, G, Midgley, GF, Stevens, N. 2023. *Steal the rain: Interception loses and rainfall partitioning by a broad-leaf and a fine-leaf woody encroaching species in a southern African semi-arid savanna.* Ecology and Evolution, pp 12pp.

Maubane, Lesego T, Lekalakala, Rakgoshi K, Orasugh, Jonathan T, Letwaba, Lesetja J. 2023. *Effect of short-chain architecture on the resulting thermal properties of polypropylene.* Polymer, 264, pp 11pp.

Feketshane, Z, Adeyemi, SA, Ubanako, P, Ndinteh, DT, Ray, Suprakas S, Choonara, YE, Aderibigbe, BA. 2023. *Dissolvable sodium alginate-based antibacterial wound dressing patches: Design, characterization, and in vitro biological studies.* International Journal of Biological Macromolecules, 232, pp 20pp.

Ezik, AC, Sadiku, ER, Ray, Suprakas S, Hamam, Y, Adekoya, GJ. 2023. *MXene/PPy nanocomposite as an electrode material for high-capacity Na-ion batteries investigated from first principle calculation.* South African Journal of Chemical Engineering, 44, pp 297-301.

Henson, SA, Briggs, N, Carvalho, F, Manno, C, Mignot, A, Thomalla, Sandy J. 2023. *A seasonal transition in biological carbon pump efficiency in the northern Scotia Sea, Southern Ocean.* Deep-Sea Research Part II: Topical Studies in Oceanography, 208, pp 12pp.

Tjale, Mabotse A, Ombinda-Lemboumba, Saturnin, Maphanga, Charles P, Mthunzi-Kufa, Patience. 2023. *TB insights, bioinformatics as a tool a search for biomarkers for point of care diagnostics.* Indian Journal of Tuberculosis, 70(4), pp 468-474.

Orasugh, Jonathan T, Ray, Suprakas S. 2023. *Functional and structural facts of effective electromagnetic interference shielding materials: A review.* ACS OMEGA, 8, pp 8134-8158.

Kumari, V, Sharmaa, A, Kumara, N, Sillanpaa, M, Makgwane, Peter R, Ahmaruzzamani, Md, Hosseini-Bandegharaeij, A, Ranik, Manju, Chinnamuthu, P. 2023. *TiO2-CeO2 assisted heterostructures for photocatalytic mitigation of environmental pollutants: A comprehensive study on band gap engineering and mechanistic aspects.* Inorganic Chemistry Communications, 151, pp 24pp.

Sink, KJ, Adams, LA, Franken, M-L, Harris, LR, Currie, J, Karenyi, N, Dayaram, A, Porter, S, Van Niekerk, Lara, Lück-Vogel, Melanie. 2023. *Iterative mapping of marine ecosystems for spatial status assessment, prioritization, and decision support.* Frontiers in Ecology and Evolution, 11, pp 17pp.

Alenoghena, CO, Ohize, HO, Adejo, AO, Onumanyi, Adeiza J, Ohihoin, EE, Balarabe, AI, Okoh, SA, Kolo, E, Alenoghena, B. 2023. *Telemedicine: A survey of telecommunication technologies, developments, and challenges.* Journal of Sensor and Actuator Networks, 12(2), pp 39pp.

Seele, PP, Dyan, B, Skepu, Amanda, Maserumule, C, Shibuyi, NRS. 2023. *Development of gold-nanoparticle-based lateral flow immunoassays for rapid detection of TB esat-6 and cfp-10.* Biosensors, 13(3), pp 15pp.

Muzata, TS, Gebrekrstos, Amanuel, Orasugh, Jonathan T, Ray, Suprakash S. 2023. *An overview of recent advances in polymer composites with improved UV-shielding properties.* Journal of Applied Polymer Science, 140(14), pp pp31.

Taljaard, Susan, Van Niekerk, Lara, Adams, JB, Riddin, T. 2023. *Advancing ecosystem accounting in estuaries: Swartkops Estuary case study.* South African Journal of Science, 119(3/4), pp 11pp.

Mosiane, KS, Nweke, EE, Balogun, Mohammed O, Fru, PN. 2023. *Polyethyleneglycol-betulinic acid (PEG-BA) polymer-drug conjugate induces apoptosis and antioxidation in a biological model of pancreatic cancer.* Polymers, 15(2), pp 17pp.

Orasugh, Jonathan T, Saasa, Valentine R, Ray, Suprakas S, Mwakikunga, Bonex W. 2023. *Supersensitive metal free in-situ synthesized graphene oxide@cellulose nanocrystals acetone sensitive bioderived sensors.* International Journal of Biological Macromolecules, 241, pp 16pp.

Ezika, AC, Sadiku, ER, Adekoya, GJ, Ray, Suprakas S, Hamam, Y. 2023. *Quantum mechanical study of the dielectric response of V2C-ZnO/PPy ternary nanocomposite for energy storage application.* Journal of Inorganic and Organometallic Polymers and Materials, pp 7pp.

Matshe, William MR, Tshweu, Lesego L, Mvango, Sindisiwe, Cele, Zamani ED, Chetty, Avashnee S, Pilcher, LA, Famuyide, IM,

McGaw, LJ, Taylor, D, Balogun, Mohammed O. 2023. *A water-soluble polymer-lumefantrine conjugate for the intravenous treatment of severe malaria.* Macromolecular Bioscience, 23(5), pp 12pp.

Brahma, S, Huang, PC, Mwakikunga, Bonex W, Saasa, Valentine R, Akande, AA, Huang, JL, Liu, CP. 2023. *Cd doped ZnO nanorods for efficient room temperature NH3 sensing.* Materials Chemistry and Physics, 294, pp 10pp.

Saasa, Valentine, Mwakikunga, Bonex W. 2023. *Facile synthesis, characterization and acetone sensing properties of n-type WO3, SnO2 and VO2 semiconducting materials and their cobalt doped performance: Outstanding SnO2-Co acetone selectivity and sensitivity.* Materials Research Bulletin, 164, pp 16pp.

Kgaphola, Motsoko J, Ramoelo, A, Odindi, J, Mwenge Kahinda, Jean-Marc, Seetal, Ashwin R, Musvoto, Constansia D. 2023. *Impact of land use and land cover change on land degradation in rural semi-arid South Africa: Case of the Greater Sekhukhune District Municipality.* Environmental Monitoring and Assessment, 195(710), pp 21.

Ntshidi, Zanele, Dzikiti, S, Mazvimavi, D, Mobe, Nompumelelo Thelma. 2023. *Effect of different irrigation systems on water use partitioning and plant water relations of apple trees growing on deep sandy soils in the Mediterranean climatic conditions, South Africa.* Scientia Horticulturae, 317, pp 13pp.

Van Heerden, N, Grobbelaar, SS, Meyer, Isabella A. 2023. *One Health studies that adopt a formal modelling approach: A scoping review.* Environmental Science & Policy, 145, pp 93-103.

Grobbelaar, S, Meyer, Isabella A, Van Eeden, J, Vandaele, N, Van Wassenhove, L, Besiou, M, Decouterre, C, Rafter, S, Nolting, C, Dondofema, Richmore A. 2023. *Creating pathways to impact: Investing in supply chain and logistics capacity development in Africa.* IEEE Engineering Management Review, pp 14pp.

Malaka, MJ, Araya, NA, Soundy, P, Du Plooy, CP, Araya, HT, Jansen Van Rensburg , WS, Watkinson, E, Levember, E, Wadiwala, Ebrahim, Amoo, SO. 2023. *Biomass, essential oil yield, and composition of marjoram as influenced by interactions of different agronomic practices under controlled conditions.* Plants, 12(1), pp 18pp.

Thomalla, Sandy J, Du Plessis, M, Fauchereau, N, Giddy, I, Gregor, L, Henson, S, Joubert, WR, Little, H, Monteiro, Pedro MS, Mtshali, T, Nicholson, Sarah-Anne, Ryan-Keogh, Thomas J, Swart, S. 2023. *Southern Ocean phytoplankton dynamics and carbon export: Insights from a seasonal cycle approach.* Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, 381(2249), pp 22pp.

Matshaba, L, Nxozi, M, Herselman, Martha E. 2023. *Guiding the development of interoperable health information systems: A conceptual IT governance framework.* Lecture Notes in Computer Science, 13873, pp 143-156.

Thwala, Nomcebo L, Ndlovu, Sphumelele C, Mpofu, Kelvin T, Lugongolo, Masixole Y, Mthunzi-Kufa, Patience. 2023. *Nanotechnology-based diagnostics for diseases prevalent in developing countries: Current advances in point-of-care tests.* Nanomaterials, 13(7), pp 2079-4991.

Kaya, SM, Isler, B, Abu-Mahfouz, Adnan MI, Rasheed, J, AlShammari, A. 2023. *An intelligent anomaly detection approach for accurate and reliable weather forecasting at IoT edges: A case study.* Sensors, 23(5), pp 17pp.

Ramotsoela, DT, Hancke, GP, Abu-Mahfouz, Adnan MI. 2023. *Practical challenges of attack detection in microgrids using machine learning.* Journal of Sensor and Actuator Networks, 12(1), pp 18pp.

Qabaqaba, M, Naidoo, L, Tsele, P, Ramoelo, A, Cho, Moses A. 2023. *Integrating random forest and synthetic aperture radar improves the estimation and monitoring of woody cover in indigenous forests of South Africa.* Applied Geomatics, 15, pp 209–225.

Swart, S, Du Plessis, MD, Nicholson, Sarah-Anne, Monteiro, Pedro MS, Dove, LA, Thomalla, Sandy J, Thompson, AF, Biddle, LC, Edholm, JM, Giddy, Isabelle. 2023. *The Southern Ocean mixed layer and its boundary fluxes: Fine-scale observational progress and future research priorities.* Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, 381(2249), pp 22pp.

Mashabatu, M, Ntshidi, Zanele, Dzikiti, S, Jovanovic, N, Dube, T, Taylor, NJ. 2023. *Deriving crop coefficients for evergreen and deciduous fruit orchards in South Africa using the fraction of vegetation cover and tree height data.* Agricultural Water Management, 286, pp 11pp.

Nkomzwayo, Thulisile N, Mguni, LL, Liu, X, Liu, R, Yao, Y. 2023. *Competitive adsorption in a multicomponent diesel system using nickel oxide/activated carbon.* Industrial & Engineering Chemistry Research, 62(8), pp 3812-3827.

Wehlitz, Carl-Peter FV, Schoonees, JS. 2023. *Hydraulic stability of the new Cubilok™ armour unit on a 3:4 slope.* Coastal Engineering, 183, pp 12pp.

Thiede, RN, Fabris-Rotelli, IN, Debba, Pravesh, Cleghorn, CW. 2023. *A Markov chain model for geographical accessibility.* Spatial Statistics, 55, pp 14pp.

Roopchund, R, Andrew, Jerome E, Sithole, B. 2023. *Using a systematic review to develop a cellulose nanocrystals production framework for use as a design baseline and optimization tool.* South African Journal of Chemical Engineering, 44, pp 344-355.

Machaka, R, Radingoana, Precious M. 2023. *Prediction of narrow HT-SMA thermal hysteresis behaviour using explainable machine learning.* Materials Today: Communications, 35, pp 9pp.

Arasteh, B, Seyyedabbasi, A, Rasheed, J, Abu-Mahfouz, Adnan MI. 2023. *Program source-code re-modularization using a discretized and modified sand cat swarm optimization algorithm.* Symmetry, 15(2), pp 28pp.

Giddy, IS, Fer, I, Swart, S, Nicholson, Sarah-Anne. 2023. *Vertical convergence of turbulent and double-diffusive heat flux drives warming and erosion of Antarctic Winter Water in summer.* Journal of Physical Oceanography, 53(8), pp 1941-1958.

TheSO-CHI Consortium, Sallée, JB, Abrahamsen, EP, Allaigre, C, Brearley, JA, De Lavergne, C, Ten Doeschate, AMM, Droste, ES, Monteiro, PMS, Nicholson, Sarah-Anne. 2023. *Southern ocean carbon and heat impact on climate.* Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, 381(2249), pp 18pp.

Ngobese, Sibusiso SG, Pelders, Jodi L, Botha, W, Magweregwede, Flecksen, Schutte, S. 2023. *Stakeholder inclusion in the design and development of equipment for the modernizing mining sector in South Africa.* Journal of the Southern African Institute of Mining and Metallurgy, 123, pp 193-202.

Ntshangase, Cynthia S, Ndlovu, Lungisani, Stofile, Akhona. 2023. *Assessing the quality of acquired images to improve ear recognition for children.* Lecture Notes of the Institute for Computer Sciences, Social Informatics and Telecommunications Engineering, 499, pp 369–380.

Ruyobeza, B, Grobbelaar, SS, Botha, Adele. 2023. *From FITT to FISTT: The task-skills fit before the introduction of assistive, digital health technologies.* Heliyon, 9(6), pp 16pp.

Khoaele, Katleho K, Gbadeyan, Oluwatoyin J, Chunilall, Viren, Sithole, B. 2023. *The devastation of waste plastic on the environment and remediation processes: A Critical review.* Sustainability, 15(6), pp 14pp.

Gallah, H, Mighri, F, Ajji, A, Sinha Roy, Jayita. 2023. *Flexible PET/(PET-TiO2) core/shell nanofibrous mats as potential photoanode layer for dye-sensitized solar cells, DSSCs.* Materials Chemistry and Physics, 305, pp 24pp.

Lawal, SA, Medupin, RO, Yoro, KO, Okoro, UG, Adedipe, O, Abutu, J, Tijani, JO, Abdulkareem, AS, Ukoba, K, Sekoai, Patrick T. 2023. *Nanofluids and their application in carbon fibre reinforced plastics: A review of properties, preparation, and usage.* Arabian Journal of Chemistry, 16(8), pp 14pp.

Khoaele, Katleho K, Gbadeyan, OJ, Chunilall, Viren, Sithole, B. 2023. *A review on waste wood reinforced polymer composites and their processing for construction materials.* International Journal of Sustainable Engineering, 16(1), pp 14pp.

Botha, Natasha, Coetzer, R, Inglis, HM, Labuschagne, FJWJ. 2023. *Statistical analysis of the effect of varying material and manufacturing conditions on the mechanical properties of high-density polyethylene/layered double hydroxide composites.* SPE Polymers, pp 19pp.

Jele, Thabisile B, Andrew, Jerome E, Mathew, Maya J, Sithole, Bruce. 2023. *Engineered transparent wood composites: A review.* Cellulose, 30, pp 5447–5471.

Sekoai, Patrick T, Chunilall, Viren, Ezeokoli, O. 2023. *Creating value from acidogenic biohydrogen fermentation effluents: An innovative approach for a circular bioeconomy that is acquired via a microbial biorefinery-based framework.* Fermentation, 9(7), pp 23pp.

Mashangoane, BF, Chirwa, EN, Mahlathi, Christopher D. 2023. *Kinetics and isotherms of a genetically engineered saccharomyces cerevisiae EBY100 strain expressing palladium binding peptides for the biosorption of Pd (II) in a batch reactor.* Chemical Engineering Transactions, 99, pp 487-492.

Ramchuran, Santosh O, O'Brien, Frances F, Dube, Noluthando N, Ramdas, V. 2023. *An overview of green processes and technologies, biobased chemicals and products for industrial applications.* Current Opinion in Green and Sustainable Chemistry, 41, pp 9pp.

Adams, Janine B, Taljaard, Susan, Van Niekerk, Lara. 2023. *Water releases from dams improve ecological health and societal benefits in downstream estuaries.* Estuaries and Coasts, pp 15pp.

Malise, TTA, Nweke, EE, Takundwa, Mutsa M, Fru, PF, Thimiri Govindaraj, Deepak B. 2023. *Treatment strategies for multiple myeloma treatment and the role of high-throughput screening for precision cancer therapy.* Advances in Experimental Medicine and Biology, pp 19pp.

Sinha Roy, Jayita, De Beer, Marinda, Kesavan Pillai, Sreejarani, Ray, Suprakash S. 2023. *Application of layered double hydroxides as a slow-release phosphate source: A comparison of hydroponic and soil systems.* ACS Omega, 8(17), pp 15017–15030.

Ramazhamba, Pardon T, Venter, HS. 2023. *Using distributed ledger technology for digital forensic investigation purposes on tendering projects.* International Journal of Information Technology, 15(5), pp 1255–1274.

Harrison, Arthur,J, Forbes, A, Naidoo, Darryl. 2023. *Improving performance prediction of diode end-pumped solid-state Nd:YAG rod amplifiers by incorporating pump mode evolution.* Optics Express, 17(31), pp 21pp.

Gusain, Rashi, Kumar, Neeraj, Ray, Suprakas S. 2023. *3D-printed hydrogels and aerogels for water treatment and energy storage applications.* ChemistrySelect, 8(20), pp 18pp.

Ellard, JJM, Mathabathe, Maria N, Siyasiya, C, Bolokang, Amogelang S. 2023. *Vacuum melting of compressed powders and hot rolling of the as-cast Ti-48Al-2Nb-0.7Cr-0.3Si intermetallic alloy: Mechanical properties and microstructural analysis.* Journal of Manufacturing Processes, 101(8), pp 1214-1223.

