

UNLOCKING THE POWER OF DATA

A review of the state of readiness of the post-school education and training sector in South Africa for enhanced data interoperability

Rooksana Rajab, Sebolelo Nomvete,
More Manda and James Keevy

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Preamble

The idea of a more interoperable data ecosystem for post-school education and training (PSET) has its origin in the early discussions between JET Education Services (JET) and the Manufacturing and Engineering Sector Education and Training Authority (merSETA) in 2018. This was a time when both organisations, albeit from different trajectories, were contemplating how best new thinking in the digital arena could be harnessed to leapfrog South African developments. JET, a non-profit with well-established research and intermediary capacities, and merSETA, a statutory body known as one of the leading SETAs in South Africa, with strong governance systems and a reputation as an early adopter, found a good fit through collaboration on this project. The shared vision and co-creation of this project were strengthened through the support of Raymond Patel (merSETA CEO at the time), resulting in the early components of a theory of change (ToC) for what soon became known as the Post-School Education and Training Collaboration and Learning Opportunities and Utilisation of Data (PSET CLOUD) project.

A key driver for this futuristic collaboration, clearly articulated in the first iteration of the ToC, is a focus on the end-user. The JET–merSETA team was, from the outset, committed to a process that would enable South African citizens to make informed labour market decisions leading to increased employment opportunities in line with the South African National Development Plan (NDP) targets. The initial ToC evolved in 2020 to outline a more refined set of activities, outputs and outcomes, while the focus remains firmly on this long-term goal to be of benefit to the end-user. The assumptions and risks which are clearly outlined continue to be carefully managed. The project also remains firmly aligned to the strategic intent of the Department of Higher Education and Training (DHET) and other key state actors. Through this collaboration, JET and the merSETA have been able to draw on key thinkers within their organisational networks to form the core team managing the project. This team has remained relatively stable and members have grown in their own thinking, writing and influence in digital ecosystems. Continuous involvement of international advisors, notably Prof. Lori Foster,¹ has been key in maintaining the momentum of the project. The relationship with the DHET and, more broadly, the alignment with other national data initiatives, will be deepened going forward as we look towards the realisation of the PSET CLOUD vision by 2024.

We remain committed to a PSET system that will position South Africa incredibly well internationally and, more importantly, has the potential to unlock deeply embedded systemic flaws that to date have been largely intractable – flaws that existed before COVID-19 but have become more accentuated as a result of the pandemic. We also look forward to new partners coming on board as the PSET CLOUD has the potential to become a mainstay of the post-schooling system in South Africa.

¹ Lori Foster is Professor in the Department of Psychology at the North Carolina State University and the School of Commerce at the University of Cape Town. Lori has worked with both the merSETA and JET and has provided invaluable support over the years.

Acknowledgements

In 2019, a team from the South African Council for Scientific and Industrial Research (CSIR) was appointed to assist with a situational analysis involving a stakeholder and systems analysis, a stakeholder mapping exercise and a feasibility analysis to determine the viability of having an interoperable and integrated Post-School Education and training (PSET) Collaboration and Learning Opportunities and Utilisation of Data (CLOUD). A series of three reports on this work completed by the CSIR was compiled in late 2019 and constitutes an important basis for the state of readiness report. We acknowledge the work completed by the CSIR team, consisting of Jeremy Gibberd, Lorato Motsatsi, Mario Marais and Antony Cooper, and that it was not an easy task. In addition, a review of interoperable data ecosystems internationally was completed in 2019 and we acknowledge the contribution made by Kelly Shiohira and Barbara Dale-Jones.

Our thanks go to Wayne Adams, the acting merSETA CEO, for his continued commitment to this process, ongoing support from Paul Laughton (Knowledge Manager in the Strategic Planning Unit of the merSETA), our colleagues at the Department of Higher Education and Training (DHET) and our fellow team members at both the merSETA and JET for being patient with us when there were many competing demands on our time.

We wish to acknowledge the contribution our team of experts: Bangani Ngeleza for his expert technical support for and monitoring of a large project such as this; Barbara Dale-Jones for the additional interviews conducted in 2020 that have enriched the data presented in this report, and for her contribution to the innovative component in the project, particularly in respect of self-sovereign identity (SSI); Lorretta Barbour for the brainstorming sessions and graphics in preparation for the European Training Foundation (ETF) conference in Turin 2019; Maureen Mosselson, our editor; Paul Laughton for all his support and review of several versions of the report; Leith Davis our graphic designer; and finally our publisher Simon Chislett for managing the production and design of the final product. We also note the contribution of Simphiwe Ntuli to this report and our work going forward in his role as the newly appointed technology researcher. Finally, thank you to all our project team members from both JET and the merSETA for their continued support.



About merSETA

The merSETA is one of 21 sector education and training authorities (SETAs) established to facilitate skills development in terms of the Skills Development Act of 1998 (as amended). The 21 SETAs broadly reflect different sectors of the South African economy. The merSETA encompasses manufacturing, engineering and related services.



About JET Education Services

JET Education Services is an independent non-governmental organisation in South Africa that works with government, the private sector, international development agencies and education institutions to improve the quality of education and the relationship between education, skills development and the world of work.

About the authors



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More Manda is currently Senior Manager: Strategic Planning at the Manufacturing, Engineering and Related Services Sector Education and Training Authority (merSETA). His research interests include e-government, human rights and ICT, smart cities, ICT for development and strategic management. He has won several awards including the Pacific Telecommunications Council (PTC) young scholar award and a government fellowship awarded by the United Nations University Policy Operating Unit on Policy Driven-Electronic Governance (UNU-EGOV) in Portugal. More holds a Doctorate in Information Systems from the University of the Witwatersrand, a Masters in Information Technology and a BSc Hons in Information Science.



James Keevy has a Doctorate in Education and is a policy researcher in the education and training sector. He was appointed to the position of Chief Executive Officer of Jet Education Services (JET) in September 2014. Prior to his appointment at JET, he was the Director for International Liaison at the South African Qualifications Authority (SAQA). James is a teacher by profession, having taught at secondary school level and at a teachers' college which was later incorporated into UNISA. He has conducted and overseen various initiatives related to national, regional and international qualifications frameworks in Africa and further afield. His research into qualifications, the recognition of learning and the professionalisation and migration of teachers has been published and presented widely. James has a special interest in harnessing technology to drive education reform. Since taking over at JET, he has worked to consolidate the organisation's position as a credible collaborator supporting the improvement of the education and training system in South Africa.

Definitions²

College	A public and/or private college established or declared as a (i) technical and vocational education and training (TVET) college or (ii) a community education and training (CET) college or a private college established or declared or registered under the Continuing Education and Training Act, 2006 (Act No. 16 of 2006).
College data manager	A college official designated and charged with certain responsibilities regarding post-school education and training (PSET) information in terms of this policy.
Community education and training college	A PSET institution that is established to cater for youth and adults who did not complete their schooling or who never attended school and thus do not qualify to study at the TVET and/or private colleges and/or universities.
Data	Representation of facts, concepts or instructions in a formal manner, suitable for communication, interpretation or processing by humans or by automatic means.
Data accuracy	The degree to which the output correctly describes the phenomena it was designed to measure.
Data archive	Repository holding documents or other material containing a variety of data, usually of historical and/or rare value.
Database	A logical collection of information that is interrelated and that is managed and stored as a unit, for example, in the same computer file.
Data coding	A process of converting verbal or textual information into codes representing classes within a classification scheme to facilitate data processing, storage or dissemination.
Data collection	The process of gathering and measuring data on targeted variables in an established, systematic fashion which then enables one to answer relevant questions and evaluate outcomes.
Data collection system	A method applied for gathering data for official statistics.
Data confidentiality	The property of data usually resulting from legislative measures which prevents it from unauthorised disclosure.
Data integration	The process of combining heterogeneous data residing in different sources and providing the user with a unified view of this data.
Data integrity	The accuracy and validity of the data set as well as the process through which the data set's validity and accuracy is assessed and maintained or protected.
Data manager	Any person who manages an administrative process by which the required data is acquired, validated, stored, protected and processed, and by which its accessibility, reliability and timeliness is ensured to satisfy the needs of the data users.

² Definitions compiled by the CSIR from various sources. See CSIR 2019b, 9–11; 2019c, 6–8.

Data quality	The fitness for use of specified data.
Data source	A record, data collection instrument, organisation, individual or database from which data is obtained.
Data verification	The processes by which data is checked, assessed, reviewed and audited.
Department	The Department of Higher Education and Training (DHET).
DHET entities	Public entities listed in Part A of Schedule 3 (Other Public Entities) of the Public Finance Management Act (PFMA) that report to the Minister of Higher Education and Training and are: the Sector Education and Training Authorities (SETAs); the South African Qualifications Authority (SAQA); the National Student Financial Aid Scheme (NSFAS); the Council on Higher Education; the Quality Council for Trades and Occupations; and also Umalusi, deemed to be a DHET entity with regard to the functions in terms of the Continuing Education and Training Act, 2006.
Higher Education and Training Information (HETIS) Officer	The DHET official appointed with certain responsibilities regarding Higher Education and Training information in terms of the Post-School Education and Training Information Policy, November 2013.
Information	Data presented in a context so that it can be applied or used.
Interoperability	The ability of independent systems and processes (technical and non-technical) to exchange data and information and to communicate using common standards to enhance efficiency and service delivery.
Institution management information system	An information system used by an institution to handle administrative, management and planning functions in terms of the Post-School Education and Training Information Policy, November 2013.
National Digital Ecosystem for Post-School Education and Training	A platform that enables users such as learners, government, industry, non-governmental organisations (NGOs) and education institutions to share and use data for decision-making that promotes a more efficient and responsive post-school education system.
Post-school education and training (PSET)	A sector comprising all education and training provision for those who have completed school, those who did not complete their schooling and those who never attended school.
Post-School Education and Training Information Standards Committee	The committee established in terms of the Post-School Education and Training Information Policy that advises the Director General with regards to higher education and training information standards.
Post-school education and training institutions	The institutions that provide education and training and which include universities, national institutes of higher education and private higher education institutions, TVET colleges, private colleges, CET colleges and skills providers. These are established, declared or registered by any law assigned to the Minister of Higher Education and Training.

Preliminary data	The first released version of a series of data before the final audited data version in terms of the Post-School Education and Training Information Policy.
Private college	Any college that provides continuing education and training on a full-time, part-time or distance basis and which is registered or provisionally registered as a private college under the Continuing Education and Training Act, 2006 (Act No. 16 of 2006).
PSET CLOUD	A platform that enables users such as learners, government, industry, NGOs and education institutions to share and use data for decision-making that promotes a more efficient and responsive post-school education system.
Public college	Any college that provides continuing education and training on a full-time, part-time or distance basis and which is established or regarded as having been established as a public college or declared as a public college under the Continuing Education and Training Act, 2006 (Act No. 16 of 2006).
Quality Councils	The primary bodies with a direct role in governing quality assurance and certification. Through their responsibility for setting standards, quality councils are also responsible for curriculum and assessment.
Sector education and training authority (SETA)	A sector education and training authority established in terms of Section 9(1) of the Skills Development Act, 1998 (Act No. 97 of 1998).
Staff	Persons employed at any PSET institution.
Stakeholder	An organisation or body with a direct and continuing interest in the education institution, programme, phase or sector in question.
Statistics	Aggregated numerical information relating to demographic, economic, financial, environmental, social or similar matters, at national, provincial or local level which is compiled and analysed according to a relevant scientific and statistical methodology.
Student	Any person registered as a student at any PSET institution in terms of the Continuing Education and Training Act, 2006 (Act No. 16 of 2006).
Survey	A process which collects, examines, and reports on data concerning variables of interest for a reference period.
Technical and vocational education and training college	Any public college that provides continuing education and training on a full-time, part-time or distance basis and which is established or regarded as having been established as a public college or declared as a public college under the Continuing Education and Training Act, 2006 (Act No. 16 of 2006).
Unique identifier	Any identifier that is assigned to a data subject and is used by a responsible party for the purpose of the operations of that responsible party and that uniquely identifies that data subject in relation to that responsible party.