Tshwane, David M, Modiba, Rosinah. 2023. *Oxidation and corrosion investigation on Ti2AlV (110) surface using first principle approach.* Surface Science, *737*, pp 8pp.

Mabena, Chemist M, Bell, Lebogang T, Mphuthi, Nokwazi P, Harrison, Arthur J, Naidoo, Darryl. 2023. *Beam quality factor of aberrated Laguerre-Gaussian optical beams.* Optics Express, 31(16), pp 26435-26450.

Singh, Asmita, Fietz, S, Thomalla, Sandy J, Sanchez, N, Ardelan, MV, Moreau, S, Kauko, HM, Fransson, A, Chierici, M, Ryan-Keogh, Thomas J. 2023. *Absence of photophysiological response to iron addition in autumn phytoplankton in the Antarctic sea-ice zone.* Biogeosciences, 20(14), pp 3073-3091.

Ramutshatsha-Makhwedzha, D, Munyengabe, A, Mavhungu, ML, Mbaya, R, Baloyi, Siwela J. 2023. *Breakthrough studies for the sorption of methylene blue dye from wastewater samples using activated carbon derived from waste banana peels.* Biomass Conversion and Biorefinery, 543, pp 13pp.

Seyisi, E, Mantlana, Khanyisa B, Ndhleve, S. 2023. *Indicators for monitoring and evaluating climate change adaptation efforts in South Africa.* Journal of Disaster Risk Studies, 15(1), pp 9pp.

Ndlela, Luyanda L, Schroeder, P, Genthe, Bettina, Cruzeiro, C. 2023. *Removal of antibiotics using an Algae-Algae consortium (Chlorella protothecoides and Chlorella vulgaris).* Toxics, 11(7), pp 12pp.

Moreau, S, Hattermann, T, De Steur, L, Kauko, HM, Ahonen, H, Ardelan, M, Assmy, P, Monteiro, Pedro, Ryan-Keogh, Thomas J, Singh, Asmita, Thomalla, Sandy J. 2023. *Wind-driven upwelling of iron sustains dense blooms and food webs in the eastern Weddell Gyre.* Nature Communications, 14(1303), pp 12pp.

Dithugoe, Choaro D, Bezuidt, OKI, Cavan, EL, Froneman, WP, Thomalla, Sandy J, Makhalanyane, TP. 2023. *Bacteria and archaea regulate particulate organic matter export in suspended and sinking marine particle fractions.* MSphere, 8(3), pp 17pp.

Giddy, IS, Nicholson, Sarah-Anne, Queste, RY, Thomalla, Sandy J, Swart, S. 2023. *Sea-ice impacts inter-annual variability in bloom phenology and carbon export in the Weddell Sea.* Geophysical Research Letters, 50(16), pp 13pp.

Goncalves, Duarte PD. 2023. *Security access control effectiveness design.* South African Journal of Industrial Engineering, 34(3), pp 84-96.

Dudeni-Tlhone, Nontembeko, Mutanga, O, Debba, Pravesh, Cho, Moses A. 2023. *Distinguishing tree species from in situ hyperspectral and temporal measurements through ensemble statistical learning.* Remote Sensing, 15(17), pp 24pp.

Ellard, JJM, Mathabathe, Maria N, Siyasiya, Charles W, Bolokang, Amogelang S. 2023. *Low-cycle fatigue behaviour of titanium-aluminium-based intermetallic alloys: A short review.* Metals, 13(8), pp 28pp.

Mwim, EN, Mtsweni, Jabu, Chimbo, B. 2023. *Conceptual mapping of the cybersecurity culture to human factor domain framework.* Lecture Notes in Networks and Systems, 652, pp 14pp.

Mwim, EM, Mtsweni, Jabu S, Chimbo, B. 2023. *Factors associated with the cybersecurity culture: A quantitative study of public e-health hospitals in South Africa.* IFIP Advances in Information and Communication Technology, pp 129-142.

Moloto, Tebatso M, Thomalla, Sandy J, Smith, Marie E, Martin, B, Louw, DC, Koppelmann, R. 2023. *Remote sensing of phytoplankton community composition in the northern Benguela upwelling system.* Frontiers in Marine Science, 10, pp 23pp.

Olatinwo, DD, Abu-Mahfouz, Adnan MI, Hancke, G, Myburgh, H. 2023. *IoT-enabled WBAN and machine learning for speech emotion recognition in patients.* Sensors, 23(6), pp 23pp.

Iroegbu, Austine OC, Ray, Suprakas S. 2023. *Chitin nanomaterials as multifunctional systems in advanced applications – Progress and challenges toward sustainability.* MacroMolecular Materials and Engineering, 308(9), pp 17pp.

Sharma, A, Makgwane, Peter R, Lichtfouse, E, Kumar, N, Hosseini Bandegharaei, A, Tahir, M. 2023. *Recent advances in synthesis, structural properties, and regulation of nickel sulfde-based heterostructures for environmental water remediation: An insight review.* Environmental Science and Pollution Research, 30, pp 64932-64948.

Banerjee, R, Gebrekrstos, A, Orasugh, JT, Ray, Suprakash S. 2023. *Nanocarbon-containing polymer composite foams: A review of systems for applications in electromagnetic interference shielding, energy storage, and piezoresistive sensors.* Industrial & Engineering Chemistry Research, 62(18), pp 6807-6842.

Koenig, C, Martinez-Val, A, Naicker, Previn, Stoychev, S, Jordaan, J, Olsen, JV. 2023. *Protocol for high-throughput semi-automated label-free- or TMT-based phosphoproteome profiling.* Star Protocols, 4(3), pp 30pp.

Cele, Zamani ED, Matshe, William MR, Mdlalose, Lindani M, Setshedi, Katlego Z, Malatji, Kanyane, Mkhwanazi, NP, Ntombela, T, Balogun, Mohammed O. 2023. *Cationic chitosan derivatives for the inactivation of HIV-1 and SARS-CoV-2 enveloped viruses.* ACS Omega, 8(35), pp 31714–31724.

Aghaei, VT, SeyyedAbbasi, AS, Rasheed, J, Abu-Mahfouz, Adnan MI. 2023. *Sand cat swarm optimization-based feedback controller design for nonlinear systems.* Heliyon, 9(3), pp 15pp.

Bambalaza, SE, Xakalashe, BS, Coetsee, Y, Van Zyl, PG, Dyosiba, Xoliswa L, Musyoka, Nicholas M, Steenkamp, JD. 2023. *Co-carbonization of discard coal with waste polyethylene terephthalate towards the preparation of metallurgical coke.* Materials, 16(7), pp 20pp.

Gebrekrstos, Amanuel, Ray, Suprakash S. 2023. *Superior electrical conductivity and mechanical properties of phase-separated polymer blend composites by tuning the localization of nanoparticles for electromagnetic interference shielding applications.* Journal of Polymer Science, pp 18pp.

Mthethwa, Sthembile N. 2023. *Securing Internet of Things (IoT) Devices Through Distributed Ledger Technologies (DLTs) and World Wide Web Consortium (W3C) Standards.* Lecture Notes in Networks and Systems, 768, pp 12pp.

Rushambwa, MC, Suvendi, R, Pandelani, Thanyani A, Palaniappan, R, Vijean, V, Nabi, FG. 2023. *A review of optical ultrasound imaging modalities for intravascular imaging.* Pertanika Journal of Science & Technology, 31(1), pp 279-289.

Sefara, Tshephisho J, Rangata, Mapitsi R. 2023. *A natural language processing technique to identify exaggerated news titles.* Lecture Notes in Networks and Systems, 757, pp 951-962.

Mabena, Chemist M. 2023. *Analytical analysis of the beam propagation factor of elegant Hermite-Gaussian and elegant Laguerre-Gaussian beams with astigmatism.* Optics Communications, 550, pp 8pp.

Iwu-Jaja, C, Ndlovu, NL, Rachida, S, Yousif, M, Taukobong, S, Macheke, M, Mhlanga, L, Van Schalkwyk, C, Le Roux, Wouter J, Schaefer, Lisa M. 2023. *The role of wastewater-based epidemiology for SARS-CoV-2 in developing countries: Cumulative evidence from South Africa supports sentinel site surveillance to guide public health decision-making.* Science of The Total Environment, 903, pp 11pp.

Ndebele, Bright B, Gledhill, IMA. 2023. *Two dimensional vortex shedding from a rotating cluster of cylinders.* Journal of Applied Fluid Mechanics, 16(11), pp 2175-2188.

Tetyana, P, Mphuthi, N, Jijana, AN, Moloto, N, Shumbula, PM, Skepu, Amanda, Vilakazi, LS, Sikhwivhilu, L. 2023. *Synthesis, characterization, and electrochemical evaluation of copper sulfide nanoparticles and their application for non-enzymatic glucose detection in blood samples.* Nanomaterials, 13(3), pp 18pp.

Dunn, M, Nel, V, Van den Berg, S, Van Huyssteen, Elsona. 2023. *The application of constructivist grounded theory methodology in an urban planning doctoral thesis.* International Journal of Qualitative Methods, 22, pp 10pp.

Makunyane, MS, Rautenbach, H, Sweijd, Neville A, Botai, J, Wichmann, J. 2023. *Health risks of temperature variability on hospital admissions in Cape Town, 2011-2016.* International Journal of Environmental Research and Public Health, 20(2), pp 18pp.

Sepotokele, KM, O'Kennedy, Martha M, Hayes, MC, Wandrag, DBR, Smith, P, Abolnik, C. 2023. *Efficacy of a plant-produced infectious bronchitis virus-like particle vaccine inspecific pathogen-free chickens.* Poultry Science, 102(10), pp 9pp.

Zandamela, Frank, Nicolls, F, Kunene, Dumisani C, Stoltz, George G. 2023. *Enhancing distracted driver detection with human body activity recognition using deep learning.* South African Journal of Industrial Engineering, 34(4), pp 17pp.

Malatji, Kanyane, Singh, Advaita A, Thobakgale, C, Alexandre, Kabamba. 2023. *Development of a multiplex HIV/TB diagnostic assay based on the microarray technology.* Biosensors (Basel), 13(9), pp 18pp.

Mayot, N, Le Quéré, C, Rödenbeck, C, Bernardello, R, Bopp, L, Djeutchouang, LM, Gehlen, M, Gruber, N, Hauck, J, Iida, Y. 2023. *Climate-driven variability of the Southern Ocean CO2 sink.* Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, 381(2249), pp 20pp.

Kunene, Z, Kapwata, T, Mathee, A, Sweijd, Neville A, Minakawa, N, Naidoo, N, Wright, CY. 2023. *Exploring the association between ambient temperature and daily hospital admissions for diarrhea in Mopani District, Limpopo Province, South Africa.* Healthcare, 11(9), pp 13pp.

Tselana, BM, Muniyasamy, Sudhakar, Ojijo, Vincent O, Mhike, W. 2023. *Melt processible biodegradable blends of polyethylene glycol plasticized cellulose diacetate with polylactic acid and polybutylene Adipate-Co-Terephthalate.* Journal of Polymers and the Environment, 31, pp 4891–4908.

Kumar, Neeraj, Gusain, Rashi, Masukume, Mike, Ray, Suprakas S. 2023. *B2O3-nanoparticles-decorated N-Rich reduced graphene oxide composites for the enhanced visible-light-assisted photocatalytic degradation of ciprofloxacin.* Solar RRL, pp 13pp.

Maubane, Lesego T, Orasugh, Jonathan T, Ray, Suprakas S. 2023. *Adsorptive removal of pollutants using graphene-based materials for water purification.* Springer Series in Materials Science, 332, pp 179-244.

Kenmogne, VL, Takalani, AMT, Nweke, EE, Takundwa, Mutsa M, Fabian, June, Maher, Heather, Du Toit, Justin, Philip-Cherian, V, Fru, PF, Govindaraj, DBT. 2023. *Establishment of ex vivo drug sensitivity screening platform for leukaemia and multiple myeloma using a South African patient cohort.* Hematology, Transfusion and Cell Therapy, 45(3), pp S32-S33.

Sepotokele, KM, O'Kennedy, Martha M, Hayes, MC, Wandrag, DBR, Smith, P, Abolnik, C. 2023. *Efficacy of a plant-produced infectious bronchitis virus-like particle vaccine in specific pathogen-free chickens.* Poultry Science, 102(10), pp 9pp.

Mboweni, IV, Ramotsoela, DT, Abu-Mahfouz, Adnan MI. 2023. *Hydraulic data preprocessing for machine learning-based intrusion detection in cyber-physical systems.* Mathematics, 11(8), pp 21pp.

Govender, Ireshyn S, Mokoena, Rethabile, Stoychev, Stoyan, Naicker, Previn. 2023. *Urine-HILIC: Automated sample preparation for bottom-up urinary proteome profiling in clinical proteomics.* Proteomes, 11(4), pp 13pp.

Maisha, RT, Ndarana, T, Engelbrecht, FA, Thatcher, M, Bopape, MM, Van der Merwe, Jacobus H, Padayachi, Yerdashin R, Masemola, Cecilia. 2023. *Simulation of the eThekwini heat island in South Africa.* Journal of Applied Meteorology and Climatology, 62(5), pp 589-609.

Mpofu, Kelvin T, Mthunzi-Kufa, Patience. 2023. *Enhanced signal-to-noise ratio in quantum plasmonic image sensing including loss and varying photon number.* Physica Scripta, 98(11), pp 13pp.

Onyebueke, EO, Manzi, MSD, Rapetsoa, MK, Kgarume, Thabang E, Westgate, M, Durrheim, RJ, Pienaar, M, Sihoyiya, M, Mpofu, Mvikel, Van Schoor, Abraham M. 2023. *Integration of in-mine seismic and GPR surveys to gain advanced knowledge of Bushveld Complex orebodies.* Near Surface Geophysics, pp 15pp.

Motlogeloa, O, Fitchett, JM, Sweijd, Neville A. 2023. *Defining the South African acute respiratory infectious disease season.* International Journal of Environmental Research and Public Health, 20(2), pp 16pp.

Mpofu, Kelvin T, Ombinda-Lemboumba, Saturnin, Mthunzi-Kufa, Patience. 2023. *Classical and quantum surface plasmon resonance biosensing.* International Journal of Optics, pp 18pp.

Bello-Salau, H, Onumanyi, Adeiza J, Adebiyi, RF, Adekale, AD, Bello, RS, Ajayi, O. 2023. *A critical appraisal of various implementation approaches for realtime pothole anomaly detection: Towards safer roads in developing nations.* Engineering Proceedings, 56(1), pp 4pp.

Khavhagali, V, Reckien, D, Biesbroek, R, Mantlana, Khanyisa B, Pfeffer, K. 2023. *Understanding the climate change adaptation policy landscape in South Africa.* Climate Policy, pp 16pp.

Ryan-Keogh, Thomas J, Thomalla, Sandy J, Chang, Nicolette, Moalusi, Tumelo C. 2023. *A new global oceanic multi-model net primary productivity data product.* Earth System Science Data, 15(11), pp 4829–4848.

Marais, Laurette, Pretorius, L. 2023. *Parsing IsiZulu text using grammatical framework.* Lecture Notes in Networks and Systems, 741, pp 167-177.

Cevik, T, Cevik, N, Rasheed, J, Abu Mahfouz, Adnan MI, Osnan, O. 2023. *Facial recognition in hexagonal domain—A frontier approach.* IEEE Access, 11, pp 46577-46591.

Karamanski, Stefan, Erfort, G. 2023. *Wind energy supply profiling and offshore potential in South Africa.* Energies, 16(9), pp 24pp.

Fon, RC, Ndjiongue, AR, Ouahada, K, Abu Mahfouz, Adnan MI. 2023. *Fibre optic-VLC versus laser-VLC: A review study.* Photonic Network Communications, 46, pp 15pp.

Ramakutoane,TV, Petronella Roux-van der Merwe, M, Badenhorst, J, Kesavan Pillai, Sreejarani, Ray, Suprakas S. 2023. *Antifungal properties of nanosilver clay composites against fungal pathogens of agaricus bisporus.* ChemistrySelect, 8(36), pp 17pp.

Harrison, Arthur J, Forbes, A, Naidoo, Darryl. 2023. *Amplification of higher-order Laguerre-Gaussian modes using a dual-pass MOPA system.* Optics Express, 31(11), pp 17408-17423.

Lain, Elisabeth J, Kravitz, K, Matthews, M, Bernard, S. 2023. *Simulated inherent optical properties of aquatic particles using the equivalent algal populations (EAP) model.* Scientific data, 10(412), pp 15pp.

Lohmann, R, Vrana, B, Muir, D, Smedes, F, Sobotka, J, Zeng, EY, Bao, L-J, Allan, IJ, Astrahan, P, Newman, Brent. 2023. *Passive-Sampler-Derived PCB and OCP concentrations in the waters of the world - First results from the AQUA-GAPS/MONET Network.* Environmental Science & Technology, 57(25), pp 9342–9352.

Lee, TT, Dalvie, MA, Röösli, MS, Merten, S, Kwiatkowski, M, Mahomed, H, Sweijd, Neville A, Cissé, G. 2023. *Understanding diarrhoeal diseases in response to climate variability and drought in Cape Town, South Africa: A mixed methods approach.* Infectious Diseases of Poverty, 12(76), pp 14pp.

Isong, B, Vhahangwele, T, Abu-Mahfouz, Adnan MI. 2023. *Blockchain-enabled vaccination registration and verification system in healthcare management.* Journal of Information Systems and Informatics, 5(2), pp 719-741.

Mphuthi, Nokwazi P, Bell, Lebohang T, Mabena, Chemist M. 2023. *Effect of aberrations on the beam quality factor of Hermite-Gauss beams.* Optics Express, 31(24), pp 39379-39395.

Olakanmi, EO, Hoosain, Shaik E, Lawal, SA, Pityana, Sisa L. 2023. *Process and materials design via statistical modeling for Inconel-625/tungsten carbide wear-resistant composite coatings fabricated by laser direct metal deposition technique.* The International Journal of Advanced Manufacturing Technology, 126, pp 635–658.

Omotola, EO, Genthe, B, Ndlela, Luyanda L, Olatunji, OS. 2023. *Evaluation of the probable synergistic toxicity of selected potentiated antiretroviral and antibiotics on some aquatic biomarker organisms.* Environmental Monitoring and Assessment, 195(1489), pp 17pp.

Skosana, Vusi J, Abu-Mahfouz, Adnan MI. 2023. *An energy-efficient sensing matrix for wireless multimedia sensor networks.* Sensors, 23(10), pp 17pp.

Agbakoba, VC, Mokhena, TC, Ferg, EE, Hlangothi, SP, Mathew, Maya J. 2023. *PLA bio-nanocomposites reinforced with cellulose nanofbrils (CNFs) for 3D printing applications.* Cellulose, pp 23pp.

Makgwane, Peter R. 2023. *Two-dimensional all-metal/metal oxide based photocatalysts for solar CO2 conversion.* Springer Series in Materials Science, pp 375-408.

Ramazhamba, Pardon T, Venter, H. 2023. *A blockchain model for sharing information in criminal justice systems.* IFIP International Conference on Digital Forensics, pp 289-309.

Motloung, Mpho P, Mofokeng, Tladi G, Sinha Roy, Jayita, Ray, Suprakas S. 2023. *Properties and soil degradation characteristics of chitin-reinforced poly(butylene succinate)/hydroxyapatite composites.* Macro-Molecular Materials and Engineering, pp 12pp.< https://doi.org/10.1002/mame.202300293https://onlinelibrary.wiley.com/doi/full/10.1002/mame.202300293>

Tlotleng, Monnamme, Pityana, Sisa L, Motha, S. 2023. *Insights on niobium micro-alloyed laser in situ synthesised gamma titanium aluminide alloys.* Applied Sciences, 13(9), pp 19pp.

Olatinwo, DD, Abu-Mahfouz, Adnan MI, Hancke, GP, Myburgh, HC. 2023. *Energy efficient priority-based hybrid MAC protocol for IoT-Enabled WBAN Systems.* IEEE Sensors Journal, 32(12), pp 13524 - 13538.

Harrison, Arthur J, Buono, WT, Forbes, A, Naidoo, Darryl. 2023. *Aberration-induced vortex splitting in amplified orbital angular momentum beams.* Optics Express, 31(11), pp 17593-17608.

Fuku, X, Modibedi, Remegia M. 2023. *Performance of BiCu2O modified Pd/C as an anode electrocatalyst for direct ethanol fuel cell system.* Catalysis Today, 425, pp 7pp.

Temane, Lesego T, Orasugh, Jonathan O, Suprakas Sinha Ray, Suprakas S. 2023. *Recent advances and outlook in 2D nanomaterial-based flame-retardant PLA materials.* Materials, 16(17), pp 45pp.

Alabi, S, Popoola, API, Popoola, OM, Mathe, Ntombizodwa R, Abdulwahab, M. 2023. *Materials for electrocatalysts in proton exchange membrane fuel cell: A brief review.* Frontiers in Energy Research, 11, pp 18pp.

Dresselhaus, C, Fabris-Rotelli, I, Manjoo-Docrat, R, Brettenny, W, Holloway, Jennifer P, Abdelatif, N, Thiede, R, Debba, Pravesh, Dudeni-Tlhone, Nontembeko. 2023. *A spatial model with vaccinations for COVID-19 in South Africa.* Spatial Statistics, 58, pp 12pp.

Rasilingwania, TE, Gumbo, JR, Masindi, V, Muedi, KL, Mbhele, Nkhangweleni R. 2023. *Effective removal of Congo red dye from aqueous solution using activated MgO-nanoparticles.* Desalination and Water Treatment, 300, pp 136-143.

Kruger, Rynhardt P, De Wet, F, Niesler, T. 2023. *Mathematical content browsing for print-disabled readers based on virtual-world exploration and audio-visual sensory substitution.* ACM Transactions on Accessible Computing (TACCESS), 16(2), pp 27pp.

Oguntuyi, SD, Shongwe, M, Tshabalala, Lerato C, Johnson, OT, Malatji, N. 2023. *Effects of SiC on the microstructure, densification, hardness and wear performance of TiB2 ceramic matrix composite consolidated via spark plasma sintering.* Arabian Journal for Science and Engineering, 48, pp 2889-2903.

Van Heerden, N, Grobbelaar, SS, Meyer, Isabella A, Vermeulen, E. 2023. *Emerging smallholder cattle farming from a One Health perspective: A system dynamics model of the highveld region of South Africa.* Environmental Science and Policy, 152, pp 13pp.

Zheng, Haitao, Shi, Xuan, Jiang, S, Han, X, Wen, L. 2023. *Insight into thermal effect on the surface properties and potentials of MnO2 (a, ß, Y) as electrocatalysts for the oxygen reduction reaction.* Journal of Physics and Chemistry of Solids, 185, pp 8pp.

Okamoto, Y, Shinonaga, T, Takemoto, Y, Okada, A, Ochi, A, Kishimoto, R, Pityana, Sisa L, Arthur, Nana KK, Omoniyi, Peter, Mahamood, Rasheedat, Maina, Martin, Akinlabi, Ester. 2023. *Study on joint characteristics in laser butt welding of AMed and wrought Ti6Al4V plates.* Welding in the World, 67, pp 1997–2005.

Karsten, Carike, Bean, WL, Van Heerden, Quentin. 2023. *Robust facility location of container clinics: A South African application.* International Journal of Mathematical, Engineering and Management Science, 8(1), pp 43-59.

Chhiba, Varsha P, Pillay, Priyen, Mtimka, Sibongile, Moonsamy, Ghaneshree, Kwezi, Lusisizwe, Pooe, OJ, Tsekoa, Tsepo L. 2023. *South Africa's indigenous microbial diversity for industrial applications: A review of the current status and opportunities.* Heliyon, 9(6), pp 18pp.

Egambaram, Orielia P, Kesavan Pillai, Sreejarani, Ray, Suprakash S, Goosen, M. 2023. *Structural and photoprotective characteristics of Zn-Ti, Zn-Al, and Mg-Al layered double hydroxides - A comparative study.* Cosmetics, 10(4), pp 16pp.

Mtibe, Asanda, Muniyasamy, Sudhakar, Mokhena, TC, Ofuso, Osei, Ojijo, Vincent O, Mathew, Maya J. 2023. *Recent insight into the biomedical applications of polybutylene succinate and polybutylene succinate-based materials.* Express Polymer Letters, 17(1), pp 28pp.

Gayen, TK, Pityana, Sisa L, Akinlabi, E, Majumdar, JD. 2023. *Studies on laser surface processing of titanium based alloy (Ti6Al4V) with titanium, carbon and a mixture of titanium and carbon.* Physica Scripta, 98(10), pp 16pp.

Arthur, Nana KK, Kubjane, SM, Popoola, API, Masina, Bathusile N, Pityana, Sisa L. 2023. *The effect of laser shock processing on the anti-corrosion performance of LENS-Fabricated Ti-6Al-4V alloy.* Journal of Composites Science, 7(6), pp 17pp.

Willemse, MG, Siyasiya, CW, Marais, D, Venter, AM, Arthur, Nana KK. 2023. *Material characteristics of Ti-6AL-4V samples additively manufactured using laser-based direct energy deposition.* Journal of the Southern African Institute of Mining and Metallurgy, 123(2), pp 93-102.

Mokhena, TC, Mtibe, Asanda, Mokhothu, TH, Mochane, MJ, Mathew, Maya J. 2023. *A review on bast-fibre-reinforced hybrid composites and their applications.* Polymers, 15(16), pp 28pp.

Singh, N, Sithole, Bishop B, Kumar, A, Govinden, R. 2023. *A glucose tolerant ß-glucosidase from a newly isolated Neofusicoccum parvum strain F7: production, purification, and characterization.* Scientific Reports, 13(5134), pp 15pp.

Roy, Abhinandan S, Kesavan Pillai, Sreejarani, Ray, Suprakash S. 2023. *A comparison of nitrate release from Zn/Al-, Mg/Al-, and Mg–Zn/Al layered double hydroxides and composite beads: Utilization as slow-release fertilizers.* ACS Omega, 8(9), pp 8427-8440.

Mandree, PM, Thopil, GA, Ramchuran, Santosh O. 2023. *Potential opportunities to convert waste to bio-based chemicals at an industrial scale in South Africa.* Fermentation, 9(10), pp 27pp.

Letwaba, J, Makwakwa, Dimakatso M, Muniyasamy, Sudhakar, Motloung, Mpho P, Moropeng, L. 2023. *Melt extruded polylactic acid (PLA)/algae bio-composites: Effect of grafting level and filler loading on thermal and mechanical properties.* Journal of Applied Polymer Science, 140(46), pp 13pp.

Sekoai, Patrick T, Chunilall, Viren, Msele, K, Buthelezi, L, Johakimu, Jonas, Andrew, Jerome E, Zungu, M, Moloantoa, K, Maningi, N, Habimana, O, Swartbooi, Ashton M. 2023. *Biowaste biorefineries in South Africa: Current status, opportunities, and research and development needs.* Renewable and Sustainable Energy Reviews, 188, pp 14pp.

Rust, FC, Sampson, LR, Cachia, AA, Verhaeghe, Benott MJ, Fourie, HS, Smit, Michelle A. 2023. *Use of causal loop diagrams to assess future drivers and trends in South African transport.* Journal of Transport and Supply Chain Management, 17(a958), pp 13pp.

Nakia, T, Matshe, William MR, Balogun, Mohammed O, Ray, Suprakas S, Egieyeh, SO, Aderibigbe, BA. 2023. *Polymer drug conjugates containing memantine, tacrine and cinnamic acid: Promising nanotherapeutics for the treatment of Alzheimer's disease.* Journal of Microencapsulation, 40(1), pp 15-28.

Dmitrenko, M, Kuzminova, A, Cherian, RM, Joshy, KS, Pasquini, D, Mathew, Maya J, Hato, MJ, Thomas, S, Penkova, A. 2023. *Edible carrageenan films reinforced with starch and nanocellulose: Development and characterization.* Sustainability, 15(22), pp 19pp.

Tjale, Mabotse A, Ombinda-Lemboumba, Saturnin, Maphanga, Charles P, Mthunzi-Kufa, Patience. 2023. *TB diagnostic insights, progress made on point of care diagnostics and bioinformatics as an additional tool for improvement.* Indian Journal of Tuberculosis, 70(4), pp 468-474.

Maleka, Prettier M, Dima, Ratshilumela S, Ntwaeaborwa, OM, Maphanga, Rapela R. 2023. *Density functional theory study of Br doped CsPbI3 perovskite for photovoltaic and optoelectronic applications.* Physica Scripta, 98(4), pp 18PP.

Hamese, Saltiel, Mugwanda, Kanganwiro, Takundwa, Mutsa M, Prinsloo, E, Thimiri Govindaraj, Deepak B. 2023. *Recent advances in genome annotation and synthetic biology for the development of microbial chassis.* Journal of Genetic Engineering and Biotechnology, 21(156), pp 9pp.

Kleebauer, M, Marz, Christopher A, Reudenbach, C, Braun, M. 2023. *Multi-resolution segmentation of solar photovoltaic systems using deep learning.* Remote Sensing, 15(24), pp 21pp.

Moodley, D, Nocanda, Xolani W, Nelson, P, Mambanda, A, Booysen, IN. 2023. *Construction of a functional and robust cobalt (II) phthalocyanine-modified electrode for the electrocatalytic detection of paraquat.* ChemElectroChem, 10(24), pp 11pp.

Agbakoba, Victor C, Webb, N, Jegede, E, Phillips, R, Hlangothi, SP, Mathew, Maya J. 2023. *Mechanical recycling of waste PLA generated from 3D printing activities: Filament production and thermomechanical analysis.* Macromolecular Materials and Engineering, pp 14pp.

Hauck, J, Gregor, L, Nissen, C, Patara, L, Hague, M, Mongwe, Ndunisani P, Bushinsky, S, Doney, SC, Gruber, N, Monteiro, Pedro MS. 2023. *The Southern Ocean carbon cycle 1985-2018: Mean, seasonal cycle, trends and storage.* Global Biogeochemical Cycles, 37(11), pp 40pp.

Sefara, Tshephisho Joseph, Rangata, Mapitsi R. 2023. *Domain-specific sentiment analysis of tweets using machine learning methods.* Communications in Computer and Information Science, 1935, pp 15pp.

Banerjee, R, Ray, Suprakas S. 2023. *Role of rheology in morphology development and advanced processing of thermoplastic polymer materials: A review.* ACS Omega, 8(31), pp 27969–28001.

Lekoadi, Paul M, Tlotleng, Monnamme, Siyasiya, CW, Masina, Bathusile N. 2023. *Investigation of network microstructure of TiB/Ti6Al4V-ELI composite manufactured with laser metal deposition.* MRS Advances, 8, pp 602-606.

Adedeji, KB, Abu-Mahfouz, Adnan MI, Kurien, AM. 2023. *DDoS attack and detection methods in internet-enabled networks: Concept, research perspectives, and challenges.* Journal of Sensor and Actuator Networks, 12(4), pp 57pp.

Ezika, AC, Sadiku, ER, Adekoya, Gbolahan J, Hamam, Y, Ray, Suprakas S. 2023. *Response surface optimization and finite element homogenization study of the effective elastic modulus and electrical conductivity of MXene-polypyrrole hybrid nanocomposite as electrode material for electronic energy storage devices.* Polymer Engineering and Science, 63(2), pp 338-352.

Matumba, Karabo I, Motloung, Mpho P, Ojijo, Vincent, Ray, Suprakas S, Sadiku, ER. 2023. *Investigation of the effects of chain extender on material properties of PLA/PCL and PLA/PEG blends: Comparative study between polycaprolactone and polyethylene glycol.* Polymers, 15(9), pp 16pp.

Ghosh, A, Orasugh, Jonathan T, Ray, Suprakas S, Chattopadhyay, D. 2023. *Integration of 3D printing-coelectrospinning: Concept shifting in biomedical applications.* ACS Omega, 8(31), pp 24pp.

Ghosh, A, Orasugh, Jonathan T, Ray, Suprakas S, Chattopadhyay, D. 2023. *Prospects of 2D graphdiynes and their applications in desalination and wastewater remediation.* RSC advances, 13(27), pp 18568–18604.

Khoele, Khotso, Ama, Onoyivwe Monday, Disai, D, Delport, J, Ray, Suprakas S. 2023. *Tribological behavior of inconel 718 nickel-based super alloy doped with graphene nanoplatelets.* Portugaliae Electrochimica Acta, pp 17-27.

Sibolla, Bolelang H, Molapo, Nkadimeng R, Vhengani, Lufuno M, Mdakane, Lizwe W. 2023. *Systems and architectural support for open data principles: A marine earth observation perspective.* The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, XLVIII-1, pp 8pp.

Sibisi, TH, Shongwe, MB, Tshabalala, Lerato C, Mathoho, Ipfi. 2023. *LAM additive manufacturing: A fundamental review on mechanical properties, common defects, dominant processing variables, and its applications.* The International Journal of Advanced Manufacturing Technology, 128, pp 2847–2861.

Haupt, Shelley A, Engelbrecht, J, Sibolla, Bolelang H, Mdakane, Lizwe. 2023. *Time series INSAR analysis for slope stability monitoring using Sentinel-1 in open pit mining.* The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, pp 945–951.

Mabuea, Busisiwe P, Kroon, RE, Sondezi, BM, Ntwaeaborwa, OM. 2023. *Sol-gel synthesis and photoluminescent properties of metal oxide-metal oxide coupled nanocomposites.* Physica B: Condensed Matter, 675, pp 11pp.

Maponya, TC, Makgopa, K, Somo, TR, Tshwane, David M, Modibane, KD. 2023. *Ethylenediamine functionalized waste polyethylene terephthalate-derived metal-organic framework for adsorption of palladium ions from aqueous solutions.* Cleaner Chemical Engineering, 6, pp 14pp.

Olatinwo, DD, Abu-Mahfouz, Adnan MI, Hancke, GP, Myburgh, HC. 2023. *Energy-efficient multichannel hybrid MAC protocol for IoT-enabled WBAN systems.* IEEE Sensors Journal, 23(22), pp 17pp.

Mdakane, Lizwe W, Sibolla, Bolelang H, Haupt, Shelley A. 2023. *Exploring the potential of open-data for oceans monitoring with AI analytics.* The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, XLVIII-1/W2-2023, pp 1467–1472.