Acronyms and abbreviations

4IR	Fourth Industrial Revolution
AI	artificial intelligence
ALT	adaptive learning technologies
CACH	Central Application Clearing House
CDS	Career Development Services
CET	community education and training
CETMIS	Community Education and Training Management Information System
CHE	Council on Higher Education
CLCs	community learning centres
CLOUD	Collaboration and Learning Opportunities and Utilisation of Data
CSIR	Council for Scientific and Industrial Research
CV	curriculum vitae
DBE	Department of Basic Education
DHET	Department of Higher Education and Training
DOC	Department of Communications
DoL	Department of Labour
DPME	Department of Planning, Monitoring and Evaluation
DPSA	Department of Public Service Administration
DQAF	Data Quality Assessment Framework
DTPS	Department of Telecommunications and Postal Services
ESSA	Employment Services of South Africa
ETF	European Training Foundation
FMPPI	Framework for Managing Programme Information
GTAC	Government Technical Advisory Centre
GWMES	Government-Wide Monitoring and Evaluation System
HE	higher education
HEI	higher education institutions
HEMIS	Higher Education Management Information System
HEQC	Higher Education Quality Committee
HEQCIS	Higher Education Quality Committee Information System
HETIS	Higher Education and Training Information System
HETMIS	Higher Education and Training Management Information System
HRD	human resource development
HRDC	Human Resource Development Council
ICT	information and communications technology
INDLELA	Institute for the National Development of Learnerships, Employment Skills and Labour Assessments
IT	information technology
LMIP	Labour Market Intelligence Partnership
M&E	monitoring and evaluation
MIOS	Minimum Interoperability Standards
MIS	management information system
MISS	Minimum Information Security Standards
MVP	minimum viable product
NADS	National Artisan Development Strategy
NAMB	National Artisan Moderation Body
NATED	National Accredited Technical Diploma
NC(V)	National Certificate (Vocational)

NDP	National Development Plan
NEDLAC	National Economic Development and Labour Council
NGO	non-governmental organisation
NIA	National Intelligence Agency
NIHSS	National Institute for Humanities and Social Sciences
NLRD	National Learners' Records Database
NPC	National Planning Commission
NQF	National Qualifications Framework
NSA	National Skills Authority
NSDP	National Skills Development Plan
NSDS	National Skills Development Strategy
NSF	National Skills Fund
NSFAS	National Student Financial Aid Scheme
OECD	Organisation for Economic Co-operation and Development
OQLMS	Occupational Qualifications Learner Management System
PAIA	Promotion of Access to Information Act
PALCs	public adult learning centres
PFMA	Public Finance Management Act
PHEI	private higher education institution
POPIA	Protection of Personal Information Act
PSET	post-school education and training
QCTO	Quality Council for Trades and Occupations
REAL	Centre for Researching Education and Labour
SANReN	South African National Research Network
SAQA	South African Qualifications Authority
SASQAF	South African Statistical Quality Assessment Framework
SAYPS	South African Youth Panel Survey
SDMX	Statistical Data and Metadata Exchange
SDP	skills development provider
SETA	sector education and training authority
SIS-cc	Statistical Information System Collaboration Community
SITA	State Information Technology Agency
SMMEs	small, medium and micro enterprises
SOA	service-oriented architecture
SOR	state of readiness
SSI	self-sovereign identity
StatsSA	Statistics South Africa
TENET	Tertiary Education and Research Network of South Africa
ToC	theory of change
TVET	technical and vocational education and training
TVETMIS	Technical and Vocational Education and Training Management Information System
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNEVOC	International Centre for Technical and Vocational Education and Training
UNWDF	United Nations World Data Forum
WIL	work-integrated learning

1

SETTING THE SCENE

INTRODUCTION

What if we could better utilise the new technologies that have become so pervasive in the modern era to improve our education and skills systems in South Africa? Imagine having the potential to link the unemployed to job vacancies or even to start to develop new, just-in-time training programmes for jobs that do not yet exist. The COVID-19 pandemic has starkly illustrated the increasing need for data for smarter decision-making and for South Africa to make a transition to more data-orientated and interoperable information platforms. We now have the technology to develop self-sustaining electronic platforms for collaboration and the creation and support of lifelong learning opportunities which are dependent on the utilisation of quality data. Perhaps we find ourselves in a situation of a “datademic”, a pandemic of sorts, with data in too many places, uncoordinated and generally just not appropriately structured to be used to its fullest potential. The high levels of unemployment are accelerating due to COVID-19, and the opportunities that technological solutions present are even more important than before.

For the post-school education and training (PSET) sector in South Africa, lifelong learning is not an end but part of the journey to enabling lifelong career advancement and the realisation of citizens’ social and economic aspirations within the South

African economy. The policy for PSET sets out a vision of an integrated post-school education and skills system that is intended to provide coherence and limitless opportunities among learning pathways from education to the world of work as well as from the world of work to education. It is accepted that institutions within the PSET system must have a clear identity and mission whilst also bringing to bear the imperative for PSET institutions to be responsive to the occupational, career and employment demand that needs to be met to advance individual social and economic livelihoods as well the country’s socio-economic growth and development trajectory in its bid to decrease poverty. The PSET system in South Africa comprises institutions and role players that traverse the world of education and work. This therefore necessitates that these various institutions and role players continuously collaborate in the utilisation of data and of developing and emerging world-class technologies to enable a match between the ever-changing career, employment and livelihood opportunities available in the economy and in education, learning and skills provisioning. These new digital ecosystems have the potential to provide us with limitless opportunities in a new world-based on the principles of interoperability.

While several role players in the PSET system in South Africa are moving towards the development of information and communications technology (ICT)

enabled solutions and platforms to improve operational efficiency and governance, these developments are largely uncoordinated. Added to the uncoordinated character of ICT solutions and platforms is the haphazard availability of and access to good quality data needed for decision-making and innovation in the PSET sector. The interface between these different strands lack interoperability and stands to benefit from improved coordination and enhanced efficiencies and transparency within the PSET system. This approach is in line with the decision for shared services to be developed across the sector education and training authorities (SETAs) in particular and also in relation to the interface between SETAs, the Department of Higher Education and Training (DHET) and other institutions in the system including colleges and universities.

In 2018, the Manufacturing, Engineering and Related Services Sector Education and Training Authority (merSETA), in collaboration with government and a well-established non-profit research organisation, JET Education Services (JET), started to explore the notion that an integrated and interoperable digital ecosystem for the PSET sector could be realised. The main objectives of this innovation are to increase integration across current and new systems/platforms; harvest rich knowledge and intelligence; enhance strategic planning and decision-making; be responsive to the needs of the labour market and national priorities; and strengthen, integrate, coordinate and improve efficiencies in the governance and management of PSET.

Overall, this initiative intends to ensure that data is understood to be an asset for continuously growing knowledge, intelligence and insights in order to enhance decision-making and improve efficiencies, governance and management for PSET-sector institutions and beneficiaries thereof. Thus it is envisaged that datasets in the South African PSET sector will be interoperable, well-synchronised and used effectively as a source of information for planning and improving efficiency in the PSET system. This establishment of a robust digital ecosystem hinges on the ability to solve several challenges including technology and capacity gaps, access to data and data interoperability. However, if managed, as the merSETA and JET have argued, the PSET digital ecosystem has the potential to provide South African citizens, government agencies and PSET institutions and role players access to a wider range of data which can be utilised in more meaningful ways to make decisions about lifelong learning, skills and labour.

The release of this review of the state of readiness (SOR) of the PSET sector for data interoperability comes at an opportune time when the National Planning Commission (NPC) has released a draft review of the National Development Plan (NDP) in terms of South Africa's readiness for the 'Fourth Industrial Revolution' (4IR) (NPC,

2020b). This SOR report is a synopsis of the outcomes of research completed in South Africa on interoperability within the PSET sector; it highlights early project activities which include consultations and a situational analysis; and it reviews the interconnectedness of stakeholders through a mapping exercise, providing an overview of varied and separate data systems that exist within the PSET sector. Additionally, a desktop review was undertaken and interviews were conducted nationally to determine the feasibility, advantages and critical success factors for developing the relevant networks and ancillaries for such a system. The report elucidates appropriate models and frameworks most relevant to South Africa and finally lays the foundation for the subsequent phases of the PSET CLOUD project and proposes a human-centred approach to digital interoperability. If there was ever a time for South Africa to be adequately prepared for the speed of technological developments globally, that time is now.

The SOR is structured according to six chapters, ranging from the background and methodology, to a careful synopsis of the broader PSET environment in South Africa, as well as a summary of the key role players, interactions and collaboration processes in this sector. In the penultimate chapter we provide some further thoughts on the feasibility of the proposed PSET CLOUD and the opportunities this long-term vision offers for South Africa.

We trust that this SOR report will provide a contemporary reference point for the state of readiness of interoperability within the PSET sector in South Africa in 2020, while also providing a launching pad for the second cycle of the project. As more partners come on board, and the broader PSET sector is actively engaged, the SOR report will ultimately provide us with a common frame of reference.

DIGITAL INTEROPERABILITY

The concept of and drive towards greater digital interoperability has been gaining momentum globally in the last few years. Interoperability can be defined as the ability of independent systems and processes (technical and non-technical) to exchange data and information and communicate using common standards to enhance efficiency and service delivery (adapted from Dos Santos & Reinhard, 2012). In short, "interoperability is the ability of different information systems, devices and applications to access, exchange, integrate and cooperatively use data in a coordinated manner" (Sucich, 2019).