Adigun, RA, Malan, FP, Balogun, Mohammed O, October, N. 2023. *Design, synthesis, and in silico-in vitro antimalarial evaluation of 1,2,3-triazole-linked dihydropyrimidinone quinoline hybrids.* Structural Chemistry, 34, pp 2065-2082.

Rong-Jie Wang, R-J, Holm, Stanley R, Josh Scheepers, J, Stiaan Gerber, S. 2023. *Load angle of flux modulated magnetic gears.* Progress in Electromagnetics Research C, 132, pp 255-269.

Mdakane, Lizwe W, Sibolla, Bolelang H, Haupt, Shelley A. 2023. *Maritime domain awareness in South Africa: A multisource approach using remote sensing and AIS data.* The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, XLVIII-1/W2-2023, pp 1473-1478.

Shaibu, FE, Onwuka, EN, Salawu, N, Oyewobi, SS, Djouani, K, Abu-Mahfouz, Adnan MI. 2023. *Performance of path loss models over mid-band and high-band channels for 5G communication networks: A review.* Future Internet, 15(11), pp 32pp.

Ezika, AC, Sadiku, ER, Ray, Suprakas S, Hamam, Y, Adekoya, GJ, Lolu, OJ. 2023. *Fabrication and investigation of electrically conductive spark plasma sintered polypyrrole-based MXene–Ti3C2Tx hybrid nanoarchitectonics for electrode material.* Journal of Materials Science: Materials in Electronics, 34(168), pp 15pp.

Chauke, Sipho H, Nzuza, Sinegugu P, Ombinda-Lemboumba, Saturnin, Abrahamse, H, Dube, FS, Mthunzi-Kufa, Patience. 2023. *Advances in the detection and diagnosis of tuberculosis using optical-based devices.* Photodiagnosis and Photodynamic Therapy, 45, pp 9pp.

Maleka, Prettier M, Dima, Ratshilumela, Tshwane, David M, Ntwaeaborwa, O, Maphanga, Rapela R. 2023. *Phase separation of Br-Doped CsPbI3: A combined cluster expansion, Monte Carlo, and DFT study.* Molecules, 29(1), pp 16pp.

Rossouw, R, Maritz, Johan. 2023. *Assessing economic vulnerability in South African municipalities: A focus on mining-dependent regions using the Economic Complexity Index.* Town and Regional Planning, 83, pp 57-67.

Luleka, Mngwengwe, Lugongolo, Masixole Y, Ombinda-Lemboumba, Saturnin, Yaseera, I, Mthunzi-Kufa, Patience. 2023. *The effects of low-level laser therapy on severe acute respiratory syndrome coronavirus 2 infection in HEK293/ACE2 cells.* Journal of Biophotonics, pp 13pp.

Pandelani, Thanyani, Ngwangwa, H, Nemavhola, F. 2023. *Experimental analysis and biaxial biomechanical behaviour of ex-vivo sheep trachea.* Frontiers in Materials, 10, pp 13pp.

Moore, K, Kouprianoff, D, Louw, Daniel F, Yadroitsava, I, Yadroitsev, I. 2023. *Monitoring for cracks in metal l-pbf using gas-borne acoustic emission.* The South African Journal of Industrial Engineering, 34(4), pp 147–154.

Smith, TG, Nicholson, Sarah-Anne, Engelbrecht, FA, Chang, Nicolette, Mongwe, Ndunisani P, Monteiro, PMS. 2023. *The heat and carbon characteristics of modeled mesoscale eddies in the South–East Atlantic ocean.* JGR Oceans, 128(12), pp 18pp.

Rolf, W, Obando, J, Bulley, HN, Cho, Moses A, Bamutaze, Y, Schelle, RM, Schirpke, U. 2023. *Odyssey of first IALE World Congress in Africa and opportunities for North-South or South-South Collaboration.* Landscape Online, pp 14pp.

Pillay, MT, Minakawa, N, Kim, Y, Kgalane, N, Ratnam, JV, Behera, SK, Hashizume, M, Sweijd, Neville A. 2023. *Utilizing a novel high-resolution malaria dataset for climate-informed predictions with a deep learning transformer model.* Scientific Reports, 13(23091), pp 14pp.

Donald, H, Blane, A, Buthelezi, Sindisiwe, Naicker, Previn, Stoychev, Stoyan, Majakwara, J, Fanucchi, S. 2023. *Assessing the dynamics and macromolecular interactions of the intrinsically disordered protein YY1.* Bioscience Reports, 43(10), pp 19pp.

Thomalla, Sandy J, Nicholson, Sarah-Anne, Ryan-Keogh, Thomas J, Smith, Marie E. 2023. *Widespread changes in Southern Ocean phytoplankton blooms linked to climate drivers.* Nature Climate Change, 13, pp 975–984.

Roberts, LC, Abernethy, D, Roberts, DG, Ludynia, K, O'Kennedy, Martha M, Abolnik, C. 2023. *Vaccination of African penguins (Spheniscus demersus)against high-pathogenicity avian influenza.* VetRecord, pp 5pp.

Masimirembwa, C, Ramsay, M, Botha, J, Ellis, E, Etheredge, H, Hurrell, Tracey, Kanji, CR, Kapungu, NN, Naidoo, Jerolen, Scholefield, Janine. 2023. *The African Liver Tissue Biorepository (ALTBio) Consortium: Capacitating population-appropriate drug metabolism and pharmacokinetics and pharmacogenetics research in drug discovery and development.* Drug Metabolism and Disposition, 51(2), pp 40pp.

Nzengue, ACB, Khumbulani Mpofu, K, Mathe, Ntombizodwa R, Muvunzi , R. 2023. *Optimising a processing window for the production of aluminium silicon-12 samples via selective laser melting.* Journal of Materials Research and Technology, pp 1062-1073.

Morake, JB, Maina, MR, Mutua, JM, Olakanmi, EO, Pityana, Sisa L. 2023. *Optimization of laser-cladded SS316L/IN625 functionally graded material deposited on a copper substrate for boiler pipe heat exchanger applications.* The International Journal of Advanced Manufacturing Technology, 130, pp 2343–2368.

Jugmohan, Jaimee, Van Der Merwe, J. 2023. *Determining the optimum reaction pathway from a reaction pathway search space: A review.* Chemical Engineering Transactions, 98, pp 6pp.

Esterhuizen, N, Berman, DM, Neumann, FH, Ajikah, L, Quick, LJ, Hilmer, E, Van Aardt, A, John, Juanette, Garland, Rebecca, Hill, T. 2023. *The South African Pollen Monitoring Network: Insights from 2 years of national aerospora sampling (2019–2021).* Clinical and Translational Allergy, 13(11), pp 13pp.

O'Kennedy, Martha M, Abolnik, C, Tanja Smith, T, Thopisang Motlou, T, Goosen, K, Sepotokele, KM, Roth, Robyn, Du Preez, Ilse, Truyts, Alma, Lemmer, Yolandy. 2023. *Immunogenicity of adjuvanted plant-produced SARS-CoV-2 Beta spike VLP vaccine in New Zealand white rabbits.* Vaccine, 41(13), pp 2261-2269.

Jain, S, Sharma, A, Yadav, S, Kumar, N, Dahiya, H, Makgwane, Peter R, Bandegharaei, AH, Jindal, J. 2023. *A facile synthesis of Ag incorporated Bi2O3/CuS nanocomposites as photocatalyst for degradation of environmental contaminants.* Inorganic Chemistry Communications, 157, pp 12pp.

Idisi, David O, Mwakikunga, Bonex W. 2023. *Two-dimensional layered metal dichalcogenides-based heterostructures for solar cells applications: A review.* Solar Energy, 263, pp 18pp.

Manyatshe, Alusani, Cele, Zamani ED, Balogun, Mohammed O, Nkambule, TTI, Msagati, TAM. 2023. *Preparation of pretreated sugarcane bagasse and chitosan bio-composite for the adsorption of phosphate from aqueous media.* Canadian Journal of Chemistry, 101(4), pp 12pp.

Nemufulwi, Murendeni I, Swart, HC, Mhlongo, Gugu H. 2023. *Advances of nano-enabled ZnFe2O4 based-gas sensors for VOC detection and their potential applications: A review.* Processes, 11(11), pp 21pp.

Jiang, J, Lin, C, Han, G, Abu-Mahfouz, Adnan MI, Shah, SBH, Martínez-García, M. 2023. *How AI-enabled SDN technologies improve the security and functionality of industrial IoT network: Architectures, enabling technologies, and opportunities.* Digital Communications and Networks, 9(6), pp 1351–1362.

Kgomo, MB, Shingange, K, Swart, HC, Mhlongo, Gugu H. 2023. *Evolution of In2O3 morphology from belt to fibrous-like structure for ethanol detection at low working temperature induced by Cr-addition.* Applied Surface Science, 639, pp 13pp.

Lufuno Nemadodzi, L, Sikhwivhilu, K, Jalama, K, Moothi, K, Bambo, M, Mutanga, Shingirirai S, Siame, J. 2023. *Salient ingredients for direct water reclamation from treated municipal wastewater for potable reuse: Diepsloot Township case study.* Frontiers of Environmental Science, 11, pp 13pp.

Dhaver, P, Pletschke, B, Sithole, Bruce B, Govinden, R. 2023. *Optimization of Xylooligosaccharides Production by Native and Recombinant Xylanase Hydrolysis of Chicken Feed Substrates.* International Journal of Molecular Sciences, 24(23), pp 21pp.

Nemufulwi, Murendeni I, Swart, HC, Shingange, Katekani, Mhlongo, Gugu H. 2023. *ZnO/ZnFe2O4 heterostructure for conductometric acetone gas sensors.* Sensors and Actuators: B. Chemical, 377, pp 12pp.

Mofokeng, Tladi G, Motloung, Mpho P, Skosana, SJ, Motloung, MT, Mochane, MJ. 2023. *The effect of expanded graphite and paraffin wax on the morphological, thermal, and rheological properties of PP/EVA blend.* Journal of Thermoplastic Composite Materials, pp 19pp.

Nel, M, Adams, JB, Human, LRD, Nunes, M, Van Niekerk, Lara, Lemley, DA. 2023. *Ineffective artificial mouth-breaching practices and altered hydrology confound eutrophic symptoms in a temporarily closed estuary.* Marine and Freshwater Research, 74(18), pp 1519-1535.

Agbakoba, Victor C, Hlangothi, P, Andrew, Jerome E, Mathew, Maya J. 2023. *Preparation of cellulose nanocrystal (CNCs) reinforced polylactic acid (PLA) bionanocomposites filaments using biobased additives for 3D printing applications.* Nanoscale Advances, 5(17), pp 4447-4463.

Gong, X, Srivastava, V, Naicker, Previn, Khan, A, Ahmad, A. 2023. *Candida parapsilosis cell wall proteome characterization and effectiveness against hematogenously disseminated candidiasis in a murine model.* Vaccines, 11(3), pp 14pp.

Baloyi, R, Gbadeyan, OJ, Sithole, B, Chunilall, Viren. 2023. *Recent advances in recycling technologies for waste textile fabrics: A review.* Textile Research Journal, 94(3-4), pp 22pp.

Hughes, DA, Read, L, Jeuland, M, Kapangaziwiri, Evison, Elkurdy, M, Lambl, D, Hale, E, Opperman, JJ. 2023. *Insights from a comparison of two hydrological modelling approaches in the Kwando (Cuando) River and the western tributaries of the Zambezi River basin.* Journal of Hydrology: Regional Studies, 48, pp 14pp.

Conference papers (200)

Nelufule, Nthatheni N, Moolla, Yasneen, Ntshangase, Cynthia S, De Kock, Antoine J. 2023. *Biometric recognition of infants using fingerprints: Can the infant fingerprint be used for secure authentication?*. Conference on Information Communications Technology and Society (ICTAS), 9-10 March 2023, pp 5pp.

Nelufule, Nthatheni, De Kock, Antoine J. 2023. *Infant iris biometric recognition system: Can the iris be used for a secure infant recognition system?*. Conference on Information Communications Technology and Society (ICTAS), Durban, South Africa, 9-10 March 2023, pp 6pp.

Mabena, Chemist, Bell, Lebohang T, Naidoo, Darryl. 2023. *Modelling the effect of astigmatism on the beam quality factor of Laguerre-Gaussian optical beams*. Proceeding of SPIE 12399, Solid State Lasers XXXII: Technology and Devices, California, United States, 28 January - 3 February 2023, pp 8pp.

Bell, Lebohang T, Mabena, Chemist M, Naidoo, Darryl. 2023. *Active control of focus position of laser beams using thermally induced lensing*. Proceeding of SPIE 12407, Laser Resonators, Microresonators, and Beam Control XXV, San Francisco, California, United States, 28 January - 3 February 2023, pp 11pp.

Maphanga, Charles P, Ombinda-Lemboumba, Saturnin, Ismail, Y, Mthunzi-Kufa, Patience. 2023. *Photonic crystal-based biosensor chip development for TB diagnosis*. Proceeding of SPIE 12387, Optical Diagnostics and Sensing XXIII: Toward Point-of-Care Diagnostics, San Francisco, California, United States, 28 January - 3 February 2023, 12387, pp 10pp.

Maphanga, Charles P, Manoto, Sello, Ombinda-Lemboumba, Saturnin, Ismail, Y, Mthunzi-Kufa, Patience. 2023. *Optical biosensing of mycolic acid biomarker for TB diagnosis*. Proceeding of SPIE 12387, Optical Diagnostics and Sensing XXIII: Toward Point-of-Care Diagnostics,, San Francisco, California, United States, 28 January - 3 February 2023, pp 12pp.

Ndlovu, Sphumelele C, Mthunzi-Kufa, Patience. 2023. *Machine learning in biophotonics: Progress and challenges*. Proceeding of SPIE 12446, Quantum Computing, Communication, and Simulation III, 1244601, San Francisco, California, United States, 28 January - 3 February 2023, pp 9pp.

Mngwengwe, Luleka, Lugongolo, Masixole Y, Ombinda-Lemboumba, Saturnin, Mthunzi-Kufa, Patience. 2023. *Low-level laser therapy for treatment of severe acute respiratory syndrome 2 infection*. Proceedings of SPIE, Volume 12377, Optical Interactions with Tissue and Cells XXXIV; 123770H, San Francisco, California, United States, 28-29 January 2023, pp 8pp.

Lugongolo, Masixole Y, Ombinda-Lemboumba, Saturnin, Mthunzi-Kufa, Patience, Maphanga, Charles P. 2023. *Optical biosensing of human immunodeficiency virus on a gold coated surface*. Proceedings of SPIE 12396, Plasmonics in Biology and Medicine XX, 123960B, San Francisco, California, United States, 16 March 2023, pp 6pp.

Lugongolo, Masixole Y, Ombinda-Lemboumba, Saturnin, Maphanga, Charles P, Mthunzi-Kufa, Patience. 2023. *Detection of human immunodeficiency virus on a photonic crystal-based platform*. Proceedings of SPIE 12377, Optical Interactions with Tissue and Cells XXXIV, 1237702, San Francisco, California, United States, 7 March 2023, pp 8pp.

Chetty, Brenton L, Isaac, Sherrin J, Walingo, T. 2023. *An experimental investigation into high bandwidth wireless communication standards for the underground mine stope*. IEEE Africon, Nairobi, Kenya, 20 - 22 September 2023, pp 6pp.

Magidimisha, Edwin, Faniso-Mnyaka, Zimbini, Naidoo, Seelenthren, Nana, Muhammad A. 2023. *Detecting wildfires using unmanned aerial vehicle with near infrared optical imaging sensor*. 15th International Conference on Advanced Geographic Information Systems, Applications, and Services (GEOProcessing 2023) Venice, Italy, 24 - 28 April 2023, pp 31-36.

Pereira, LC, Guterres, B, Sbrissa, K, Mendes, A, Vermeulen, F, Lain, Elisabeth J, Smith, Marie E, Martinez, J, Drews, P, Duarte, N. 2023. *The not-so-easy task of taking heavy-lift ML models to the edge: A performance-watt perspective*. SAC '23: Proceedings of the 38th ACM/SIGAPP Symposium on Applied Computing, Tallin, Estonia, 17-31 March 2023, pp 699-706.

Masonta, Moshe. 2023. *Towards bridging the digital divide using innovative and community-based interventions*. IST Africa 2023 Conference, Pretoria, South Africa, 31 May - 2 June 2023, pp 8pp.

Botha, Johannes G, Botha-Badenhorst, Danielle P, Leenen, L. 2023. *An analysis of crypto scams during the Covid-19 pandemic: 2020-2022*. Proceedings of the 18th International Conference on Cyber Warfare and Security, Towson University, Baltimore County, Maryland, USA, 9-10 March 2023, pp 10pp.

Botha, Johannes G, Pederson, T, Leenen, L. 2023. *An analysis of the MTI crypto investment scam: User case*. 22nd European Conference on Cyber Warfare and Security, Ellenic Air Force Academy and the University of Piraeus, Greece, 22-23 June 2023, 22(1), pp 89-99.

Naidoo, S, Khan, Sumaya, Swettenham, T, Ramparsad, S. 2023. *Communications and engagement tool for local suppliers and small, medium enterprises.* Digital Transformation in Mining, The Canvass, Riversands, Fourways, 28 - 29 June 2023, pp 47-58.

Miyambo, Mangalani E, Von Kallon, DV, Pandelani, Thanyani A, Reinecke, John D. 2023. *Review of the development of the split Hopkinson pressure bar.* The 33rd CIRP Design Conference, Sydney, Australia, 17-19 May 2023, pp 9pp.

Likaku, Y, Pelders, Jodi L, Bull, S, Swettenham, T, Ramparsad, S. 2023. *Community social-needs assessment tool.* Digital Transformation in Mining, The Southern African Institute of Mining, The Canvas, Riversands, Fourways, 28-29 June 2023, pp 59-70.

Kemp, Lana, Matchett, R, Roux, Michael P, De Klerk, L. 2023. *Technology solutions for strategic bridge inspections in South Africa.* 41st Southern African Transport Conference, CSIR International Convention Centre (CSIR ICC), Pretoria, South Africa, 10 - 13 July 2023, pp 13pp.

Schmitz, P, Pretorius, R, Du Plooy, N, Cooper, Antony K. 2023. *Groth's algorithm to detect the possible presence of landmines using changes in the reflection of plants.* 31st International Cartographic Conference, Cape Town, South Africa, 13 - 18 August 2023, pp 6pp.

Sefara, Tshephisho J, Rangata, Mapitsi R. 2023. *Topic classification of tweets in the broadcasting domain using machine learning methods.* 2023 International Conference on Artificial Intelligence, Big Data, Computing and Data Communication Systems (icABCD), Durban, South Africa, 03-04 August 2023, pp 6pp.

Cooper, Antony K, Coetzee, Serena, Moellering, H, Rapant, P, Crompvoets, J, Hjelmager, J, Delgado, T, Iwaniak, A, Kaczmarek, I. 2023. *A review of the ICA model of stakeholders in a spatial data infrastructure (SDI).* 31st International Cartographic Conference (ICC 2023), Cape Town, South Africa, 13-18 August 2023, pp 8pp.

Moabalobelo, Phindile T, Ngobeni, Sipho J, Molema, Bokang C, Pantsi, Phumeza N, Dlamini, Thandokuhle M, Nelufule, Nthatheni. 2023. *Towards a privacy compliance assessment toolkit.* IST-Africa 2023 Conference, CSIR ICC, Pretoria, South Africa, Pretoria, 31 May - 2 June 2023, pp 8pp.

Marole, Busisiwe C, Asiimwe, F, Vanner, T. 2023. *Measuring the impact of COVID-19 on mobility in Gauteng Province, South Africa.* 41st Southern African Transport Conference, CSIR International Convention Centre (CSIR ICC), Pretoria, South Africa, 10 - 13 July 2023, pp 9pp.

Thaba, James M, Mtsweni, Jabu S. 2023. *Developing robust cyber warfare capabilities for the African battlespace.* Proceedings of the European Conference on Cyber Warfare and Security (ECCWS) 2023, Athens, Greece, 22-23 June 2023, pp 10pp.

Barnard, HC, Venter, Karien. 2023. *Best practices in support of vulnerable road user protection in South Africa.* 41st Southern African Transport Conference, CSIR International Convention Centre (CSIR ICC), Pretoria, South Africa, 10 - 13 July 2023, pp 14pp.

Marole, Busisiwe C, Venter, Karien, Sallie, Ismail M, Muronga, Khangwelo, Kemp, Lana, Kemp, Mauritz, De Franca, Volanda, Dube, Mxolisi, Matsaung, Ntsetsadi, Bosilong, Keolebogile, Malope, Retang K, Mogae, T, Mashaba, Hasane P, Kwange, Boniswa N, Kwange, Mamokgolwane L, Maraga, C, Feikie, M. 2023. *Towards a dedicated transport safety research facility for South Africa.* 41st Southern African Transport Conference, CSIR International Convention Centre (CSIR ICC), Pretoria, South Africa, 10 - 13 July 2023, pp 10pp.

Rathogwa, Mashudu, Singano, Afika P. 2023. *Proposed methodology of optimizing the secondary public transport network of a city in demand.* 41st Southern African Transport Conference, CSIR International Convention Centre (CSIR ICC), Pretoria, South Africa, 10 - 13 July 2023, pp 10pp.

Mbiada, AK, Isong, B, Lugayizi, F, Abu-Mahfouz, Adnan MI. 2023. *Towards integrated framework for efficient educational software development.* IEEE/ACIS 21st International Conference on Software Engineering Research, Management and Applications (SERA), Orlando, FL, USA, 23-25 May 2023, pp 8pp.

Afachao, K, Abu-Mahfouz, Adnan MI. 2023. *An examination of virtualization technologies for enabling intelligent edge computing.* International Conference on Sustainable Computing and Smart Systems, Coimbatore, India, 14-16 June 2023, pp 6pp.

Mahwai, Nare J, Phiri, Charles, Dlamini, Sifiso B, Herselman, Martha E, Meyer, Isabella A. 2023. *A scoping review for proposing an eParticipation framework for South African local municipalities.* IST-Africa Conference (IST-Africa), Tshwane, South Africa, 31 May - 2 June 2023, pp 8pp.

Maarsingh, B, Grobbelaar, Sarah S, Herselman, Martha, E. 2023. *Functional dynamics of innovation for inclusive development projects: Event history analysis of the stock visibility system (SVS) in South Africa.* 2023 Portland International Conference on Management of Engineering and Technology (PICMET), Monterrey, Mexico, 18 August 2023, pp 11pp.

Badenhorst, Danielle P. 2023. *Navigating the intersection of innovation and cybersecurity: A framework.* 22nd European Conference on Research Methodology for Business and Management Studies, Lisboa, Portugal, 6 September 2023, pp 8pp.

Rathogwa, Mashudu, Malope, Retang K. 2023. *Using systems dynamics to support a city's growth and development strategy (GDS): A city of Johannesburg case study.* 41st Southern African Transport Conference, CSIR International Convention Centre (CSIR ICC), Pretoria, South Africa, 10 - 13 July 2023, pp 12pp.

Rathogwa, Mashudu. 2023. *The improvement of the operational efficiencies in the minibus taxis industry: A work in progress system dynamics approach.* System Dynamics Society Conference, Chicago & Online, 23 – 27 July 2023, pp 10pp.

Plantinga, P, Dlamini, N, Pienaar, G, Nkosi, M, Dvids, YD, Okem, A, Dlamini, Sifiso B. 2023. *The Governance of eParticipation: Towards a Rights-based approach.* IST-Africa Conference (IST-Africa), Tshwane, South Africa, 31 May - 02 June 2023, pp 16pp.

Botha-Badenhorst, Danielle P, Veerasamy, Namosha. 2023. *Examining barriers to entry: Disparate gender representation in cybersecurity within Sub-Saharan Africa.* Proceedings of the 6th International Conference on Gender Research Conference, Ulster University Magee Campus Londonderry, Northern Ireland, 20 -21 April 2023, pp 47-55.

Moodley, Jayandren, Meiring, Gys AM, Mtetwa, Njabulo S, Motuba, Obakeng M, Mphephu, Mutali, Maluleke, Mikateko SG, Balmahoon, Reevana. 2023. *Beyond reality: An application of extended reality and blockchain in the metaverse.* 2023 IEEE International Conference on Omni-layer Intelligent Systems (COINS), Berlin, Germany, 23-25 July 2023, pp 4pp.<10.1109/COINS57856.2023.10189285DOI: 10.1109/COINS57856.2023.10189285https://ieeexplore.ieee.org/document/10189285/https://www.computer.org/csdl/proceedings-article/coins/2023/10189285/1P7EsusLUU8>

Mtsweni, Jabu S, Ndlovu, Lungisani, Mthethwa, Sthembile N, Mkuzangwe, Nenekazi NP. 2023. *Measuring misinformation trends on social media in South Africa using Machine Learning.* International Conference on Artificial Intelligence and its Applications (icARTi 2023), Preskil Island Resort Mauritius, Mahebourg, Mauritius, 9-10 November 2023, pp 7pp.

Thaba, James M, Mtsweni, Jabu S. 2023. *Defining cyber warfare capability attributes and characteristics for African Cyber Missions.* 28th International Command and Control Research and Technology Symposium (ICCRTS), Laurel, Maryland, 28-30 November 2023, pp 7pp.

Afachao, K, Abu-Mahfouz, Adnan MI. 2023. *Running virtual services for the intelligent edge: A review.* IEEE World AI IoT Congress (AIIoT), Seattle, WA, USA, 7-10 June 2023, pp 6pp.

Mtsweni, Jabu S. 2023. *The state of data breaches in the African cyberspace: A trend analysis using social media and research literature.* EAI AFRICOMM 2023, Bobo-Dioulasso, Burkina Faso, 23-25 November 2023, pp 16pp.

Veerasamy, Namosha, Mkhwanazi, Dephney T, Dawood, Zubeida C. 2023. *Digital innovation through cybersecurity learning factories.* 24th European Conference on Knowledge Management, Lisboa, Portugal, 7-8 Sptember 2023, 24(2), pp 9pp.

Thungatha, Lamla, Nyembe, Nobuhle C, Mahlase, Andrew CK, Ngcebesha, Pholisa, Ncwane, Simphiwe E. 2023. *Evaluating the enhancing potential of metal hydride in high explosives using a simulation approach.* South African Ballistics Organisation Symposium 2023, International Convention Centre, Pretoria, South Africa, 11 May 2023, pp 12pp.

Roach, Philip, Pelser, Winnie C. 2023. *Investigation into a surrogate test system for kinetic energy less lethal projectile validation.* South African Ballistics Organisation Symposium 2023, International Convention Centre, Pretoria, South Africa, 9-11 May 2023, pp 95-110.

Pienaar, PA, Mokonyama, Mathetha T, Das, DK, Pienaar, WJ, Stander, HJ, Van As, SC, Robinson, A. 2023. *Guidelines for the provision of bypass roads at and through-ways in cities and towns.* Southern African Transport Conference, ICC, CSIR, Pretoria, 10-13 July 2023, pp 15pp.

Ditshego, JK, Mokonyama, Mathetha T. 2023. *The integration of smart mobility systems on the revised taxi recapitalisation program as a strategy to modernise the taxi industry.* Southern African Transport Conference, ICC, CSIR, Pretoria, 10-13 July 2023, pp 12pp.

Pandelani, Thanyani A, Modungwa, Dithoto M, Reinecke, John D. 2023. *Characterisation of home-made explosives such as ANFO and NM against a military grade explosive, PE4, in open air environment.* Proceedings of the South African Ballistics Organisation Symposium 2023, CSIR ICC, Pretoria, RSA, 9-11 May 2023, pp 44-47.

Gupta, A, Onumanyi, Adeiza J, Ahlawat, S, Prasad, Y, Singh, V. 2023. *TSPD: A robust online time series two-stage peak detection algorithm.* 2023 IEEE International Conference on Service-Oriented System Engineering (SOSE), Athens, Greece, 17-20 July 2023, pp 7pp.

Van Reenen, Coralie A, Manley, D. 2023. *Classroom acoustics: Mainstreaming and application of standards.* Proceedings of Meeting on Acoustics, Chicago, Illinois, 8-12 May 2023, 51(1), pp 9pp.

Thothela, NT, Markus, E, Masinde, M, Abu-Mahfouz, Adnan MI. 2023. *A framework for an intelligent agro-climate decision support system for small-scale farmers in Swayimane.* 2023 3rd International Conference on Electrical, Computer, Communications and Mechatronics Engineering (ICECCME), Canary Islands, Spain, 19-21 July 2023, pp 7pp.

Pienaar, M, Durrheim, RJ, Manzi, MSD, Nwaila, GT, Grobler, HCI, Kgarume, Thabang E, Pretorius, Dean D, Van Schoor, Abraham M, Oberholster, AJ. 2023. *Mitigating the rock fall and rockburst risk in South African gold and platinum mines through advanced knowledge of the ore body.* 15th International ISRM Congress & 72nd Geomechanics Colloquium, Salzburg, Austria, 9-14 October 2023, pp 900-905.

Auret, Marius, Erasmus, Louwrence D. 2023. *A novel enterprise engineering method to make architecture practical.* International Conference on Industrial Engineering, Systems Engineering and Engineering Management (ISEM 2023), Lord Charles Hotel, Somerset West, South Africa, 2 - 5 Oct 2023, pp 19pp.

Marais, Laurette, Wilken, Ilana, Pretorius, L, Posthumus, L. 2023. *Multimodal, multilingual dynamic stories for literacy development and language learning.* Proceedings of the 5th International Conference on Conversational User Interfaces, Eindhoven, The Netherlands, 19-21 July 2023, pp 5pp.

Veerasamy, Namosha, Mkhwanazi, Dephney T, Dawood, Zubeida C. 2023. *Towards the usefulness of learning factories in the cybersecurity domain.* 18th International Conference on Cyber Warfare and Security 2023 (ICCWS), Maryland, USA, 9-10 March 2023, pp 8pp.

Marais, Laurette, Pretorius, L. 2023. *Extending the usage of adjectives in the Zulu AfWN.* Global Wordnet Conference, Donostia, Spain, 23-27 January 2023, pp 12pp.

Mtsweni, Jabu S. 2023. *Using open-source intelligence and machine learning to analyze cyberattack trends in the African cyberspace.* 16th International Conference on Information Society (i-Society 2023), Dún Laoghaire, Ireland, 24-26 October 2023, pp 10pp.

Louw, Johannes A. 2023. *Cross-lingual transfer using phonological features for resource-scarce text-to-speech.* 12th ISCA Speech Synthesis Workshop, Grenoble, France, 26-28 August 2023, pp 7pp.

Pandarum, Aradhna, Rakaibe, Tshwanelo K, Mbam, Vuyo. 2023. *Battery energy storage systems value chain analysis for the identification of opportunities for enterprise development.* 11th CIGRE Southern Africa Regional Conference, CSIR International Convention Centre, Pretoria, South Africa, 24 - 27 October 2023, pp 13pp.

Koloane, SD, Molapo, Makhabane L. 2023. *FMEA/FMECA application for the safer industry - systematic literature review.* ISEM 2023 Conference, Cape Town, Lord Charles Hotel, 2 - 4 October 2023, pp 31pp.

Sikhakhane, K, Rimer, S, Gololo, M, Ouahada, K, Abu-Mahfouz, Adnan MI. 2023. *Hybrid speckle de-noising filters for ultrasound images.* 2023 IEEE AFRICON, Nairobi, Kenya, 20-22 September 2023, pp 6pp.

Nzengue, AGB, Mpofu, K, Mathe, Ntombizodwa R, Daniyan, I, Muvunzi, R. 2023. *An experimental investigation of selective laser process parameters on aluminium alloy (AlSi12).* Procedia CIRP, 118, pp 638-642.

Maodzeka, DK, Mosalagae, M, Hagedorn-Hansen, D, Pityana, Sisa L, Olakanmi, EO. 2023. *Response surface methodology for modelling tribological behaviour of maraging steel 300 parts manufactured by laser powder bed fusion.* Proceedings of the 3rd International Conference on Engineering Facilities Maintenance and Management Technologies (EFM2T'21), June 2023, 2581(1), pp 9pp.

Sebetoa, Matlapane R, Nwanebu, Docas, Malinga, Andries L, Venter, Jacobus P. 2023. *Tactical datalink: Enabling effective coordination between forward air controllers and close air support.* 9th Military Information and Communication Symposium of South Africa, CSIR ICC, South Africa, 20 - 25 August 2023, pp 6pp.

Ebrahim, Rozeena, Vilakazi, Mlamuli C, Burger, Chris R, Lysko, Albert A. 2023. *Power consumption measurement tool for research on open 5G and beyond.* 2023 IEEE AFRICON, Kenya, 20-22 September 2023, pp 5pp.

Chauke, Mapoo D, Gama, G, Sebetoa, Matlapane R, Marimuthu, Luveshan, Mavhona, Tshifhiwa. 2023. *IoT-enabled supply chain management and logistics.* South African Transport Conference (SATC), ICC, Pretoria, South Africa, 10-13 July 2023, pp 11p.

Verster, Jacobus J, Roux, Pieter W, Magweregwede, Fleckson, De Ronde, Willis, Crafford, Gerrie, Mashaba, Mathews M, Turundu, Safiya L, Mpofu, Mvikel, Prinsloo, Jacobus V, Ferreira, Pieta, Brodner, Hartmut D. 2023. *A digital twin framework to support vehicle interaction risk management in the mining industry.* RAPDASA-RobMech-PRASA-AMI Conference, CSIR International Convention Centre, Pretoria, South Africa, 30 October – 2 November 2023, pp 24pp.

Mukhuba, Gumani, Machabe, Sheldon, Ndlovu, Hlamulo P. 2023. *The digital transformation gap between Universities and Industry.* 9th UNESCO Africa Engineering Week (AEW) and the 7th Africa Engineering Conference, CSIR, ICC, Pretoria, 25 - 28 September 2023, pp 8pp.

Mamushiane, Lusani, Lysko, Albert A, Makhosa, Thoriso M, Mwangama, J, Kobo, Hlabishi I, Mbanga, Alec, Tshimange, Rofhiwa. 2023. *Towards stress testing Open5GS core (UPF Node) on a 5G standalone testbed.* 2023 IEEE AFRICON, Kenya, 20-22 September 2023, pp 7pp.