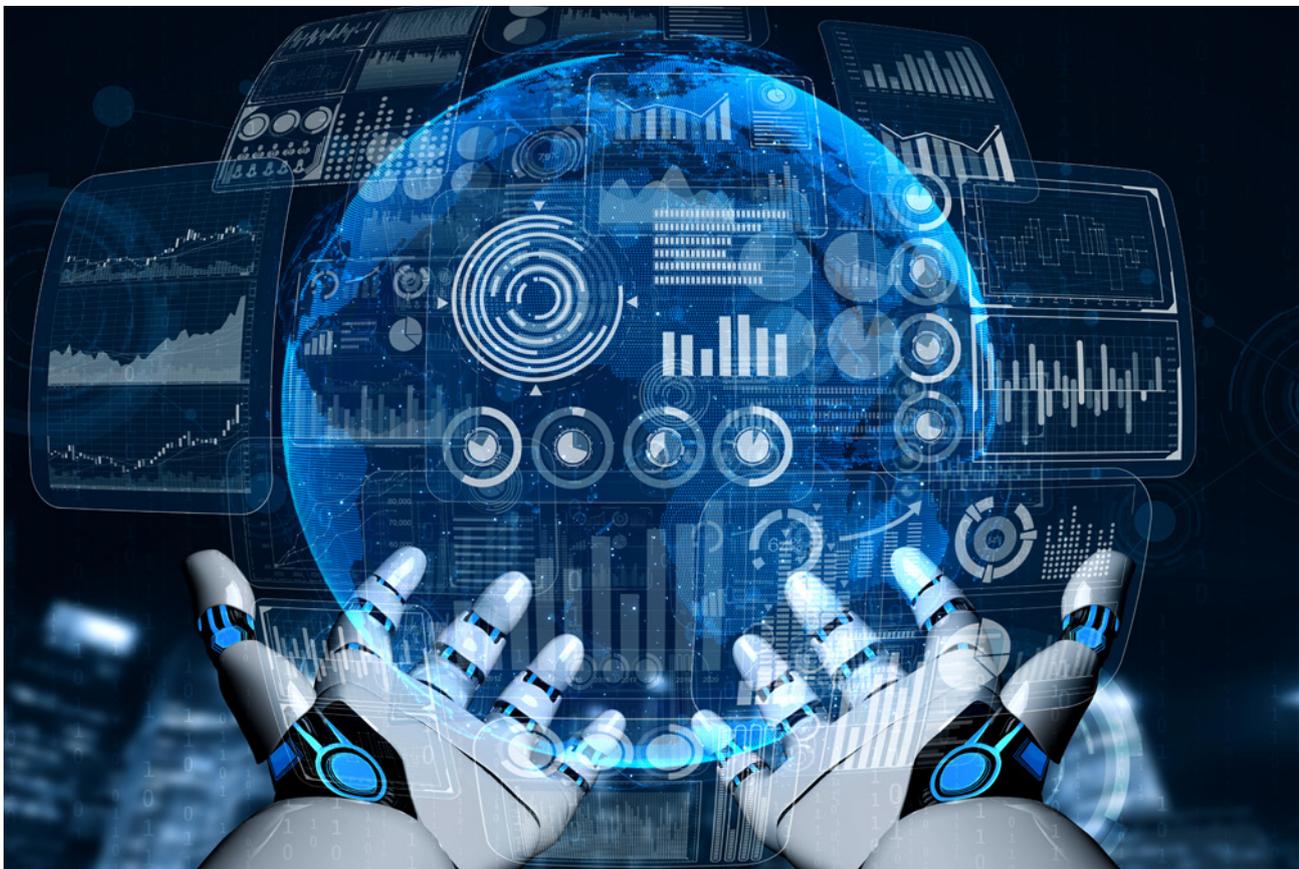
In smart societies and smart government, public institutions, civil society, business and other social partners need to adapt and collaborate with each other to fully leverage the advantages of new technologies.

Interoperability is thus important for fostering collaboration between organisations (Manda & Backhouse, 2016). Not only does information sharing focus on the exchange of information between partnering organisations, it also provides opportunities for the sharing of experiences and innovations that can enhance efficiency and service delivery for the benefit of all stakeholders, and this makes interoperability a prerequisite. To allow for effective inter-organisational data and information sharing, organisations need to build systems that are interoperable and put in place formal standards and business processes (Gil-Garcia, Chun & Janssen, 2009; Gil-Garcia, Schneider, Pardo & Cresswell, 2005).

The role of technology in promoting interoperability cannot be downplayed (Scholl & Al Awadhi, 2016). Advanced technologies such as sensor networks, data analytics, artificial intelligence and robotics can certainly make organisations and governments “smarter” by aiding efficiency, decision-making, information sharing, transparency, accountability and efficient service delivery (Scholl & Al Awadhi, 2016). Governments worldwide are transforming into “smart governments” as a way of responding to increasingly connected and smart societies that demand efficient service delivery, and the integration and interoperability of e-government systems has emerged as one of the key enablers of this transformation (Du & Qin, 2014; Gil-Garcia, Zhang & Puron-Cid, 2016).

Moreover, “as technological advances in data gathering, processing, and management continue, our ability to move from an information society to a ‘smart’ society will increasingly rely on improvements and expansion in technical, organisational, and other aspects of interoperability” (Jiménez, Solanas & Falcone, 2014, 22). Governments are, however, still experiencing blockages in moving up to higher levels of maturity due to challenges with the integration and interoperability of systems (Lam, 2005; Pardo, Nam & Burke, 2012). Achieving high levels of e-interoperability is thus one of the most significant challenges facing governments (Lisboa & Soares, 2014).

The PSET CLOUD project being conducted in South Africa, a developing country, will contribute to reviewing the post-school ecosystem in terms of how interoperability can best be used in coordinating and sharing data using common standards for individual citizens, institutions and organisations involved in education and lifelong learning for the labour market. It is often seen, more so in the developing world, that systems are developed in isolation from each other, often with much duplication and limited attention to interoperability. This is not a criticism of the work done by those that came before us: it is simply a fact that the technology we now have at our disposal allows us to think across systems and beyond the limits of what the human mind can achieve.



FOUNDATIONAL TENETS OF THE PSET CLOUD

Drawing on the 2017 United Nations World Data Forum (UNWDF) which resulted in the “Collaborative on SDG Data Interoperability”, Steele and Orrell (2017) point out that interoperability and data ecosystems can help to

- *modernise governance and institutional frameworks to allow national statistical systems to meet the demands and opportunities of evolving data ecosystems*
- *modernise statistical standards, particularly those aimed to facilitate data integration and automation of data exchange across different states of the statistical production process* (cited in Steele & Orrell, 2017, 11).

In addition, the traditional methods used to capture data on learner achievement have not proved to be efficient means of matching qualifications and skills to employer needs. In our view, current technology offers better data harvesting opportunities, drawing on a modernised and agreed national statistical system and guided by modern statistical standards. This kind of data-driven platform is fundamental to the South African PSET system and is undoubtedly the new frontier that we need to actively explore. The PSET CLOUD initiative, which attempts to improve interoperability across education and training systems in the post-school sector, is at an early stage but the main principles guiding it have been agreed and are briefly summarised below:

Principle 1: **Cooperation on a systems level**

Cooperation at this level is best sought nationally to start with and requires strong leadership. In some countries, this is best done by a government agency, and in others with more liberal economies, the private sector could take the lead.

Principle 2: **Consolidation of systems**

Linked to Principle 1 above, a careful review of existing systems is required to provide a basis for interoperability. Many systems are in place on national levels, and these provide the first level of consolidation. Some may be outdated and based on expensive and archaic technologies, while others may be modern and ready for integration. The identification of obvious compatibilities is a good place to start and can readily lead to a tipping point as the core national systems are included in the emerging ecosystem. This process requires technical expertise with the inclusion of experts who may not have had much interaction with educational policy measures.

Principle 3: **Establishment of data standards**

Once a basic level of cooperation has been established and system consolidation has been completed, the need for data standards will become obvious. These standards will provide the necessary guidance to find the synergies and common elements within individual systems which can then be linked in a broader interoperable system.

Principle 4: **Proactive development of missing subsystems**

There is a need to proactively coordinate, facilitate and encourage the development of subsystems where gaps are identified; this includes specific articulation with services such as Career Development Services (CDS), the Central Application Clearing House (CACH), the National Learners’ Records Database (NLRD), the Technical and Vocational Education and Training Management Information System (TVETMIS) and others.

Principle 5: **Introduction of innovation**

It is necessary to develop innovative and cutting-edge aspects of using artificial-intelligence-based solutions including tacit object modelling.

Principle 6: **Knowledge sharing and creation**

A clearinghouse for research and publications that affect the PSET system must be set up and maintained.

Principle 7: **Effective monitoring and evaluation**

Effective monitoring and evaluation (M&E) tools must be developed and made freely available.

Principle 8: **Sharing and drawing on global learnings**

The PSET CLOUD must draw on the best insights and learnings from across the world (see Gloss et al., 2016), particularly from international organisations such as the UNESCO International Centre for Technical and Vocational Education and Training (UNEVOC) and the International Labour Organization (ILO), through the establishment of an international advisory panel.

JET and the merSETA hold the view that digital solutions and ecosystems should be built only after understanding the interaction that needs to be facilitated for the participants in the system concerned. In addition, it is extremely important to ensure that building such an

integrated, interoperable national data system is both viable and feasible. It is with this view that the PSET CLOUD project was conceptualised. Early project activities included stakeholder analyses and consultations, mapping the relationships between institutions within the broader post-school landscape and reviewing national and international research which seeks to determine the feasibility, advantages and critical success factors for developing the relevant networks and ancillaries for such a system. The methodology used for this project is based on the theory of change approach: reviews of policy and legislation are carried out to understand the implications for the PSET CLOUD project; results from stakeholder interviews and database reviews are presented and their implications for the PSET CLOUD project ascertained; the next steps are spotlighted as the project evolves from conceptualisation to conclusion.

LOOKING TOWARDS THE FUTURE

The development of the PSET CLOUD in South Africa is located in a broader international trend towards digitisation. In this modern digital age, we find ourselves in a situation where we have an over-supply of data, while our analytical and harvesting abilities struggle to keep up, requiring our gaze to shift to the lure that artificial intelligence offers. The digitalisation of the economy has brought about changes in the way work and business are organised and conducted, impacting on occupations and professions and related capabilities within these. All sectors of the economy are experiencing change, transforming old and creating new occupations and professions. The change in the organisation of business/work and occupational and professional demand undoubtedly has implications for both the education that is required and, using the technology that is now available, learning processes and systems as well. This is also the digital age wherein the very way in which we recognise learning is being challenged as we are confronted with concepts such as interoperability, immutability and disintermediation (Hughes et al., 2019; Karoudis & Magoulas, 2018; Keevy, 2020). What this really means is that we are having to give conscious thought to how systems and people *work together* – **interoperability** (Cupoli, Earley & Henderson, 2017); *how records get changed*, what traceability, auditability and testability we need our data to have – **immutability** (Bertoli, 2017); and finally, *who needs to be involved in the learning transaction* through a process of

using technology to reduce the number of intermediaries we rely on and make the learning transaction more direct – **disintermediation** (Bashir, 2018).

What is important to recognise is that technology has challenged not only the way we think about the recognition of learning (McAlpine, 2005; McKinsey Global Institute, 2019) but also the way in which we are identified digitally. Globally, these two strands are complementary, even overlapping, but not enough has been done to have the interdisciplinary discussion required to understand and explore the potential synergies. These are certainly uncharted waters, and it is important that we steer these processes where we can, else they will steer us, and human rights in terms of data privacy and security will certainly suffer.

Overall, this initiative intends to ensure that datasets in the South African PSET sector will be interoperable, well-synchronised and used effectively as a source of information for planning and improving efficiency in the PSET system. This is in keeping with the mandate of the State Information Technology Agency (SITA) to ensure reduction in duplication and to enable people to share information. The SITA has created minimum operability standards to allow government data systems to talk to one another and exchange data freely (interview with W. Needham, 2 July 2020), and these standards will be explored further while remaining cognisant that the PSET sector is highly complex and comprises a large number of stakeholders with varied and separate data systems. These stakeholders could be supported by an effective shared platform that is able to provide accurate and up-to-date data to the different role players and support effective reporting, planning and decision-making. Ideally, over time, this system could be populated with real-time data to enhance its responsiveness. Linking the system to other sources of data such as relevant market and industry indicators could further enhance the system's analytical capability. This could include big data approaches. Big data refers to datasets that are very large, diverse, combinable, flexible and scalable (Williamson, 2016). Big data is continuously generated and can be analysed in or near real time. This provides the capability for the provision of static snapshots as well as dynamic and continuously updated insights, where the value of “non-traditional data” such as data from citizens, NGOs and the private sector contributes further to the spectrum of research that can be done in a credible manner. Our journey into the future with the PSET CLOUD begins with this long-term vision.