Mthethwa, Nosipho B, Sebopetse, Nakampe, Vilakazi, Mlamuli C, Mfupe, Luzango P, Mofolo, Raarone OM, Mekuria, F. 2023. *Sustainable Internet4All in South African rural and township communities.* IEEE Africon, Nairobi, Kenya, 20 - 22 September 2023, pp 6pp.

Masonta, Moshe T, Rananga, S. 2023. *Quality of service aware channel allocation for white spaces radio networks.* Southern Africa Telecommunication Networks and Applications Conference (SATNAC), Champagne Sports Resort, Central Drakensberg, KwaZulu-Natal, South Africa, 27 - 29 August 2023, pp 7pp.

Mthethwa, Sthembile N, Singano, ZothileT, Ndlovu, Lungisani, Khutlang, Rethabile, Shadung, Lesiba D, Ngebeni, Bongani W. 2023. *Decentralised digital identity and verifiable credential tracking and management system.* 3rd International Conference on Electrical, Computer and Energy Technologies (ICECET 2023), Cape Town, South Africa, 16-17 November 2023, pp 6pp.

Mvelase, Gculisile M, Rampersad, Ashiel, Mokoena, Refiloe, Mgangira, Martin B, Komba, J, Reynolds-Clausen, K. 2023. *Determining best performing unclassified pond ash and soil mixtures for the construction of embankments and lower pavement layers in road construction.* 13th Conference on Asphalt Pavements for Southern Africa (CAPSA), Champagne Sports Resort, Drakensberg, South Africa, 15-18 October 2023, pp 26pp.

Vermaak, F, Erasmus, Louwrence D. 2023. *A systems engineering and management approach to establishing a fleet management system in an underground UG2board and pillar platinum mine in South Africa.* Proceedings of the International Conference on Industrial Engineering, Systems Engineering and Engineering management (ISEM), Lord Charles Hotel, Somerset West, South Africa, 2-4 October 2023, pp 181-198.

Singano, Zothile T, Nelufule, Nthatheni, Nkwe, Boitumelo CA, Masemola, Kelebogile B, Shadung, Lesiba D, Ngubane, Zamokuhle, Thwala, Ntombizodwa, Mokoena, Chantel JM. 2023. *Digital forensics investigations: Major challenges in mobile and cloud forensics.* EAI AFRICOMM 2023 - 15th EAI International Conference on Africa Internet infrastructure and Services, Burkina Faso, 23-25 November 2023, pp 19pp.

Ebrahim, Rozeena, Luvhengo, Fhatuwani, Vilakazi, Mlamuli C, Mamushiane, Lusani, Lysko, Albert A. 2023. *Software tools for power consumption monitoring of open 5G and beyond research: A review.* IEEE Africon, Nairobi, Kenya, 20 - 22 September 2023, pp 6pp.

Simiyu, Donah S, Rakaibe, Tshwanelo K, Pandarum, Aradhna. 2023. *Contribution of refurbishment of solar panels to energy security in South Africa.* 11th CIGRE Southern Africa Regional Conference, Pretoria, South Africa, 24 - 27 October 2023, pp 12pp.

Madiba, L, Erasmus, Louwrence D. 2023. *Management of basic service delivery tracking and reporting system in the south african local government.* Proceedings of the International Conference on Industrial Engineering, Systems Engineering and Engineering management (ISEM), Lord Charles Hotel, Somerset West, South Africa, 2-4 October 2023, pp 17pp.

Heera, J, Erasmus, Louwrence D, Pretorius, HC. 2023. *The human competencies (soft skills) required to be an effective project manager and ensure project success. A case study in South Africa.* Proceedings of the International Conference on Industrial Engineering, Systems Engineering and Engineering management (ISEM), Lord Charles Hotel, Somerset West, South Africa, 2-4 October 2023, pp 17pp.

Komane, Rebone, Du Plessis, DJ, Van Heerden, Q. 2023. *Social facility planning: Comparing accessibility in Tshwane based on different transport networks.* 41st Southern African Transport Conference, Pretoria, South Africa, 10-13 July 2023, pp 13pp.

Rampersad, Ashiel, Mvelase, Gculisile M, Simelane, Melusi S, Harrilall, Kaveer. 2023. *Variations in pavement performance assessments using the visual condition index and deduct point methods for maintenance prioritization.* 13th Conference on Asphalt Pavements for southern Africa (CAPSA), Champagne Sports Resort, Drakensberg, South Africa, 15-18 October 2023, pp 17pp.

Venter, Jacobus P. 2023. *Risk and scenario based communication system-of-systems design.* 9th Military Information and Communication Symposium of South Africa, (MICSSA 2023), CSIR ICC, South Africa, 20-25 August 2023, pp 3pp.

Modiba, Rosinah, Ledwaba, R, Mtintsilana, O. 2023. *Supporting South African women in physics during the COVID-19 pandemic: A multi-modal outreach approach to address gender, race, and scarcity.* Women in Physics: 7th IUPAP International Conference on Women in Physics, 2023 AIP Conference Proceedings, Volume 3040, 3040(1), pp 3pp.

Panther, F, Gledhill, I, Jin, K, Nnekka Okeke, FN, Biira, S, Bossard, N, Da Costa Ludwig, ZM, Deng, M, Fang, Z, Modiba, Rosinah. 2023. *Women in physics in developing countries.* Women in Physics: 7th IUPAP International Conference on Women in Physics. AIP Conference Proceedings, Volume 3040, pp 6pp.

Mokoatle, Mpho, Coleman, Toshka, Mokilane, Paul M. 2023. *A comparative study of over-sampling techniques as applied to seismic events.* The Southern African Conference on AI Research (SACAIR 2023), Muldersdrift, Gauteng, 4-8 December 2023, pp 15pp.

Nelufule, Nthatheni N, Lefophane, Samuel, Holder, Ross P, Moabalobelo, Phindile T, Mulihase, Nkgomeleng D, De Kock, Antonie J, Ndlovu, Lungisani, Pantsi, Phumeza N. 2023. *Enhancing biosecurity and combating livestock theft through cybersecurity technologies.* THREAT2023: Cyberfuture, a unique and forward-looking cybersecurity conference, Stellenbosch, 19-24 November 2023, pp 7pp.

Nelufule, Nthatheni, N, Nkwe, Boitumelo C, Shadung, Lesiba D, Masemola, Kelebogile B, Singano, Zothile T, Mokoena, Chantel J, Ngubane, Zamokuhle, Thwala, Ntombizodwa. 2023. *Intersection of electronic security and digital forensics: Data protecting techniques and uncovering data clues.* 15th EAI International Conference on Africa Internet infrastructure and Services(EAI AFRICOMM 2023), Bobo-Dioulasso, Burkina Faso, November 23-25, 2023, pp 18pp.

Vilakazi, Mlamuli C, Olwal, TO, Mfupe, Luzango P, Lysko, Albert A. 2023. *OpenAir interface for 4G core network and 4G/5G base stations.* International Conference on Electrical, Computer and Energy Technologies (ICECET 2023), Cape Town, South Africa, 16-17 November 2023, pp 7pp.

Ntshangase, Cynthia S, Baruni, Kedimotse P, Mahlasela, Oyena N, Matimatjatji, Rethabile M, Mgaga, Sboniso S. 2023. *Secure authentication using zero knowledge proof and biometrics: A review.* THREAT2023: Cyberfuture, a unique and forward-looking cybersecurity conference, Stellenbosch, 19-24 November 2023, pp 7pp.

Pandarum, Aradhna, Mbam, Vuyo. 2023. *Creating a JUST energy transition for embedded generation via customer empowerment in South Africa.* CIGRE International Symposium, Cairns, Australia, 4-7 September 2023, pp 15pp.

Pandarum, Aradhna. 2023. *The development of green hydrogen in South Africa.* 11th CIGRE Southern Africa Regional Conference, Pretoria, South Africa, 24-27 October 2023, pp 11pp.

Mahlasela, Oyena N, Steyn, AA. 2023. *Benefits of adopting microcredentials for skills development.* The 9th African Conference on Information Systems and Technology 2023, Zimbabwe (Virtual), 15-16 September 2023, pp 11pp.

O'Connell, Johannes S, Maina, J, Bredenhann, SJ, Marais, H, Komba, J. 2023. *Evaluating the efficacy of laboratory ageing of asphalt mix binders as a prediction for field ageing.* 13th Conference on Asphalt Pavements for southern Africa (CAPSA), Champagne Sports Resort, Drakensberg, South Africa, 15-18 October 2023, pp 16pp.

Tsebesebe, Nkgaphe T, Mpofu, Kelvin T, Ndlovu, Sphumelele C, Sivarasu, S, Mthunzi-Kufa, Patience. 2023. *Application of Machine Learning Algorithms to Tuberculosis Detection.* 9th Military Information and Communications Symposium of South Africa (MICSSA 2023), CSIR-ICC, Pretoria, South Africa, 21 - 25 August 2023, pp 23-28.

O'Connell, Johannes S, Maina, J, Bredenhann, SJ, Marais, H, Komba, J. 2023. *Relating the rheology of recovered binders from asphalt surfacing in the field to their fatigue performance.* 13th Conference on Asphalt Pavements for Southern Africa (CAPSA), Champagne Sports Resort Drakensberg, 15-18 October 2023, pp 9pp.

Mahlasela, Oyena N, Steyn, AA. 2023. *Challenges of adopting micro-credentials for skills development in South Africa: A literature review.* 4th International Conference on Teaching, Assessment and Learning in the Digital Age (digiTal2K), Cape Town, South Africa, 6-7 December 2023, pp 14-23.

Mpofu, Kelvin T, Mthunzi-Kufa, Patience. 2023. *Application of quantum computers to the simulation of phase-based quantum biosensing experiments.* 9th Military Information and Communications Symposium of South Africa (MICSSA 2023), CSIR-ICC, Pretoria, South Africa, 21-25 August 2023, pp 29-36.

Tyukala, Mkhululi, Mudau, Tshimangadzo C, Ndlovu, Lungisani, Ngejane, Hombakazi C, Singano, Zothile T. 2023. *Cloud computing in developing nations: Beyond cybersecurity to national security implications.* Threat 2023, Cape Town, South Africa, 20-21 Nov 2023, pp 6pp.

Makondo, Ntshuxeko, Kobo, Hlabishi I, Mathonsi, TE, Mamushiane, Lusani. 2023. *A review on edge computing in 5G-enabled IoT for agricultural applications: Opportunities and challenges.* 3rd International Conference on Electrical, Computer and Energy Technologies (ICECET 2023), Cape Town, South Africa, 16-17 November 2023, pp 6pp.

Komba, J, Rampersad, Ashiel, O'Connell, Johannes S, Verhaeghe, Benoit MJ, Horak, E. 2023. *A decade of monitoring the performance of Enrobé à Module Élevé (EME) trial section on South Coast Road in eThekwini.* 13th Conference on Asphalt Pavements for Southern Africa (CAPSA), Drakensberg, 15-18 October 2023, pp 22pp.

Kgaphola, Motsoko J, Mbhem, Siyabulela, Joubert, Petro, Cloete, William E, Hamilton, Silumko L, Mantsi, Andile M. 2023. *An Automated End-To-End workflow of 3D model construction and Printing using Pleiades Stereo Satellite Imagery (50cm)*.* 9th Military Information and Communications Symposium of South Africa (MICSSA 2023), CSIR-ICC, Pretoria, South Africa, 21 - 25 August 2023, pp 83-91.

Bhebhe, M, Grobbelaar, S, Herselman, Martha E. 2023. *Scoping review on lead user engagement methods in the development of telemedicine products.* ICISS '23: Proceedings of the 6th International Conference on Information Science and Systems, Edinburgh, UK, 11-13 August 2023, pp 273-280.

Singano, Zothile T, Ngejane, Hombakazi C, Mudau, Tshimangadzo C, Ndlovu, Lungisani, Tyukala, Mkhululi. 2023. *ML-based security analytics in South African SMEs: A review and classification.* 3rd International Conference on Electrical, Computer and Energy Technologies (ICECET 2023), Cape Town, South Africa, 16-17 November 2023, pp 6pp.

Mudau, Tshimangadzo C, Tyukala, Mkhululi, Meyer, Heloise. 2023. *Mobile Application Security Assessement Platform (mSAP).* THREAT2023: Cyberfuture, a unique and forward-looking cybersecurity conference, Stellenbosch, 19-24 November 2023, pp 9pp.

Mtsweni, Jabu S, Maduma, Mary P, Nefale, Vhuthu, Ramantswana, Thanyani A, Masango, Mfundo G, Mutemwa, Muyowa. 2023. *Emerging phishing attack trends: A South African case study.* EAI AFRICOMM 2023, Burkina Faso, 23 - 25 November 2023, pp 16pp.

Makondo, Ntshuxeko, Kobo, Hlabishi I, Mathonsi, TE. 2023. *The latest developments in Software Defined Networking: Adoption rate and challenges.* 2023 IEEE AFRICON, Kenya, Nairobi, 20-23 September 2023, pp 6pp.

Guterres, B, Sbrissa, K, Mendes, A, Meireles, L, Novoveska, L, Vermeulen, F, Martinez, J, Garcia, A, Lain, Elisabeth J, Smith, Marie E. 2023. *HAB detection within aquaculture industry: A case study in the Atlantic Area.* IEEE International Conference on Industrial Informatics (INDIN) 2023, Lemgo, 17-20 July 2023, pp 6pp.

Manuel, M, Van Schoor, Abraham M, Filho, JA, Harrison, S. 2023. *Application of electrical resistivity tomography as a physicochemical tool for tailings valorisation and remediation strategies.* Proceedings of the Geometallurgy Conference 2023 (Geomet Meets Big Data), Hazendal Wine Estate, Stellenbosch, 4-7 September 2023, pp 149-161.

Raposo, S, Bredenhann, SJ, Rowe, GM, O'Connell, Johannes O. 2023. *Review of South African high-temperature performance grade (PG) definition.* 13th Conference on Asphalt Pavements for southern Africa, Champagn Sport Resort, South Africa, 15-18 October 2023, pp 14pp.

Bernabe, C, Keet, M, Dawood, Zubeida C, Rosinach, NQ. 2023. *A method to improve alignments between domain and foundational ontologies.* Proceedings of the 13th International Conference on Formal Ontology in Information Systems (FOIS 2023), Sherbrooke, Canada, 18-20 July 2023, pp 15pp.

Wilken, Ilana, Marais, Laurette. 2023. *Bringing children's dictionaries to digital life.* 4th Conference of the Digital Humanities Association of Southern Africa (DHASA) Conference, Port Elizabeth, South Africa, 27 November - 1 December 2023, 5(1), pp 7pp.

Mgaga, Sboniso S, Khanyile, Nontokozo M, Thwala, Ntombizodwa, Baruni, Kedimotse P, Mokoena, Nthabiseng ME, Ntshangase, Cynthia S. 2023. *Ridge structure enhancement for optical coherence tomography latent fingerprint images.* 17th International Conference on Signal Image Technology & Internet based Systems, The Berkeley Hotel Pratunam, Bangkok, Thailand, 8-10 November 2023, pp 7pp.

Van Eden, Beatrice, Botha, Natasha. 2023. *Simulating object handover between collaborative robots.* RAPDASA-RobMech-PRASA-AMI Conference, CSIR International Convention Centre, Pretoria, South Africa, 30 October – 2 November 2023, pp 17pp.

Botha, Natasha, Van Eden, Beatrice, Lehman, Lodewyk, Verster, Jacobus J. 2023. *Prototype design of an aerial robotic platform for indoor applications.* RAPDASA-RobMech-PRASA-AMI Conference, CSIR International Convention Centre, Pretoria, South Africa, 30 October – 2 November 2023, pp 15pp.

Mkhwanazi, Dephney T, Shibambu, Ncedisa AM, Nefale, Vhuthu, Mtsweni, Jabu S, Phahlamohlaka, Letlibe J, Mutemwa, Muyowa, Nelufule, Norman. 2023. *Potential cyber threats to the national elections in the digital age in Africa.* 15th EAI International Conference on Africa Internet Infrastructure and Services, EAI AFRICOMM 2023, Burkina Faso, Bobo-Dioulasso, 23 -25th November 2023, pp 20pp.

Govender, Avashna, King, S. 2023. *Cognitive load of modern TTS systems under noisy conditions.* Cognitive AI 2023, Bari, Italy, 13-15 November 2023, pp 6pp.

Mashigo, K, Erasmus, Louwrence D, Ayomoh, MK. 2023. *Research proposal for the development of an integrated solution for wheel misalignment detection in the road transport industry in South Africa.* Proceedings of the International Conference on Industrial Engineering, Systems Engineering and Engineering Management (ISEM), Lord Charles Hotel, Somerset West, South Africa, 2-4 October 2023, pp 1348-1357.

Young, Gertruida M. 2023. *Following a Systems Engineering approach to establish a canine system for force multiplication.* Proceedings of the International Conference on Industrial Engineering, Systems Engineering and Engineering management (ISEM), Lord Charles Hotel, Somerset West, South Africa, 2-4 October 2023, pp 263-276.