2

METHODOLOGY

THEORY OF CHANGE

Framing the vision

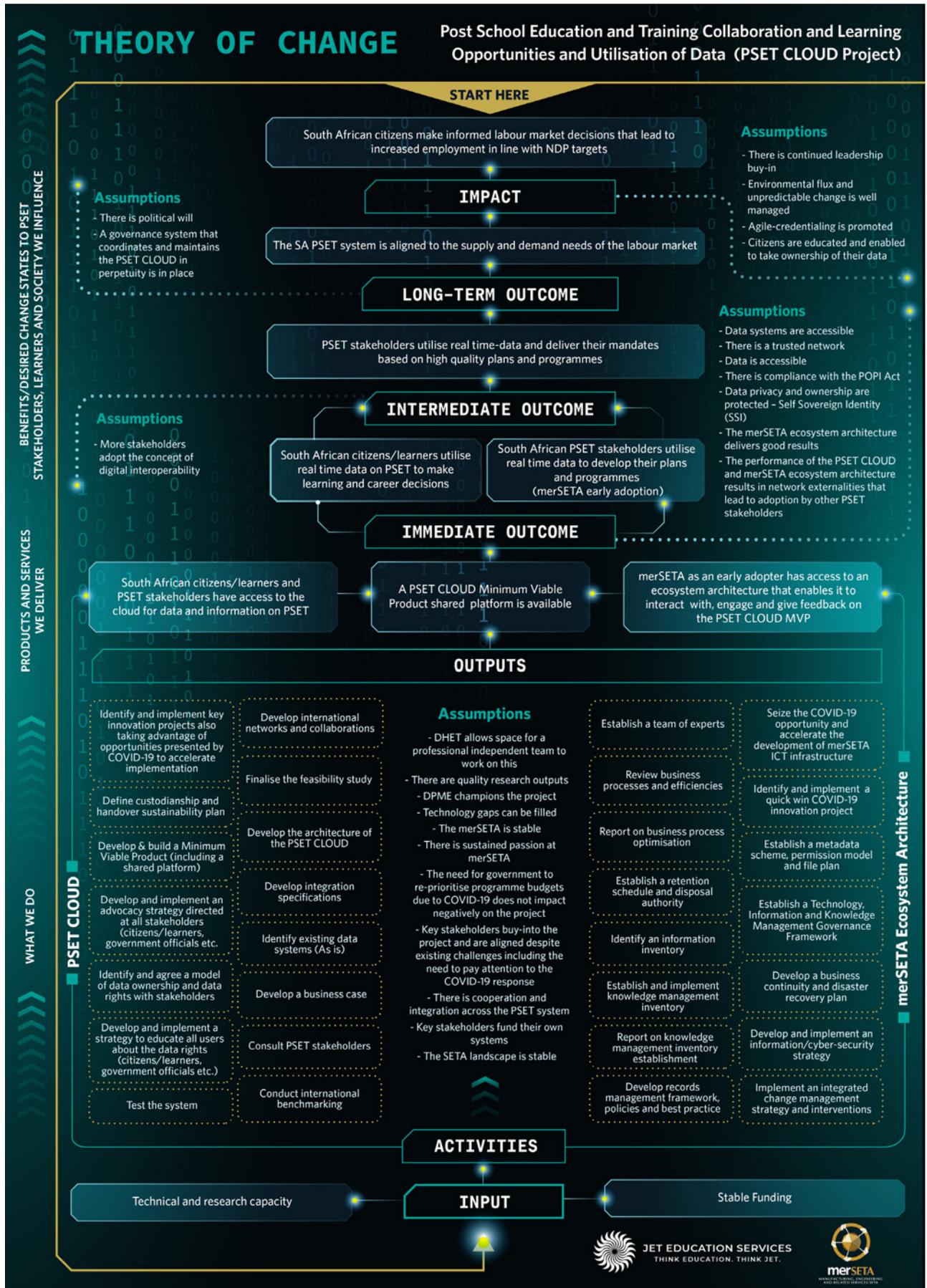
The theory of change (ToC) approach is a specific type of methodology that entails planning, participation and evaluation that is used to promote social change. A ToC defines long-term goals and outcomes from which it maps pathways linking the outcomes to actions and necessary preconditions for achieving those goals (Mayne, 2015). The ToC “explains the process of change by outlining causal linkages in an initiative, that is, the initiative’s shorter-term, intermediate, and longer-term outcomes. The identified changes are mapped as the “outcomes pathway”, showing each outcome in a logical relationship to all the others as well as the causal and, potentially, chronological flow” (Wikipedia contributors, 2020). By stipulating preconditions that need to be achieved en route to a bigger goal, the ToC makes it “easier for a team to track its progress and see whether an initiative is on the right track as it unfolds” (Reinholz & Andrews, 2020, 3). The links between outcomes as well as between outcomes, outputs and activities are explained by “rationales” or statements (also referred to as assumptions) as to why one outcome is thought to be a prerequisite for another or why a set of outputs and activities will

produce the particular outcome. These assumptions are often based on previous experience on similar projects but also embody some uncertainty and may need revision as the project evolves (Reinholz & Andrews, 2020).

The benefit of the ToC approach is that (1) it enables the identification of the ways in which actual outcomes deviate from those that are desired; and (2) it requires “stakeholders to model their desired outcomes before they decide on the forms of intervention to be used to achieve those outcomes” (Wikipedia contributors, 2020); this means that clarity about desired outcomes is essential.

In conceptualising the ToC, robust discussions took place on what the PSET CLOUD project is about, what problems we generally confront in the PSET sector, what the envisaged end results of the project are and the assumptions that inform the causal pathway we anticipate will lead to the achievement of the desired end result (impact). A well-defined ToC was developed and is depicted in the ToC infographic (see Figure 1). This ToC, in essence the theoretical framework of the project, will assist the team to determine whether the project is on track and following the pathway set out and identify any hindrances to the approach. Referring to the ToC allows for continuous reflection and evaluation of progress, including lessons learnt.

Figure 1: The theory of change for the PSET CLOUD (produced by JET & merSETA project teams, 2020)



As presented in Figure 1, the ToC makes **long-term goals** explicit at the outset. The project is then designed by working back from these goals and ensuring that all **assumptions** for their achievement are identified. The ToC also specifies the desired impact, assumptions relating to the existing situation and indicators for the project. These are set out below:

Impact: The desired impact of the PSET CLOUD is that South African citizens are able to make informed decisions that lead to employment in line with NDP targets.

Outcomes: The **long-term outcome** of the project is to develop a platform (a National Digital Ecosystem) that enables users such as learners, government, industry, NGOs and education institutions to share and use data for decision-making that promotes a more efficient and responsive post-school education system. **The intermediate outcome** that is identified is that PSET stakeholders will use real-time data and deliver their mandates based on high quality plans and programmes. During Phase 2, the current phase and the topic of this publication, the **immediate outcome** is to produce a minimum viable product (MVP) that we will share with stakeholders as we engage with them.

Assumptions: Some preconditions or requirements necessary to achieve the goal of the project are that there must be data that can be shared within the platform - entities to which the data belongs must make their data freely available; data must be readily accessible and structured in a way that it can be handled easily; data must be accurate, up-to-date and useful to users; there must be users that are interested in accessing and using this data; and a user-friendly system must enable users to access, analyse and present data in ways they find useful. Finally, an inherent assumption is that there will be buy-in to the development of such a platform, with political will and a governance system that will co-ordinate and maintain the PSET CLOUD in perpetuity.

Indicators: With the ToC in place, indicators are used to measure the effectiveness of implementation for monitoring purposes.

MONITORING AND EVALUATION

In addition to the ToC, it is critical to have a comprehensive M&E framework implemented from inception. The main goal of the M&E framework is to improve current and future management of outputs and activities which contribute to the achievement of project outcomes and impact. Monitoring on an ongoing basis provides the team with a lens into progress made and the opportunity to learn about what is working well and what the challenges are. This support activity enhances the work of the team, enabling timely decisions that need to be made to be brought into focus; and the lessons learned through the process make it possible to manage, apply and share knowledge among the JET and merSETA teams. A monitoring expert was brought into the project at an early stage, and robust discussions on a monthly basis continue to provide a platform for reflection, allowing for flexibility in design and implementation. A mid-term evaluation process is planned as we move into the next phase of the project. It is envisaged that a high-quality evaluation at mid-term and another at the end of the project, conducted by external evaluators, will provide relevant information that will enable the team to make improvements, judge the overall merits of the project and highlight the successes achieved.

The M&E framework provides key areas of focus aligned to activities and outputs measured by indicators that are set and agreed up front with each member of the team. These indicators are both qualitative and quantitative in nature. Although, as indicated above, an evaluation has yet to take place, we remain optimistic that we will contribute to the achievement of the outcomes highlighted in the ToC in Figure 1. The stage has been set with a well-established ToC, a clearly defined M&E framework and a core project team ready to explore whether data ecosystems in the PSET sector in South Africa are ready to become interoperable.

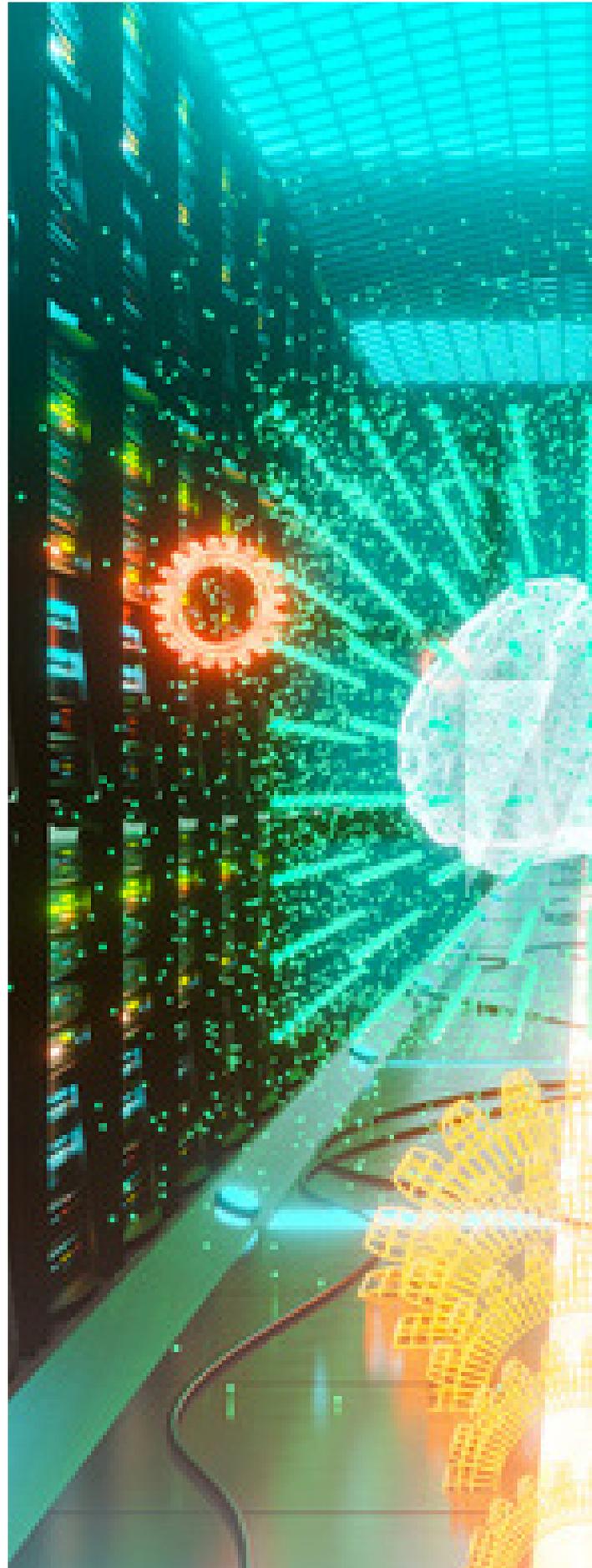
The main goal of the M&E framework is to improve current and future management of outputs and activities which contribute to the achievement of project outcomes and impact

PROJECT PARTNERS

Digital solutions and ecosystems should be built only after understanding the interaction that needs to be facilitated among the participants in the system concerned. It is therefore critical to ensure that while building a viable and feasible integrated interoperable national data system in South Africa, each aspect of the research is well defined and the role of each partner explicit. JET and the merSETA have been proactive co-partners in the project since inception and have brought on board service providers as and when necessary during the various stages of the project.

At inception, a **situational analysis** of stakeholders and systems was necessary to identify what data systems currently exist in the PSET sector and what their features are, which stakeholders in the system provide and/or utilise the data and what factors affect these data systems and stakeholders (CSIR, 2019c). A **mapping exercise** was conducted which produced a matrix of all stakeholders according to their current systems as well as their anticipated level of engagement with the PSET CLOUD. The exercise also provided in-depth information on system capabilities and any gaps in the system. A value proposition, that is, the potential value of the project to the stakeholders, was developed (CSIR, 2019b). Finally, a **feasibility analysis** was done to determine the viability of the idea of having an interoperable and integrated PSET CLOUD, whether it is legally and technically feasible as well as economically justifiable. The feasibility analysis was done to establish whether the project is doable and worth the investment (CSIR, 2019a).

The CSIR was appointed to conduct the three components highlighted above, while high-level international benchmarking research charted the various approaches to interoperability in several countries globally. The CSIR reports (2019a 2019b, 2019c) presented analyses of the current PSET systems to inform the development and implementation of a PSET platform. The major data sources were interviews and other reviews carried out during the situational analysis phase of the project. Focused interviews were conducted with key players in the information flows of the greater PSET system, for example, DHET officials and the Director responsible for the NLRD. Desktop research looked at relevant websites, published Acts, the annual reports of important entities (such as the Labour Market Intelligence Partnership [LMIP]) and research papers. In order to gain a deeper understanding of the PSET landscape and various technological systems that currently exist, additional reviews and interviews were conducted by project team members to enhance this report.





KEY CONSIDERATIONS

In a project such as this, it is always good for the team to ask themselves what should be well considered to achieve success. It was established that the following would be required to create the desired change in the long-term:

- A thorough understanding of key stakeholders that exist within the PSET system;
- Engaging with as many stakeholders as possible to make them aware of and receive their views on the PSET CLOUD project;
- Understanding the data systems that these stakeholders use, how the data is captured and stored and what the data is used for;
- Exploring the interaction with these stakeholders and whether the data systems enable data to be usefully handled and applied to assist decision-making within the stakeholder organisations;
- Understanding the education and technology policy environment.

Of paramount importance to consider was the kind of sustained effort required in order to achieve success. At inception of the project, the 4IR was topical in South Africa. However, COVID-19 has had a tremendous impact globally and on our society since December 2019, shifting the need to recognise the value of technology as an urgent one. We will inevitably be influenced by our current circumstances and by the lessons we have learned during an unprecedented and difficult period in our history. However, during the early stages of the project, it was decided that the PSET CLOUD needed to take on a phased approach. A detailed phased approach is explained in the last chapter of this report as next steps.

Current challenges presented by the worldwide pandemic have expedited our reliance on technology and focused our attention on how best we can collaborate with all stakeholders within the PSET sector to achieve success with an interoperable data ecosystem. Dialogues and engagement are an integral aspect of information sharing and planning in order to realise the international trend of platform development for education systems. Essentially, the concept of a platform ecosystem allows us to pursue larger, more complex solutions, collectively working towards a greater good which we would not be able to address individually. Equally important is the need to understand the policy environments for the labour market, education and technology and the impact these will have on the development of the PSET CLOUD.

3

THE ENVIRONMENT

This chapter discusses the ICT, e-government and PSET legal and policy environment. Policy and legislation play a critical role in transforming the ICT and PSET sector to respond to challenges and opportunities brought by the digitally driven 4IR. Technology trends such as microlearning, gamification, immersive learning, data-driven learning and insights and adaptive and personalised learning and their impact on learning are also discussed.

SOUTH AFRICAN CONSTITUTION

Although written in 1996, before the advent of the digital era, the rights enshrined in the South African Constitution are relevant as we consider the development of the PSET CLOUD.

The South African government has recognised that ICTs have the potential to further the rights enshrined in the South African Constitution by transforming the way citizens access information, communicate and participate in social and economic activities. Section 22 of the Constitution of the Republic of South Africa (RSA, 1996), for example, states that every citizen has the right to choose their trade, occupation or profession freely; and Section 29(b) states that everyone has the right to further education, which the state, through

reasonable measures, must make progressively available and accessible (RSA, 1996). These rights cannot be guaranteed if citizens do not have access to relevant and timely data and information to help them make informed decisions about their occupations, professions or careers.

In the digital era in general, including in integration and interoperability initiatives, data privacy and data ownership is of significant concern. The right to privacy is addressed in Section 14 of the Constitution, which states that everyone has the right to privacy including the right not to have their person or home searched; their property searched; their possessions seized; or the privacy of their communications infringed. The Constitution, as the supreme law, guarantees citizens' right to privacy, a right which every public or private institution must protect.

Security in the digital age has become a concern for governments the world over. Increasing incidents of cyber-terrorism require governments to implement mechanisms for preventing such attacks on government, business and society. National security is arguably at the top of the agenda for governments. Section 198 of the South African Constitution addresses national security and stipulates that national security must reflect the resolve of South Africans, as individuals and as a nation, to live as equals, to live in peace and harmony, to be free from fear and want and to seek a better life (RSA, 1996).

THE 4IR: TOWARDS AN INTEGRATED STRATEGY

The 4IR is characterised by a merging of technologies leading to the lines between the physical, digital, and biological spheres becoming blurred (Schwab, 2016) and presents governments, business and society with challenges and opportunities that require that they respond with context-relevant strategies.

The South African government is putting in place measures to respond effectively to these challenges. In April 2019, President Cyril Ramaphosa appointed the Presidential Commission on the Fourth Industrial Revolution to coordinate the development of South Africa's national action plan for responding to the 4IR by identifying policies, strategies and plans for positioning South Africa as a leader in the adoption of 4IR technologies. The establishment of the commission is in support of the NDP's vision of utilising ICTs to "build a more inclusive society in order to eliminate poverty and reduce inequality" (DTPS, 2016, 1). One of the key roles of the commission is the development of a national integrated strategy which details interventions to be carried out to assure the competitiveness of vital economic sectors (including manufacturing), with science, technology and innovation as key enablers. In support of the inclusive growth and economic transformation agenda, the commission is also tasked with making recommendations on approaches to promote inclusivity and address the digital divide as well as interventions to enable entrepreneurs and small, medium and micro enterprises (SMMEs) to take advantage of the 4IR. The role of the commission in advising the president and cabinet on skills development and the future of work is of particular interest to the PSET system. In 2020, the NPC released a draft review of the NDP in terms of South Africa's readiness for the 4IR (NPC, 2020b).

Below we unpack some of the policies, legislation and strategies that will be important in supporting South Africa's response to the 4IR.

POLICY AND LEGAL FRAMEWORK

This section discusses the ICT and e-government policy framework in South Africa. The important role of ICTs has gained recognition, as evidenced by the increasing adoption of technology by business, government and society. Furthermore, the government has provided a policy framework that places at the centre of planning, monitoring, reporting and evaluation the imperative

for organs of state and institutions to collect, store, disseminate and use data and information for purposes of decision-making. The PSET sector, identified as pivotal in South Africa's growth and development agenda, has undoubtedly benefited from the adoption of technology and been shaped by the technology-related policies discussed below.

Policies relating to e-government and ICT

Electronic Government: The Digital Future – A Public Service IT Policy Framework (2001)³

In 2001, South Africa adopted its first ever e-government policy and strategy to guide the development of e-government *Electronic Government: The Digital Future – A Public Service IT Policy* (DPSA, 2001). The policy identifies four key pillars, termed the "IT house of values", that underpin e-government development in South Africa, namely:

- 1. Interoperability** – The need for government ICT systems (data, infrastructure, communication systems and platforms, applications) to communicate and exchange data to promote the centralisation and integration of all IT systems.
- 2. IT security** – The need to protect physical IT systems and data from unauthorised access, malicious code and sabotage. With growing incidents of cybercrime, security has become a priority for governments worldwide.
- 3. Economies-of-scale** – The need to take full advantage of the purchasing power of government in promoting compliance and building skills and research capacity so as to minimise exploitation by vendors and influence the development of the local ICT industry.
- 4. Elimination of duplication** – Increased efficiency by abolishing unnecessary duplication of similar ICT functions, projects and resources (including collection, processing and archiving of the same data), as well as practices of "re-inventing the wheel" (DPSA, 2001, 8).

These pillars of the government's ICT strategy complement each other: interoperability, for example, is essential in eliminating duplication and achieving economies of scale; and security is critical for promoting trust in interoperability. An architecture framework provides the foundation for interoperability, security and reduced duplication. Currently, almost two decades after the development of its first e-government framework, South

³ <http://www.dpsa.gov.za/dpsa2g/documents/acts®ulations/frameworks/it.pdf>

Africa remains a leader in e-government development in Africa, ranking in the top three African countries in the United Nations (UN) e-government survey (UN, 2020). There is no doubt that the PSET sector has benefited from the government's adoption of the digital transformation agenda. Since the majority of institutions in the PSET sector (e.g. TVET colleges, higher education institutions [HEIs], SETAs, quality councils) are public institutions, the sector as a whole is covered by and benefits from this policy.

Policy Framework for the Government-Wide Monitoring and Evaluation System (2007)

The *Policy Framework for Government-Wide Monitoring and Evaluation System* (GWMES) is the overarching policy framework for monitoring and evaluation in government. It provides for "an integrated, encompassing framework of M&E principles, practices and standards" (The Presidency, 2007, 5) for M&E within government and for government planning and decision-making. The policy supports the statutory requirement for departments and public entities such as the merSETA to establish M&E systems for the collection, storage, dissemination and use of data and information pertaining to their mandates. The policy states that data and information collected by an organ of state or institution will be used by other stakeholders in the state system, e.g. the Department of Planning, Monitoring and Evaluation (DPME), to create an integrated picture of national, provincial and local performance with regard to implementation of varying mandates.