Setati, Tiro, Maweni, Thabisa, Botha, Natasha. 2023. *Reliability of visual inertial odometry on an unmanned aerial vehicle.* RAPDASA-RobMech-PRASA-AMI Conference, CSIR International Convention Centre, Pretoria, South Africa, 30 October – 2 November 2023, pp 8pp.

Van Eden, Beatrice, Botha, Natasha, Rosman, B. 2023. *A comparison of visual place recognition methods using a mobile robot in an indoor environment.* RAPDASA-RobMech-PRASA-AMI Conference, CSIR International Convention Centre, Pretoria, South Africa, 30 October – 2 November 2023, pp 18pp.

Mabeba, K, Sithole, E, Modiba, Rosinah. 2023. *The study of the properties of Titanium alloys for biomedical applications employing the first-principles approach.* The 67th Annual Conference of the South African Institute of Physics (SAIP), University of Zululand, Richards Bay campus, South Africa, 3-7 July 2023, pp 5pp.

Van Reenen, Coralie A. 2023. *Classroom acoustics: A case study of the cost-benefit of retrofitted interventions.* 185th Meeting of the Acoustical Society of America, Sydney, Australia, 4-8 December 2023, pp 12pp.

Mathews, T, Sithole, E, Modiba, Rosinah. 2023. *The study of Zr and Nb alloyed on the beta Ti for bio medical applications first principle approach.* The 67th Annual Conference of the South African Institute of Physics (SAIP), University of Zululand, South Africa, 3–7 July 2023, pp 5pp.

De Ronde, Willis, Bosscha, Peter A, Marais, Stephen T, Pretorius, A. 2023. *ARGUS: A pole climbing surveillance robot.* RAPDASA-RobMech-PRASA-AMI Conference, CSIR International Convention Centre, Pretoria, South Africa, 30 October – 2 November 2023, pp 17pp.

De Ronde, Willis, Crafford, G, Roux, Pieter W, Wenhold, Derryn L. 2023. *Streamlining factory simulations with an intuitive factory layout tool.* RAPDASA-RobMech-PRASA-AMI Conference, CSIR International Convention Centre, Pretoria, South Africa, 30 October – 2 November 2023, pp 10pp.

Ntshangase, Cynthia S, Lefophane, Samuel, Singano, Zothile T, Shadung, Lesiba D, Mokoena, Nthabiseng ME, Mthethwa, Sthembile. 2023. *Digital identity frameworks: A review.* EAI AFRICOMM 2023 - 15th EAI International Conference on Africa Internet infrastructure and Services, Bobo-Dioulasso, Burkina Faso, 23-25 November 2023, pp 15pp.

Amssaya, H, Mekuria, F, Modungwa, Dithoto M. 2023. *A monitoring and rescuing system using Next Generation Mobile, Internet of Things and Artificial Intelligence for freshwater lakes in Africa.* 2023 IEEE AFRICON, Kenya, Nairobi, 20-22 September 2023, pp 6pp.

Mathews, T, Sithole, E, Modiba, Rosinah, Madigoe, Mandy N. 2023. *Study of shape memory properties of Ti(50)Ni(50-x) Mx (M= Nb, Mo and Fe) alloys for biomedical applications using first principle approach.* RAPDASA-RobMech-PRASA-AMI Conference, CSIR International Convention Centre, Pretoria, South Africa, 30 October – 2 November 2023, pp 7pp.

Afachao, K, Abu-Mahfouz, Adnan MI, Hancke, GP. 2023. *Comparative analysis of nature-inspired algorithms for energy efficiency and load-balancing in the edge-cloud environment.* Southern Africa Telecommunication Networks and Applications Conference (SATNAC), Champagne Sports Resort, Central Drakensberg, KwaZulu-Natal, South Africa, 27 - 29 August 2023, pp 6pp.

Dibakwana, PM, Tshwane, David M, Sithole, ME, Modiba, R. 2023. *Surface properties of Al2O3 and Fe2O3 (100) surfaces using First-Principle method.* The 67th Annual Conference of the South African Institute of Physics (SAIP), University of Zululand, Richards Bay campus, South Africa, 3-7 July 2023, pp 595 - 600.

Madigoe, Mandy N, Modiba, Rosinah. 2023. *Microstructural characterization of low elastic modulus ß-Ti alloy fabricated by arc melting process.* The 67th Annual Conference of the South African Institute of Physics (SAIP), University of Zululand, Richards Bay campus, South Africa, 3-7 July 2023, pp 202-207.

Kunene, Dumisani C, Zandamela, Frank, Mabuza-Hocquet, Gugulethu P, Ratshidaho, Terence. 2023. *Automated uniform recognition to enhance video surveillance at correctional services in South Africa.* RAPDASA-RobMech-PRASA-AMI Conference, CSIR International Convention Centre, Pretoria, South Africa, 30 October – 2 November 2023, pp 22pp.

Kufakunesu, R, Hancke, GP, Abu-Mahfouz, Adnan MI. 2023. *Evaluating the impact of the Adaptive Data Rate Algorithm in LoRaWAN.* Southern Africa Telecommunication Networks and Applications Conference (SATNAC), Champagne Sports Resort, Central Drakensberg, KwaZulu-Natal, South Africa, 27 - 29 August 2023, pp 5pp.

Monareng, K, Maphanga, Rapela R, Ntoahae, P. 2023. *Machine learning models for predicting density of sodium-ion battery materials.* RAPDASA-RobMech-PRASA-AMI Conference, CSIR International Convention Centre, Pretoria, South Africa, 30 October – 2 November 2023, pp 8pp.

Nelufule, Nthatheni, Singano, Zothile T, Shadung, Lesiba D, Masemola, Kelebogile B. 2023. *Privacy-preservation and containment in IoT forensics investigations: A comparative study.* International Japan - Africa Conference on Electronics, Communications & Computation (JAC-ECC 2023), Egypt-Japan University of Science and Technology (E-JUST), and Egypt University of Informatics (EUI), 18-20 December 2023, pp 4pp.

Mathoho, Ipfi, Arthur, Nana KK, Tlotleng, Monnamme. 2023. *Modification of H950 condition for 17-4 PH stainless steel processed by DED.* TMS 2023 152nd Annual Meeting & Exhibition Supplemental Proceedings, February 2023, pp 165–176.

Dickens, John S, Maweni, Thabisa, Setati, Tiro, Suddoo, Zubair. 2023. *Design of HERMES: a mobile autonomous surveillance robot for security patrol.* RAPDASA-RobMech-PRASA-AMI Conference, CSIR International Convention Centre, Pretoria, South Africa, 30 October – 2 November 2023, pp 13pp.

Mamushiane, Lusani, Lysko, Albert A, Kobo, Hlabishi I, Mwangama, J. 2023. *Deploying a stable 5G SA testbed using srsRAN and Open5GS: UE integration and troubleshooting towards network slicing.* 2023 International Conference on Artificial Intelligence, Big Data, Computing and Data Communication Systems (icABCD), Durban, South Africa, 3-4 August 2023, pp 11pp.

Mamushiane, Lusani, Lysko, Albert A, Mwangama, J, Kobo, Hlabishi I, Otieno, HO. 2023. *Experience in profiling and optimizing a 5G standAlone Radio Access Network (RAN) based on an open source testbed.* Southern Africa Telecommunication Networks and Applications Conference (SATNAC), Champagne Sports Resort, Central Drakensberg, KwaZulu-Natal, South Africa, 27 - 29 August 2023, pp 81-88.

Kgomo, Matshela TH, Masina, Bathusile N, Lekoadi, Paul M, Mathoho, Ipfi, Pesha, Thabo, Sibisi, T, Mulaudzi, Vusimusi. 2023. *Investigation of the corrosion behaviour of TiC/Ti6Al4V manufactured through laser additive manufacturing.* RAPDASA-RobMech-PRASA-AMI Conference, CSIR International Convention Centre, Pretoria, South Africa, 30 October – 2 November 2023, 388, pp 18pp.

Mnynadu, W, Terzoli, A, Kobo, Hlabishi I. 2023. *A blueprint for South African public schools ICT infrastructure.* EAI AFRICOMM 2023 - 15th EAI International Conference on Africa Internet infrastructure and Services, Bobo-Dioulasso, Burkina Faso, 23-25 November 2023, pp 15pp.

Marengwa, Matshidiso S. 2023. *Data cleaning using OpenRefine: A case of blast incidents and explosives research data extraction from social media platforms.* Proceedings of the South African Ballistics Organisation 2023 Symposium, CSIR Iternational Convention Centre, Pretoria, South Africa, 9-11 May 2023, pp 111-123.

Maweni, Thabisa, Setati, Tiro, Botha, Natasha. 2023. *Optimised path planning of a UAV for inventory management applications.* RAPDASA-RobMech-PRASA-AMI Conference, CSIR International Convention Centre, Pretoria, South Africa, 30 October – 2 November 2023, pp 10pp.

Wu, Lorinda, Mwania, FW, Van der Walt, JG, Koen, Wayne S. 2023. *An evaluation of the suitability of a new polypropylene powder for powder bed fusion additive manufacturing.* RAPDASA-RobMech-PRASA-AMI Conference, CSIR International Convention Centre, Pretoria, South Africa, 30 October – 2 November 2023, pp 9pp.

Sekhwama, Masindi, Mpofu, Kelvin T, Mthunzi-Kufa, Patience. 2023. *Using 3D printing to fabricate microfluidic chips for biosensing applications.* RAPDASA-RobMech-PRASA-AMI Conference, CSIR International Convention Centre, Pretoria, South Africa, 30 October – 2 November 2023, pp 10pp.

Maphanga, Charles P, Ombinda-Lemboumba, Saturnin, Yaseera Ismail, Y, Mthunzi-Kufa, Patience. 2023. *Photonic crystal-based biosensing for TB detection.* The 67th Annual Conference of the South African Institute of Physics (SAIP), University of KwaZulu-Natal, Durban, South Africa, 3–7 July 2023, pp 317-325.

Maleka, Prettier M, Tshwane, David M, Dima, Ratshilumela S, Mogakalane, L, Ntwaeaborwa, OM, Maphanga, Rapela R. 2023. *A comparative study on Mn-doped CsPbI3 and CsPbBr3 using first principle-based DFT.* Proceedings of the 67th Annual Conference of the South African Institute of Physics (SAIP), University of Zululand, Durban, 3-7 July 2023, pp 149-156.

Ranwaha, TS, Dima, Ratshilumela S, Maluta, NE, Maphanga, Rapela R. 2023. *Density functional theory study of NaxMn0.5Ti0.5O2 as a cathode material.* Proceedings of the 67th Annual Conference of the South African Institute of Physics (SAIP), University of Zululand, Richards Bay, 3-7 July 2023, pp 486-492.

Shandukani, K, Dima, Ratshilumela S, Letsoalo, MR, Ranwaha, TS, Maluta, NE, Maphanga, Rapela R. 2023. *Doping of Co and Ni to ZnO (101) surface using DFT Method: For gas sensing application.* Proceedings of the 67th Annual Conference of the South African Institute of Physics (SAIP), University of Zululand, Richards Bay, 3-7 July 2023, pp 474-479.

Patel, S, Ranwaha, TS, Dima, Ratshilumela S, Maluta, NE, Maphanga, Rapela R. 2023. *First-principle study of sodium de-intercalation from dichalcogenides NaNbSe2.* Proceedings of the 67th Annual Conference of the South African Institute of Physics (SAIP), University of Zululand, Richards Bay, 3-7 July 2023, pp 480-485.

Chauke, V, Tshwane, David M, Ngoepe, P, Chauke, H. 2023. *Probing the stability of nickel titanium (100) and (110) surfaces: A DFT study.* Proceedings of the 67th Annual Conference of the South African Institute of Physics (SAIP), University of Zululand, Richards Bay, 3-7 July 2023, pp 39-44.

Ndlovu, Lungisani, Mkuzangwe, Nenekazi NP, De Kock, Antonie J, Thwala, Ntombizodwa, Mokoena, Chantel JM, Matimatjatji, Rethabile M. 2023. *A situational awareness tool using Open-Source Intelligence (OSINT) and Artificial Intelligence (AI).* The 2023 IEEE International Conference on Advances in Data-Driven Analytics and Intelligent Systems, Marrakech, Morocco, 22-25 November2023, pp 6pp.

Mrwata, K, Siyasiya, C, Arthur, Nana K. 2023. *Microstructural characterization of additively manufactured Ti-6Al-4V with the addition of ß-Stabilizer, niobium.* RAPDASA-RobMech-PRASA-AMI Conference, CSIR International Convention Centre, Pretoria, South Africa, 30 October – 2 November 2023, pp 12pp.

Booysen, TN, Jamiru, T, Adegbola, T, Arthur, Nana KK. 2023. *Microstructural effects on properties of as-fabricated Inconel 625 with direct energy deposition process.* RAPDASA-RobMech-PRASA-AMI Conference, CSIR International Convention Centre, Pretoria, South Africa, 30 October – 2 November 2023, pp 27pp.

Tsebesebe, Nkgaphe T, Mpofu, Kelvin T, Ndlovu, Sphumelele C, Sivarasu, S, Mthunzi-Kufa, Patience. 2023. *Majority voting algorithm for TB detection: Machine learning approach.* The 67th Annual Conference of the South African Institute of Physics (SAIP), University of Zululand, Richards Bay Campus, South Africa, 3-7 July 2023, pp 10.

Mpofu, Kelvin T, Mthunzi-Kufa, Patience. 2023. *Quantum phase-based plasmonic biosensing for enhanced COVID-19 detection.* The 67th Annual Conference of the South African Institute of Physics (SAIP), University of Zululand, Richards Bay campus, South Africa, 3-7 July 2023, pp 288-296.

Tsebesebe, Nkgaphe T, Mpofu, Kelvin T, Ndlovu, Sphumelele C, Sivarasu, S, Mthunzi-Kufa, Patience. 2023. *Detection of SARS-CoV-2 from raman spectroscopy data using machine learning models.* RAPDASA-RobMech-PRASA-AMI Conference, CSIR International Convention Centre, Pretoria, South Africa, 30 October – 2 November 2023, pp 9pp.

Randela, RR, Ranwaha, TS, Mathomu, LM, Maphanga, Rapela R, Maluta, NE. 2023. *Density functional theory study of porphyrin dye molecule adsorbed onto TiO2 (101) anatase surface.* The 67th Annual Conference of the South African Institute of Physics (SAIP), University of Zululand, Richards Bay Campus, South Africa, 3-7 July 2023, pp 486-492.

Tshwane, David M, Dima, Ratshilumela S, Mogakane, Lethabo, Ngcobo, Thabani, Maleka, Prettier M, Maphanga, Rapela R. 2023. *First-principle study of structural, thermodynamic and mechanical stability of ternary NaVSe2*. The 67th Annual Conference of the South African Institute of Physics (SAIP), University of Zululand, Richards Bay campus, South Africa, 3-7 July 2023, pp 124-128.

Mogakane, Lethabo, Dima, Ratshilumela S, Tshwane, David M, Maleka, Prettier M, Maphanga, Rapela R. 2023. *Structural, electronic, and thermodynamic properties of ternary NaVS2: A computational study*. The 67th Annual Conference of the South African Institute of Physics (SAIP), University of Zululand, Richards Bay Campus, South Africa, 3-7 July 2023, pp 136-141.

Ngwenya, SO, Heymann, R, Swart, TG, Lysko, Albert A. 2023. *Addressing accessibility, affordability and sustainability barriers for broadband internet access and penetration in rural areas*. 22nd International Conference on WWW/Internet (ICWI 2023), Madeira Island, Portugal, 21- 23 October 2023, pp 9pp.

Bester, Duwan C. 2023. *Applying design for additive manufacturing to existing aerospace parts*. RAPDASA-RobMech-PRASA-AMI Conference, CSIR International Convention Centre, Pretoria, South Africa, 30 October – 2 November 2023, pp 9pp.

Tema, Thabo H, Blaauw, Ciara, Nel, Willem AJ, Abdul-Gaffar, Y. 2023. *Factors to consider for radiometric calibration of Airborne FMCW SAR imagery*. International Radar Conference, Sydney, Australia, 6-10 November 2023, pp 6pp.

Grobler, Inus. 2023. *Conducted emission measurements with a CDN showing very high-frequency component effects in a syncronous buck converter*. 4th International Conference on Electrical, Communication and Computer Engineering (ICECCE), Dubai UAE, 30-31 December 2023, pp 6pp.

Botha, Louis. 2023. *Offset reflector with a non-focal phased array feed for space applications*. 2023 IEEE Conference on Antenna Measurements and Applications (CAMA), Genoa, Italy, 15-17 November 2023, pp 3pp.

Ndlovu, Lungisani, De Kock, Antonie J, Mkuzangwe, Nenekazi NP, Thwala, Ntombizodwa, Mokoena, Chantel JM, Matimatjatji, Rethabile J. 2023. *Uncovering influential factors of civil unrest in South Africa: A machine learning and OSINT approach*. 11th Machine Intelligence and Digital Interaction (MIDI), Conference, Virtual/remote event, 12-14 December 2023, pp 10pp.