The policy framework also outlines at least three data terrains that should underpin systems of organs of state, namely: performance information on the achievements of their plans and programmes; evaluations; and social, economic and demographic statistics. The policy encourages key practices such as the establishment of a central repository of M&E outputs which should be reliable and easily accessible. It also encourages organs of state and institutions to explore means for sharing knowledge, insights and wisdom generated from M&E outputs, and for connecting such mechanisms to organisations' knowledge management and organisational learning culture and strategy. The GWMES works together with other supporting frameworks such as the National Treasury's *Framework for Managing Programme Performance Information* (National Treasury, 2007) and the *South African Statistics Quality Assurance Framework* (SASQAF) developed by Statistics South Africa (StatsSA) in 2010, both of which are also summarised in this section.

Framework for Managing Programme Performance Information (2007)

The *Framework for Managing Programme Information* (FMPPI) links to the GWMES and Section 92 of the

Constitution that states that "members of the Cabinet are accountable collectively and individually to Parliament for the exercise of their powers and performance of their functions" (National Treasury, 2007, 2), and that they must "provide Parliament with full and regular reports concerning matters under their control" (National Treasury, 2007, 2). The significance of reporting to Parliament is that Parliament is the body that represents citizens' interests, and reported information to Parliament is aimed at informing citizens. The framework deals with one of the data terrains of the GWMES, namely performance information.

The FMPPI thus emphasises the importance of performance data, information and records as management tools for decision-making in relation to the implementation of the mandates of government departments, public entities and institutions. The FMPPI further emphasises that performance information, data and records enables the public and oversight bodies such as Parliament to compare performance against delivery plans and the spending of public funds and thereby determine whether public institutions are providing value for money. The provision of data and knowledge can thus facilitate improvements in service delivery and a better understanding of issues pertaining to mandates. The framework provides guidance on: key concepts such as good quality indicators to enable the collection of quality performance data, information and records; capacity and resource requirements for managing and using the data; and the publication of performance information.

South African Statistical Quality Assessment Framework (2010)

The *South African Statistical Quality Assessment Framework* (SASQAF) is intended to enable the production of high-quality data so as to build trust in official and non-official statistics. It also aims to enable the availability of quality data and statistics capable of informing the development agenda of the state and data useful to the private sector and NGOs for planning and decision-making. The SASQAF specifies eight dimensions of data quality: relevance; accuracy; timeliness; accessibility; interpretability; comparability and coherence; methodological soundness; and integrity (StatsSA, 2010, foreword). These are in line with the requirements of the Statistics Act, 1999 (Act No. 6 of 1999), which is briefly summarised in the legislation section of this chapter. The SASQAF is also aligned to international best practice in the form of the *United Nations Fundamental Principles of Official Statistics* (UN, 2015).

The SASQAF enables the production of statistics in at least four specific ways: (1) it facilitates the extension of statistical production to various levels from national to provincial to local where availability of data may be insufficient and allows for the development and

coordination of data standards and statistics thereof; (2) the countrywide adoption of SASQAF facilitates linking the various subsystems of statistical production that have occurred in isolation into one system, the National Statistics Systems (NSS); (3) through the SASQAF, StatsSA has set standards for statistic products of all organs of state within one system so as to address the quality challenge; and (4) the SASQAF points to capacity requirements and thus allows for the development of capacity in the form of skills and infrastructure across the state, other agencies and the private and NGO sectors, thus both deepening and broadening the country's capacity to provide quality data and high integrity statistics (StatsSA, 2010, preface).

Broadcasting Digital Migration Policy (2008)⁴

The *Broadcasting Digital Migration Policy* (DOC, 2008) sets the parameters for the migration of South Africa's broadcasting from an analogue to a digital system. The policy was formulated in response to external coercive pressure from the International Telecommunications Union 2006 resolution which gave member countries a June 2015 deadline to migrate to digital broadcasting. The adoption of the resolution was South Africa's firm commitment to building a people-centred and inclusive digital and smart society. The broadcasting digital migration allows the radio frequency spectrum to be freed up for mobile broadband services and is critical for promoting digital access and connectivity. This is important in achieving the goals of a digitally transformed government and an inclusive society. The implementation of the broadcasting digital migration policy has been surrounded by controversy. Legal battles between the Department of Communications (DOC) and the Independent Communications Authority of South Africa (ICASA) have hindered progress. The migration, initially scheduled for June 2015, is yet to be finalised (more than 10 years after the development of the policy). Policy development and implementation is a complex process that involves consultation, negotiation and bargaining. In the context of digital governance, "the study of the broad impact of e-government policies needs to offer new and better accounts for the role played by the complex nature of the interplays and negotiations, which shape public service delivery mediated by ICTs" (Cordella & Hesse, 2015, 105). The finalisation of this policy is vital to South Africa's digital transformation journey and will also be to the benefit of the PSET sector as issues of high data costs are a hindrance to advancing the digital transformation agenda.

Corporate Governance of ICT Framework (2012)⁵

The role of ICT in advancing social, economic, and political development has led to the increasing emphasis of the need to recognise ICT as an important resource in institutions. The need for effective and efficient management and governance of ICT in institutions, including public institutions, requires that institutions implement relevant regulative and normative mechanisms.

In 2012, the government of South Africa implemented the *Public Service Corporate Governance of Information and Communication Technology Policy* to institutionalise the governance of ICT as an integral part of corporate governance within government in a standardised and coordinated manner (DPSA, 2012). The policy stipulates that "all ICT decisions of importance should come from senior political and managerial leadership and should not be delegated to technology specialists" (DPSA, 2012, 3). The management of information should be carried out on the same level as the management of other resources in the public service such as people, finance and material. Top leadership support and the recognition of information as an important resource is set to see the prioritisation of ICT as a strategic resource in government. This is important for the success of e-government, which requires top leadership commitment to develop and implement relevant strategies, policies and other mechanisms. Such improvements in governance within government serve to support increased institution-based trust as accountability and transparency are promoted.

National Broadband Policy (SA Connect) (2013)⁶

Broadband access is at the heart of the digital society and vital for promoting the right to information guaranteed in the South African Constitution. It is also essential for achieving government's vision of a digitally transformed government and society and realising the NDP's vision of "a seamless information infrastructure by 2030 that will underpin a dynamic and connected vibrant information society and a knowledge economy that is more inclusive, equitable and prosperous" (NPC, 2012, 190). While broadband is set to play an important role in connecting and integrating people, government and business in the pursuit of economic growth and social cohesion (NPC, 2012), the current poor state of broadband penetration in South Africa is a threat to the vision of an integrated and connected "smart society". *South Africa Connect: Creating opportunity, ensuring inclusion. South Africa's Broadband Policy* (DOC, 2013) aims to address both supply-side issues such as regulation, infrastructure and competition,

4 <https://www.ellipsis.co.za/wp-content/uploads/2014/01/Broadcasting-Digital-Migration-Policy-2008-8-September-2008.pdf>

5 https://www.gov.za/sites/default/files/gcis_document/201409/cgictpolicyframework.pdf

6 <https://wiki.lib.sun.ac.za/images/c/c7/Doc-bb-policy.pdf>

and demand-side issues such as affordability and digital literacy. For the PSET sector, connectivity via broadband will enable citizens to access information for making informed labour market and career decisions.

National Cyber Security Policy Framework (2015)⁷

The South African government published the *National Cyber Security Policy Framework for South Africa* in 2015 in response to the increasing threat of “cyber-attacks launched in recent years against advanced information societies aimed at undermining the functioning of public and private sector information systems” (NIA, 2015, 70). The policy framework seeks to:

- a. Promote a cyber security culture and demand compliance with minimum security standards;
- b. Strengthen intelligence collection, investigation, prosecution and judicial processes, in respect of preventing and addressing cybercrime, cyber terrorism and cyber warfare and other cyber ills;
- c. Establish public–private partnerships for national and international action plans;
- d. Ensure the protection of National Critical Information Infrastructure;
- e. Promote and ensure a comprehensive legal framework governing cyberspace (NIA, 2015, 77).

As stated in the policy document, “The policy framework is intended to implement an all-encompassing approach pertaining to all the role players (state, public, private sector, civil society and special interest groups) in relation to cybersecurity” (NIA, 2015, 77). This is critical for promoting better collaboration and coordination, especially as far as the interoperability of systems is concerned. Regulatory mechanisms also play a pivotal role in building trust and confidence in the digital environment if citizens know that they are protected.

National Integrated ICT Policy White Paper (2016)⁸

The *National Integrated ICT Policy White Paper* (DTPS, 2016) was developed in response to the challenges caused by the fragmentation of South Africa’s ICT policy and provided an opportunity to take advantage of the convergence of communication technologies. The objective of the integrated ICT policy is to develop a people-centred, developmental-oriented and inclusive digital society (DTPS, 2011). With the increasing use of ICTs in government, business and society, building trust and confidence in the digital and smart society is critical. The *National Integrated ICT Policy* reiterates that public and business confidence and trust in the digital and smart society is essential in promoting e-government and e-commerce growth in South Africa. The policy, in an effort to realise the NDP’s vision of ensuring that “by 2030, ICT will underpin the development of a dynamic and connected information society and a vibrant knowledge economy that is more inclusive and prosperous” (NPC, 2012, 190), addresses cybercrime, accessibility, equality, data protection, privacy, security, open access, integration, consumer protection and innovation. The three essential pillars that inform the policy are also important for the digital transformation agenda of the PSET sector.

- Digital transformation of government to fulfil government’s development objectives and increase efficiency across the public service. Digitisation of the public service will drive up demand for access to the Internet and therefore boost growth in e-commerce and other sectors that include the PSET sector.
- Digital access focusing on ensuring all citizens have the capacity to actively participate in the digital society and realise the potential of ICTs to improve their quality of life (including e-skilling, development of digital identity verification systems and promoting trust and security).
- Digital inclusion to ensure that no South African citizen is excluded from the benefits of a digital economy and knowledge society (DTPS, 2016, 9).

Digital inclusion in the PSET sector remains central in addressing the historical injustices that excluded certain groups from receiving quality education and training.

7 https://www.gov.za/sites/default/files/gcis_document/201512/39475gon609.pdf

8 https://www.gov.za/sites/default/files/gcis_document/201512/39475gon609.pdf

National e-Strategy (2017)⁹

Digital Society South Africa: South Africa's National e-Strategy towards a thriving and inclusive digital future seeks to transform South Africa into a “full digital society marked by a widespread diffusion, uptake and usage of ICTs in the whole society” (DTPS, 2017, 2). Digital transformation has been identified as one of the main catalysts in facilitating inclusive economic growth and economic and social inclusion. An inclusive digital society will be underpinned by the effective coordination of the following key drivers:

- **Enabling policies** that are innovative and promote the digital transformation agenda;
- **Infrastructure development** to address supply-side issues such as attracting infrastructure investment and competition;
- **Universal access** to address demand-side issues such as affordability and high-quality services irrespective of geography and social status;
- **Security** to promote citizen’s trust in the digital environment through the protection of their privacy and personal information;
- **Content** – Promoting the development of local content so as to stimulate the growth of the local ICT sector;
- **Innovation** – Promoting the development of local intellectual property, innovation and stimulating local production and manufacturing;
- **Skills** – Initiating skills development programmes to create awareness, uptake of ICTs in society and building capability for the 4IR (DTPS, 2017, 2–3).

The PSET sector is set to play a key role in coordinating key drivers such as skills and innovation in support of the inclusive growth agenda.

Legislation relating to e-government and information

Legislation is a regulative institutional mechanism that serves to enforce and ensure compliance to policy. Key legislation that addresses concerns around digital transformation is discussed briefly below.

The Public Service Act, No. 103 of 1994

To provide for the organisation and administration of the public service of the Republic, the regulation of the conditions of employment, terms of office, discipline, retirement and discharge of members of the public service, and matters connected therewith.

The Act assigns the responsibility of governance and the management of e-government and ICT to the Minister of Public Service and Administration. The Ministry guided the development of the first e-government policy framework in 2001 and the *Public Service Corporate Governance of Information and Communication Technology Policy* in 2012.

The State Information Technology Agency (SITA) Act, No. 88 of 1998

To provide for the establishment of a company that will provide information technology, information systems and related services to, or on behalf of, participating departments and in regard to these services, act as an agent of the South African Government; and to provide for matters connected therewith.

The Act gives the SITA a mandate to consolidate and coordinate the state’s IT resources in order to achieve cost savings through scale, increasing delivery capabilities and enhancing interoperability. The SITA is responsible for implementing the interoperability standards for improving interoperability.

The Statistics Act, No. 6 of 1999

The Act advances the planning, production, analysis, documentation, storage, dissemination and use of official and other statistics by providing for, amongst other matters, coordination between StatsSA and other organs of state that produce official and other statistics; cooperation between producers of official statistics and users across government, other sectors of the society and the public at large; cooperation between producers of official statistics and respondents supplying data and information that results in official statistics; and liaison with international bodies that request official statistics and those that make recommendations about standardisation, classification, collection, processing, analysing and dissemination of statistics. The SASQAF has proved to be a critical enabler in broadening and deepening the implementation of the Act across various role players and stakeholders, both in and outside government, who are producers of data for statistical products. These are statistics that are to help

⁹ https://www.dtps.gov.za/images/phocagallery/Popular_Topic_Pictures/National-e-strategy.pdf

organs of state, businesses, other organisations and the public with planning and decision-making as well as monitoring and evaluating implementation of policies, strategies and mandates.

The Act further outlines the purposes of official statistics and statistical principles. The purposes are to assist organs of state, businesses, other organisation such as NGOs, non-profit or voluntary organisations and the public in planning, and to provide data for decision-making as well as for monitoring and assessment of policy implementation and the implementation of decisions and other actions. The first principle is that official statistics must protect the identity of respondents and the confidentiality of the information provided. The second is that for information collected to be useful, the information provided should be: relevant, accurate, reliable and timeous; objective and comprehensive; compiled, reported and documented in a scientific and transparent manner; disseminated impartially; accessible; in accordance with appropriate national and international standards and classifications; and sensitive to distribution by gender, disability, region and similar socio-economic features (Act No. 6 of 1999).

Promotion of Access to Information Act (PAIA), No. 2 of 2000

To give effect to the constitutional right of access to any information held by the State and any information that is held by another person and that is required for the exercise or protection of any rights; and to provide for matters connected therewith.

As Salau (2017, 368) points out, “The right of access to information is the hallmark of an effective constitutional democracy.” There is much controversy surrounding the limits of the right to access to information and where governments should draw the line when it comes to information pertaining to national security. This right, like any other right, is not absolute.

The Electronic Communication and Transactions Act, No. 25 of 2002

To provide for the facilitation and regulation of electronic communications and transactions; to provide for the development of a national e-strategy for the Republic; to promote universal access to electronic communications and transactions and the use of electronic transactions by SMMEs; to provide for human resource development in electronic

transactions; to prevent abuse of information systems; to encourage the use of e-government services; and to provide for matters connected therewith.

The Act regulates the collection, use and protection of personal information obtained through electronic transactions and promotes privacy and security by governing the requirements for and restrictions on the collection, use, storage and disposal of personal information. Section 51 of the Act outlines the principles for collecting personal information electronically.

The Regulation of Interception of Communications and Provision of Communication-related Information Act, No. 70 of 2002

To regulate the interception of certain communications, the monitoring of certain signals and radio frequency spectrums and the provision of certain communication-related information; to regulate the making of applications for, and the issuing of, directions authorising the interception of communications and the provision of communication-related information under certain circumstances; to regulate the execution of directions and entry warrants by law enforcement officers and the assistance to be given by postal service providers, telecommunication service providers and decryption key holders in the execution of such directions and entry warrants; to prohibit the provision of telecommunication services which do not have the capability to be intercepted; to provide for certain costs to be borne by certain telecommunication service providers; to provide for the establishment of interception centres, the Office for Interception Centres and the Internet Service Providers Assistance Fund; to prohibit the manufacturing, assembling, possessing, selling, purchasing or advertising of certain equipment; to create offences and to prescribe penalties for such offences; and to provide for matters connected therewith.

This Act has been criticised for infringing people’s constitutional right to privacy as stipulated in Section 14 of the South African Constitution. The argument for the provisions of the Act is that they are necessary for national security, and, as mentioned above, no right is absolute. The Act is thus an example of an attempt to balance citizens’ rights to privacy and the imperative of national security.

The Protection of Personal Information Act (POPIA), No. 4 of 2013

To promote the protection of personal information processed by public and private bodies; to introduce certain conditions so as to establish minimum requirements for the processing of personal information; to provide for the establishment of an Information Regulator to exercise certain powers and to perform certain duties and functions in terms of this Act and the Promotion of Access to Information Act, 2000; to provide for the issuing of codes of conduct; to provide for the rights of persons regarding unsolicited electronic communications and automated decision-making; to regulate the flow of personal information across the borders of the Republic; and to provide for matters connected therewith.

This Act proposes several ways in which privacy, security and trust concerns should be addressed by promoting transparency with regard to what information is collected and processed. This covers the capturing of data, ensuring accuracy and removing data that is no longer required. The Act also addresses issues relating to the quality of information (Section 16), security measures on the integrity and confidentiality of personal information (Section 19) and the right of the data subject to access their personal information held by another party (Section 23).

The Cybercrimes and Cyber Security Bill, 2016

To create offences and impose penalties which have a bearing on cybercrime; to criminalise the distribution of data messages which is harmful and to provide for interim protection orders; to further regulate jurisdiction in respect of cybercrimes; to further regulate the powers to investigate cybercrimes; to further regulate aspects relating to mutual assistance in respect of the investigation of cybercrime; to provide for the establishment of a 24/7 Point of Contact; to further provide for the proof of certain facts by affidavit; to impose obligations on electronic communications service providers and financial institutions to assist in the investigation of cybercrimes and to report cybercrimes; to provide for the establishment of structures to promote cybersecurity and capacity-building; to regulate the identification and declaration of critical information infrastructures and measures to protect critical information infrastructures; to provide that the

Executive may enter into agreements with foreign States to promote cybersecurity; to delete and amend provisions of certain laws; and to provide for matters connected therewith.

Delays in the implementation of this crucial Bill leave South Africa vulnerable.

Skills and labour market policy

The role of technology and data integration in strengthening the PSET system is also supported by key national skills and labour market policies discussed in the sections below.

The National Development Plan (2012)¹⁰

The *National Development Plan 2030: Our future – Make it work*, adopted by the South African government in 2012, is South Africa's overarching policy that aims to eliminate poverty and reduce inequality by 2030 (NPC, 2012). Skills have been identified as critical in achieving some of the key priorities identified in the NDP, including: (i) raising employment through faster economic growth; (ii) improving the quality of education, skills development and innovation; and (iii) building the capability of the state to play a developmental, transformative role. Furthermore, the NDP, recognises ICT as an important tool for social and economic development. The vision of the NDP is that "by 2030, ICT will underpin the development of a dynamic and connected information society and a vibrant knowledge economy that is more inclusive and prosperous" (NPC, 2012, 190). The NDP identifies integration of government programmes, processes and systems as pivotal for increasing efficiency in the pursuit of social and economic development and envisages that:

By 2030 the ecosystem of digital networks, services, applications, content and devices, are firmly integrated in the economic and social fabric. Such integration will connect public administration and active citizens while promoting economic growth, development and competitiveness, and strengthen social cohesion; and support local, national and regional integration. (NPC, 2012, 290)

Integration, interoperability and information sharing in government are important for collaboration, planning and decision-making in the implementation of government programmes. The lack of an integrated approach may result in efforts that are often fragmented and duplicated, with unclear lines of responsibility, leading to wastage of resources. The NDP's prioritisation of an integrated

10 https://www.gov.za/sites/default/files/gcis_document/201409/ndp-2030-our-future-make-it-workr.pdf

approach to the development and implementation of government programmes has laid a strong foundation for the integration of e-government systems.

Human Resource Development Strategy for South Africa (HRD-SA) (2010, rev. 2017)¹¹

South Africa's *Human Resource Development Strategy Towards 2030, a revised version of the Human Resource Development Strategy for South Africa (HRD-SA) 2010–2030*, takes into account increasing competition and the expansion of global production systems and addresses equity, poverty reduction and social cohesion throughout South Africa (HRDC, 2017). The strategy's priority is to accelerate skills development so that the supply of skills in the country will match the demand for a skilled workforce. The strategy includes both high and intermediate skills development. Data and information are identified as crucial for monitoring and evaluating the HRD strategy, as highlighted in seven of the nine principles on which the strategy's approach to the use of data for M&E is based:

- **Relevance:** providing data and information that is relevant to the strategy and its implementation.
- **Accuracy:** ensuring that the data and information provided has been verified and that its accuracy can be depended on.
- **Currency:** finding data that is as up-to-date as is possible.
- **Accessibility:** presenting the data and information in a manner that is easy to understand and engage with.
- **Results-based:** constantly seeking to explain cause and effect in terms of the theory of change and using monitoring data to improve implementation.
- **Fairness:** information and data equally accessible among the team.
- **Transparency:** information disclosure regarding the results, process, substantive measures when developing the system, and realignment following monitoring and evaluation, is critical (HRDC, 2017, 37).

The White Paper on Post-School Education and Training (2014)¹²

The *White Paper for Post-School Education and Training: Building on Expanded, Effective and Integrated Post-School Education* (DHET, 2014b) envisages the development of an "integrated system in such a way that the different components complement one another, and work together to improve the quality, quantity and diversity of

post-school education and training opportunities in South Africa" (DHET, 2014, 75). One of the main policy objectives of the white paper is to establish "a single, coordinated Post-School Education and Training system" (DHET, 2014, xi). This stresses the importance of collaboration between and integration of government programmes, systems and services, echoing the NDP. Achieving this goal demands that government departments and agencies share information and ensure that their information systems can be integrated and are interoperable.

The National Skills Development Plan (2019)¹³

The *National Skills Development Plan (NSDP) 2030* locates skills development in an integrated PSET system which is demand-led in order to assist economic growth and transformation. The purpose of the NSDP is to "ensure that South Africa has adequate, appropriate and high quality skills that contribute towards economic growth, employment creation and social development" (DHET, 2019f, 5). The entire post-school system has been the focus of a significant and radical improvement in the quality of education and training (DHET, 2019f). An integrated approach, collaboration and inclusivity and strengthening systems within the PSET system are highlighted as pivotal in the implementation of the NSDP. Partnerships and collaboration between SETAs, employers, social partners, labour, civil society and government are critical in achieving the NSDP's vision of "An educated, skilled and capable workforce for South Africa".

Legislation that has shaped the PSET sector

Below we highlight some of the key legislation that has shaped the development of the PSET sector in the past two decades since South Africa attained freedom from the oppressive apartheid system. The democratic government inherited an education and training system that perpetuated inequality, and this is still evident in the labour market. The focus of skills development policy and legislation in the past two decades has thus been to address low levels of skills in the labour market by improving access to education and training.