Lysko, Albert A, Nkosi, M, Lysko, MD. 2023. *Sharing experiences: Near Line-Of-Sight TVWS*. International Japan-Africa Conference on Electronics, Communications and Computations 2023 (JAC-ECC 2023), Alexandria, Egypt, 18-20 December, 2023, pp 5pp.

Naicker, Dhananathan M, Purdon, Kyla, Ramruthan, Kshir. 2023. *Modular robotic arm for automation of SMME industrial press*. RAPDASA-RobMech-PRASA-AMI Conference, CSIR International Convention Centre, Pretoria, South Africa, 30 October – 2 November 2023, pp 13pp.

Mosito, Katlego E, Magaoga, Mpereke E, Nel, Willem AJ, Blaauw, Ciara, Tema, Thabo H. 2023. *A real-time implementation of a DPCA GMTI technique for a UAV SAR demonstrator system developed by the CSIR*. International Radar Conference, Sydney, Australia, 6-10 November 2023, pp 6pp.

Ramruthan, Kshir, Kuchwa-Dube, C. 2023. *4-RRS PKM for stabilisation on a mobile sensor platform*. RAPDASA-RobMech-PRASA-AMI Conference, CSIR International Convention Centre, Pretoria, South Africa, 30 October – 2 November 2023, pp 17pp.

Isong, B, Ratanang, T, Gasela, N, Abu-Mahfouz, Adnan MI. 2023. *Integrated framework for enhancing SDN security and reliability*. International Conference on Electrical, Computer and Energy Technologies (ICECET), Cape Town, South Africa, 16-17 November 2023, pp 8pp.

Adams, A, Abu-Mahfouz, Adnan MI, Hancke, GP. 2023. *Machine learning – Imaging applications in transport systems: A review*. International Conference on Electrical, Computer and Energy Technologies (ICECET 2023), Cape Town, South Africa, 16-17 November 2023, pp 7pp.

Zandamela, Frank, Pratt, Lawrence E, May, Siyasanga I, Mkasi, Hlaluku W, Mabeo, Reuben T. 2023. *Towards improved solar PV module characterisation: Correlating electroluminescence image defects with I-V curve characteristics using a semantic segmentation based multi-defect detection algorithm*. Southern African Sustainable Energy Conference (SASEC), Gqeberha, Port Elizabeth, 15-17 November 2023, pp 120-126.

Veerasamy, Namosha, Dawood, Zubeida C, Mkhwanazi, Dephney T, Senamela, Pertunia M. 2023. *Towards improving the cybersecurity skills gap using learning factories*. 9th Military Information and Communications Symposium of South Africa (MICSSA 2023), CSIR-ICC, Pretoria, South Africa, 21 - 25 August 2023, pp 6pp.

Berndt, Robert J, Wabeke, Leon O, Van Rensburg, Vanessa, Potgieter, Pieter F, Kloke, Kevin H. 2023. *Ground-based surveillance and classification radar for wildlife protection*. International Radar Conference (RADAR), Sydney, Australia, 6-10 November 2023, pp 5pp.

Mthethwa, Siyabonga, Nthatheni, Ronewa G, Maremi, Keneilwe J, Thulare, Tumiso. 2023. *Recommendations for sustainable post COVID-19 eLearning development in rural schools in South Africa*. digiTAL2K International Conference on Teaching, Assessment and Learning, Cape Town, South Africa, 6-7 December 2023, pp 14pp.

Lekoadi, Paul M, Tlotleng, Monnamme, Siyasiya, Charles, Masina, Bathusile N. 2023. *Investigation of TiB distribution characteristics on the microstructure of in situ TiB/Ti6Al4V-ELI manufactured by laser metal deposition*. RAPDASA-RobMech-PRASA-AMI Conference, CSIR International Convention Centre, Pretoria, South Africa, 30 October – 2 November 2023, pp 11pp.

Purdon, Kyla, Van Niekerk, T, Phillips, R, Marais, Stephen T. 2023. *3D mapping and photogrammetry sensor payload for unmanned aerial vehicles*. RAPDASA-RobMech-PRASA-AMI Conference, CSIR International Convention Centre, Pretoria, South Africa, 30 October – 2 November 2023, pp 16pp.

Purdon, Kyla, Dickens, John S, De Ronde, Willis, Ramruthan, Kshir, Crafford, Gerrie. 2023. *Voyager, a ground mobile robotic platform for research development*. RAPDASA-RobMech-PRASA-AMI Conference, CSIR International Convention Centre, Pretoria, South Africa, 30 October – 2 November 2023, pp 12pp.

Magogodi, Steven M, Mathabathe, Maria N, Bolokang, Amogelang S, Siyasiya, Charles. 2023. *Hot corrosion effect of the vacuum arc melted (a2/y)Ti-48Al-2Nb-0.7Cr-0.3Si alloy under an environment of NaCl-Na2SO4 salt*. RAPDASA-RobMech-PRASA-AMI Conference, CSIR International Convention Centre, Pretoria, South Africa, 30 October – 2 November 2023, pp 318-320.

Nyakane, Ntswaki E, Mathabathe, Maria N, Bolokang, Amogelang S, Siyasiya, CW. 2023. *Investigating the mechanical properties of A356 (Sr doped) using mechanical stirring*. RAPDASA-RobMech-PRASA-AMI Conference, CSIR International Convention Centre, Pretoria, South Africa, 30 October – 2 November 2023, pp 6pp.

Adekoya, GJ, Sadiku, ER, Hamam, Y, Mwakikunga, Bonex W, Ray, Suprakas S. 2023. *DFT and MC investigation of EDOT on honeycomb borophene as potential energy storage material*. Proceedings of the 36th Conference of the Polymer Processing Society, Montreal, Canada, 26–29 September 2021. Published in: AIP Proceedings, Volume 2607, Issue 1, May 2023, 2607 (1), pp 6pp.

Abigail, N, Phasha, M, Raganya, Mampai L, Diale, MG, Chauke, H, Makhatha, ME. 2023. *Investigation of microstructural and micro-hardness properties of Ti-15.05Mo alloy for biomedical applications*. RAPDASA-RobMech-PRASA-AMI Conference, CSIR International Convention Centre, Pretoria, South Africa, 30 October – 2 November 2023, pp 8pp.

Ellard, JJM, Mathabathe, Maria N, Siyasiya, CW, Bolokang, Amogelang S. 2023. *Effects of Sn on the densification and microstructure of a Ti-48Al-2Nb-0.7Mn-0.3Si-1Sn alloy fabricated from cold-pressed powders through vacuum melting*. RAPDASA-RobMech-PRASA-AMI Conference, CSIR International Convention Centre, Pretoria, South Africa, 30 October – 2 November 2023, pp 11pp.

Fourie, Nicolene MR. 2023. *Public bodies compliance to PAI and SDI Act: An enabler for geospatial information freedom*. 31st International Cartographic Conference (ICC 2023), Cape Town, South Africa, 13-18 August 2023, pp 3pp.

Molose, RRS, Isong, B, Dladlu, N, Abu-Mahfouz, Adnan MI. 2023. *A novel energy-aware SDWSN controller placement scheme*. International Conference on Electrical, Computer and Energy Technologies (ICECET), November 2023, Cape Town, South Africa, pp 8pp.

Isong, B, Manuel, M, Dladlu, N, Abu-Mahfouz, Adnan MI. 2023. *Trust management framework for securing software-defined wireless sensor networks*. International Conference on Electrical, Computer and Energy Technologies (ICECET), 16-17 November 2023, Cape Town, South Africa, pp 6pp.

Adekoya, GJ, Folorunso, O, Adekoya, OC, Hamam, Y, Sadiku, ER, Ray, Suprakas S. 2023. *Adsorption of EDOT on Graphene: DFT and MC Studies*. Proceedings of the 36th Conference of the Polymer Processing Society, Montreal, Canada, 26–29 September 2021. Published in: AIP Proceedings, Volume 2607, Issue 1, May 2023, 2607, pp 7pp.

Afachao, F, Abu-Mahfouz, Adnan MI. 2023. *Towards energy-efficient intelligent edge computing.* 3rd International Conference on Electrical, Computer and Energy Technologies (ICECET 2023), Cape Town, South Africa, 1-17 November 2023, pp 6pp.

Mabena, Chemist M, Mphuthi, Nokwazi P, Bell, Lebohang T, Naidoo, Darryl. 2023. *Effect of astigmatism on the beam quality factor of Hermite-Gauss laser beams.* Proceedings of SPIE, Volume 12664, SPIE Optical Engineering + Applications, Optical Modeling and Performance Predictions XIII, 20-25 August 2023, pp 8pp.

Thulare, Tumiso, Maremi, Keneilwe J, Herselman, Martha E. 2023. *A scoping review of applying the Delphi method based on how the COVID-19 pandemic impacted conducting research pandemic impacted conducting research.* digiTAL2K International Conference on Teaching, Assessment and Learning in the Digital Age, Cape Town, South Africa, 6-7 December 2023, pp 257-265.

Sheik, Muhammed, Segakweng, Tshiamo, Sekhuthe, Karabelo L. 2023. *Magnetite thermal energy storage for CSP plants.* SASEC 2023, Nelson Mandela University, 15-17 November 2023, pp 148-154.

Manamela, Selolo S, Cilliers, Jacques E, Gaffar, YA. 2023. *Vegetation path loss modeling using a modified parabolic equation Toolbox.* Proceedings of the 4th International Conference on Electrical, Communication and Computer Engineering (ICECCE), Dubai, UAE, 30-31 December 2023, pp 6pp.

Ramasobane, P, Mashinini, MP, Masina, Bathusile N. 2023. *Nano mechanical study on a single layer TiC/TI6Al4V-ELI composite manufactured with laser metal deposition.* RAPDASA-RobMech-PRASA-AMI Conference, CSIR International Convention Centre, Pretoria, South Africa, 30 October – 2 November 2023, pp 7pp.

Otto, AJ, Rananga, S, Masonta, Moshe T. 2023. *Work in Progress: Deep learning vs. traditional learning for radio frequency fingerprinting.* Southern Africa Telecommunication Networks and Applications Conference (SATNAC) 2023, Champagne Sports Resort, 27 - 29 August 2023, pp 2pp.

Kgoahla, Reneilwe M, Lekoadi, Paul M, Masina, Bathusile N. 2023. *Effect of heat treatment temperature on the microstructure and microhardness of TiC/Ti6Al4V composite manufactured with laser metal deposition.* RAPDASA-RobMech-PRASA-AMI Conference, CSIR International Convention Centre, Pretoria, South Africa, 30 October – 2 November 2023, pp 22pp.

Dlamini, N, Mamushiane, Lusani, Nkosi, M, Dlamini, S, Ramaboka, T. 2023. *Towards a digitally transformed criminal justice system: A South African case study.* 9th Military Information & Communications Symposium of South Africa (MICSSA), International Convention Centre (ICC), Pretoria, South Africa, 22-24 August 2023, pp 6pp.

Venter, Karien, James, J, Ahmed, F, Greyling, N, Mavuso, S, Malan, C, Romijn, M, Harding, C, Baker, R. 2023. *Implementation of the safe system approach in South Africa: Overview of the Limpopo road safety programme.* 41st Southern African Transport Conference, CSIR International Convention Centre (CSIR ICC), Pretoria, South Africa, 10 - 13 July 2023, pp 11p.

Books (3) and book chapters (21)

Baichan, P, Naicker, Previn, Devar, J, Smith, M, Nweke, EE. 2023. *A look at emerging therapeutic targets for gallbladder cancer: A multi-omics approach.* Gallbladder Cancer: Current Treatment Options, pp 161-175.
Bandyopadhyay, Jayita, Ray, Suprakash S. 2023. *Nanotechnology in innovative food preservation and packaging.* Emerging Technologies in Food Preservation, pp 8134-8158.

Sinha Ray, Suprakas, Banerjee, R. 2023. *Sustainable Polylactide-Based Composites. 1st Edition.* pp 392pp.

Mtibe, Asanda, John, Maya J. 2023. *Sustainable materials from starch based plastics.* Natural Materials for Food Packaging Application, pp 179-198.

Große-Stoltenberg, A, Lizarazo, I, Brundu, G, Gonçalves, VP, Osco, LP, Masemola, Cecilia R, Müllerová, J, Werner, C, Kotze, I, Oldeland, J. 2023. *Remote sensing of invasive Australian Acacia species: State of the art and future perspectives.* Wattles: Australian Acacia Species Around the World, pp 474-495.

Moodley, Dhiveshni, Pillay, S, Ramdhani, B, Pillay, K, Adikhari, B, Mohanlal, S, Ballabh, H. 2023. *Flood Risk, food security and vulnerability in two disparate communities of the Klein Brak Estuary floodplain, Western Cape, South Africa.* Recent Advances in Environmental Sustainability, pp 135-160.

Orasugh, Jonathan T, Temane, LT, Ray, Suprakas S. 2023. *Application of MXenes in Water Purification, CO2 Capture and Conversion.* Two-Dimensional Materials for Environmental Applications, pp 17-74.

Selatile, Koena, Ray, Suprakash S, Kumar, Neeraj, Ojijo, Vincent O, Sadiku, RE. 2023. *Fabrication of advanced 2d nanomaterials membranes for desalination and wastewater treatment.* Two-Dimensional Materials for Environmental Applications, pp 245-268.

Khomsi, K, Elwakil, RE, Nwaigwe, CO, Mateyisi, Mohau J, Nangombe, S. 2023. *Current and projected climate changes in African subregions.* Impact of Climate Change on Health in Africa, pp 21-52.

Kavitha, C, Maphanga, Rapela R. 2023. *Graphene-based hybrid nano composites for bio/chemical sensors.* Emerging Nanomaterials for Catalysis and Sensor Applications, pp 217-248.

Ghosh, A, Orasugh, Jonathan T, Chattopadhyay, D, Ray, Suprakas S. 2023. *Polymers for foams and their emerging applications.* Specialty Polymers: Fundamentals, Properties, Applications and Advances, pp 15pp.

Gusain, R, Kumar, Neeraj, Ray, Suprakas S. 2023. *Applications of MoS2 nanostructures in wastewater treatment.* Two-dimensional Materials for Environmetal Applications, pp 351-374.

Makgwane, Peter R, Hlekelele, Lerato, Motaung, DE, Mavuso, Mlungisi A, Mphahlele-Makgwane, MM, Mokoena, TP. 2023. *Recent advancement in the development of metal oxide heterostructures for environmental remediation.* Metal Oxide-Based Heterostructures: Fabrication and Applications. 1st Edition, pp 193-246.

Ghosh, A, Orasugh, Jonathan T, Ray, Suprakas S, Chattopadhayay, D. 2023. *Foaming Technology.* Polymeric Foams: Applications of Polymeric Foams. Volume 2, pp 1-27.

Ali, MS, Orasugh, Jonathan T, Ray, Suprakas S, Chattopadhyay, D. 2023. *Wastewater remediation for reuse through emerging technologies.* Development in Wastewater Treatment Research and Processes: Bioelectrochemical Systems for Wastewater Management, pp 61-77.

Ghosh, A, Orasugh, Jonathan T, Ray, Suprakas S, Chattopadhayay, D. 2023. *Recent development in polyurethanes for biomedical applications.* Polyurethanes: Preparation, Properties, and Applications Volume 3: Emerging Applications, pp 163-189.

Motshekga, SC, Temane, Lesego T, Orasugh, Jonathan T, Ray, Suprakas S. 2023. *Marine algae and their importance.* Current Status of Marine Water Microbiology, pp 67–124.

Ray, Suprakas S, Geberekrstos, Amanuel, Orasugh, Jonathan T, Muzata, TS. 2023. *Process-Induced Phase Separation in Polymer Blends: Materials, Characterization, Properties, and Applications.* pp 211pp.

Sharma, BK, Jha, A, Agarwal, R, Chowdhury, SR, Ray, Suprakas S. 2023. *Development of multi-component polymeric systems by high energy radiation.* Applications of High Energy Radiations: Synthesis and Processing of Polymeric Materials, pp 317–346.

James, J, Van Niekerk, Lara, Lamberth, S. 2023. *Climate change and the Knysna Estuary*. Knysna Estuary – Jewel of the Garden Route, pp 251-270.

Eziki, AC, Sadiku, ER, Ray, Suprakas S, Oyeoka, HC, Ibenta, ME, Okpechi, VU. 2023. *Wood fibre-reinforced polyester composite*. Polyester-Based Biocomposites. 1st Edition, pp 24pp.

Bolokang, Amogelang S, Mathabathe, Maria N. 2023. *Advanced Materials Processing and Manufacturing: Research, Technology, and Applications*. pp 200pp.

Neyt, Nicole, Jugmohan, Jaimee, Bonnet, W, Panayides, Jenny-Lee, Riley, Darren L. 2023. *Large-scale flow chemistry*. Mechanochemistry and Emerging Technologies for Sustainable Chemical Manufacturing, pp 28pp.

Mdanda, S, Mdlophane, A, Ndlovu, H, Ramonaheng, K, Qebetu, M, Mahapane, J, Kgatle, M, Mzizi, Y, Sebatana, R, Cele, Zamani ED, Zeevaart, JR, Sathekge, MM. 2023. *Targeted alpha therapy in cancer management: Therapeutic prospects of nuclear medicine in oncology*. Interdisciplinary Cancer Research, pp 1-26.

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