Skills development Act, No. 97 of 1998

To provide an institutional framework to devise and implement national, sector and workplace strategies to develop and improve the skills of the South African

11 <http://hrdcsa.org.za/wp-content/uploads/2017/07/Revised-HRD-Strategy-June-2017.pdf>

12 https://www.gov.za/sites/default/files/gcis_document/201409/37229gon11.pdf

13 https://www.gov.za/sites/default/files/gcis_document/201903/42290gon375.pdf

work force; to integrate those strategies within the National Qualifications Framework contemplated in the South African Qualifications Authority Act, 1995; to provide for learnerships that lead to recognised occupational qualifications; to provide for the “financing” of skills development by means of a levy-grant scheme and a National Skills Fund; to provide for and regulate employment services; and to provide for matters connected therewith.

National Qualifications Framework Act, No. 67 of 2008

The objectives of the National Qualifications Framework (NQF) Act are to:

- Create a single integrated national framework for learning achievements;
- Facilitate access to, and mobility and progression within, education, training and career paths;
- Enhance the quality of education and training;
- Accelerate the redress of past unfair discrimination in education, training and employment opportunities.

The Act further provides for maintaining a National Learners’ Records Database (NLRD) comprising registers of national qualifications, part-qualifications, learner achievements, recognised professional bodies, professional designations and associated information.

Higher Education Act, No. 101 of 1997

To regulate higher education; to provide for the establishment, composition and functions of a Council on Higher Education; to provide for the establishment, governance and funding of public higher education institutions; to provide for the appointment and functions of an independent assessor; to provide for the registration of private higher education institutions; to provide for quality assurance and quality promotion in higher education; to provide for transitional arrangements and the repeal of certain laws; and to provide for matters connected therewith.

TECHNOLOGICAL TRENDS AND THEIR IMPACT ON LEARNING

A review of literature identified microlearning, gamification, immersive learning, big data analytics, and adaptive and personalised learning as some of the technological trends that are impacting learning in the 4IR. Data is also at the core of these technologies, and their adoption calls for institutions to embrace a data-centric approach. While the extent of the adoption of these technologies in South Africa remains unclear, there are several initiatives currently being implemented by civil society organisations, government, companies and private training providers aimed at promoting their use. The merSETA, for example, is using a 4IR paradigm to re-imagine and develop a high-quality new apprenticeship skills development process in South Africa that is more efficient, accessible, scalable and that prepares apprentices for “Industry 4.0”. The PSET CLOUD initiative is a key initiative in promoting technology adoption in the PSET sector by, among other things, advocating for a data-centric approach through interoperability.

The trends that are impacting learning are described below.

Microlearning

Traditional learning has often been criticised for its inability to stimulate innovation and creativity due to its failure to motivate students to learn new things (Mohammed, Wakil & Nawroly, 2018). Conventional learning models, learning activities and theoretical concepts are becoming ineffective, which calls for a new approach to training. Microlearning is increasingly being recognised as a solution to this challenge. Research into this approach aims to explore microlearning as “a new way of responding to the growing need for lifelong learning or learning on demand” (Gabrielli, Kimani & Catarci, 2017, 1). Microlearning essentially parcels knowledge into small and understandable segments (Mohammed et al., 2018) and can provide learners with the knowledge and skills they need as they discover career or job paths for themselves (Gutierrez, 2015). Furthermore, microlearning uses flexible technologies that facilitate access to the newest information whenever, wherever, and allow users to learn at their own pace (Gabrielli, et al., 2017; Mohammed et al., 2018).

Gamification

Gamification or game-based learning is increasingly being used in many disciplines and is defined as “the use of ‘game-based mechanics, aesthetics and game thinking to engage people, motivate action, promote learning

and solve problems” (Kapp, 2012, cited in Markopoulos, Fragkou, Kasidiaris & Davim, 2015, 119). Studies have shown that game-based learning is a powerful tool to engage and motivate learners (Karagiorgas & Niemann, 2017; Markopoulos et al., 2015). Markopoulos et al. (2015, 129), in their investigation of gamification in engineering education and professional training, concluded that gamification has “a positive effect in engineering in education by making difficult subjects more manageable, increase intrinsic motivation, scientific knowledge, collaboration, interest and reduce or better manage work load”.

Immersive learning

Extended reality (XR) technologies which incorporate various technologies such as augmented reality (AR), virtual reality (VR) and mixed reality (MR) promote immersive learning experiences. Advances in these technologies have led to increased adoption of simulated training as a means to increase training efficiency through reducing costs and risks where the physical environment may be unsafe (Kaplan et al., 2020). Hilfert and König (2016) also concluded that in engineering and the built environment, immersive learning technologies such as VR allows people to experience realistic, first-person situations without having to worry about injuries.

Data-driven learning and insights

In the digital and data-driven environment and the 4IR, the importance of data cannot be emphasised enough. Technology such as big data analytics and machine learning can be used to collect, aggregate and analyse data to provide insights that can improve the learning and performance of learners. Big data analytics can provide insights into labour market trends and employment data that can assist learners in making informed career choices. Data can also be used to enhance planning, operations and decision-making in institutions: insights can be generated that can assist PSET institutions to respond to

the changing economic, social, political and technological landscape. According to Daniel (2017, 19),

Globally, the landscape of [the] higher education sector is under increasing pressure to transform its operational and governing structure; to accommodate new economic, social and cultural agendas; relevant to regional, national and international demands... As a result, institutions are constantly searching for actionable insights from their data, to generate strategies they can use to meet these new demands.

South Africa is no exception, as the PSET sector is also under pressure to transform to support South Africa’s inclusive growth and development agenda. Insights from data are therefore critical for enabling institutions to respond with relevant strategies.

Adaptive and personalised learning

Personalised learning is based on the principle that learning needs to be tailor-made to meet the needs of the individual learner. Emerging technologies such as machine learning, artificial intelligence and big data allow for more “in-depth personalisation of the content for an individual’s learning needs” (Marr, 2020). As described by Moltudal, Høydal and Krumsvik (2020, 13), “Adaptive learning technologies (ALT) and learning analytics (LA) are expected to contribute to the customisation and personalisation of learning by continually calibrating and adjusting learning activities towards the skill and competence level of the learner.” For example, findings from the evaluation of the Training Layoff Scheme conducted by the merSETA concluded that there is a need for criteria to determine what constitutes appropriate training for displaced workers based on their individual training needs and aspirations. This requires flexibility as a “one size fits all” approach is unlikely to work (merSETA, 2017).

Personalised learning is based on the principle that learning needs to be tailor-made to meet the needs of the individual learner

4

THE PSET SYSTEM IN SOUTH AFRICA

UNDERSTANDING THE PSET SYSTEM

The PSET system is complex. This is confirmed by a situational analysis of the socio-economic and political environment where various stakeholders and institutions, target groups and problems within the PSET sector have been highlighted (CSIR, 2019b). At least seven different types of institutions besides government departments share responsibilities at the national level. These include government agencies such as the National Skills Authority (NSA), three independent quality councils, the National Artisan Moderation Body (NAMMB), the SETAs where business, organised labour, community and government are represented, the National Skills Fund (NSF), professional bodies and an advisory body, the National Skills Authority (NSA) and the Human Resource Development Council (HRDC) (see Figure 2).

Education and training institutions

Education and training institutions include public universities, TVET colleges and CET colleges as well as private universities, private colleges, private skills development providers and education and training bodies within other government departments.

There are 26 public universities and 125 private universities in South Africa. In 2017, there were

1 036 984 students enrolled at universities. Of this total, 36.4% were distance students and 63.6% were contact students; 84.9% were enrolled at public universities and 15.1% at private universities (DHET, 2019e).

South Africa has 50 public TVET colleges that are spread over 252 campuses. In 2017, there were 688 028 TVET students, a decrease of 2.5% from 2016. 74.1% of the enrolments are in the National Technical Education (NATED) programmes, with the vocational learning pathway, the National Certificate Vocational (NC[V]), making up 20.7%. The NATED and NC(V) programmes benefit from appearing in a ministerial approved programme register, allowing them to be more visible to prospective students, but also to be state-funded. Occupational qualifications and other programmes with lower enrolment are funded from other sources such as self-paying students, SETA grants or the NSF. TVET colleges have a focus on job-linked programmes, and therefore require strong links with industry (DHET, 2019e).

CET colleges are designed to cater for youth and adults who have not completed their schooling or have never attended school and therefore do not qualify to study at TVET colleges or universities. In 2017, there were 258 199 students enrolled in CET colleges. Overall enrolment decreased by 10.8% over the period 2011–2017, with major decreases recorded for Adult Education and Training Levels 1–3 (46.6% or 43 712) and non-formal programmes (37.7% or 3 431). In contrast, a 21.2% (14 886) increase was recorded for Grade 12 in the same period. Despite the overall decrease in enrolment,

the enrolment for non-formal programmes almost doubled. It is expected that the enrolments in the sector would improve significantly through the opening of additional centres. In addition, the NDP requires the CET sector to reach a target of 1 million in enrolments by 2030 (DHET, 2019e).

There are 268 private colleges registered with the DHET, and in 2017, total student enrolments were at least 187 354 (some colleges did not respond to the departmental survey). The numbers of students at private colleges are therefore about a fifth of the numbers at public TVET colleges. Enrolments have, however, varied widely over the last five years, and data is not complete (DHET, 2019e).

Skills levy organisations

Skills levy organisations include SETAs, the NSA and the NSF. These organisations try to balance the skills development interests and priorities of business, organised labour, communities and government. The main focus of the government's skills development initiatives has been the SETAs. There were originally 23 SETAs delivering skills development services and training to 23 sectors. The number was recently reduced to 21. In 2017, the number of workers registered for SETA-supported learning programmes (learnerships, internships and skills programmes) was 124 456. SETAs also supported 144 691 unemployed persons and 32 330 persons entering artisan training (DHET, 2019e).

SETAs are funded from the skills levies. The Skills Development Act, No. 97 of 1998 requires all employers with a monthly salary bill of R500 000 or more to pay 1% of their total salaries as a levy to the South African Revenue Service. Of these funds, 20% is distributed to the NSF and 80% to the SETAs. Some of the SETAs' funding goes to employers for training of their employees, and funding is also provided to the Quality Council for Trades and Occupations (QCTO). The SETAs retain 10% for administrative expenses. Each SETA is required to draw up a sector skills plan which is used to determine how funding is allocated for training (DHET, 2019e).

Qualifications and quality assurance bodies

Qualifications and quality assurance bodies include the QCTO, the Council for Higher Education (CHE), the South African Qualifications Authority (SAQA) and the Council for Quality Assurance in General and Further Education and Training, Umalusi.

The quality assurance landscape in South Africa is possibly best understood from the vantage point of a qualification. The quality assurance structures have been put in place to

ensure that qualifications meet required quality standards so that the person who achieves the qualification is thereby given a better opportunity of securing future employment (Schwartz, 2019).

PSET qualifications are registered with the DHET and SAQA. SAQA oversees the development and implementation of the National Qualifications Framework (NQF) by formulating and publishing policies and criteria for the registration of bodies responsible for establishing education and training standards or qualifications. The NQF has 10 levels of learning achievements, ranging from a general certificate (at level 1) to a Doctoral degree (at level 10). The NQF allows qualifications to be categorised and learner achievements to be modularised and articulated (Lange, 2017), assisting learners to find a learning pathway where they constantly build on their knowledge and expertise. Learner achievements and qualifications are recorded in the NLRD, providing a permanent record for each learner that exists beyond the boundaries of individual institutions.

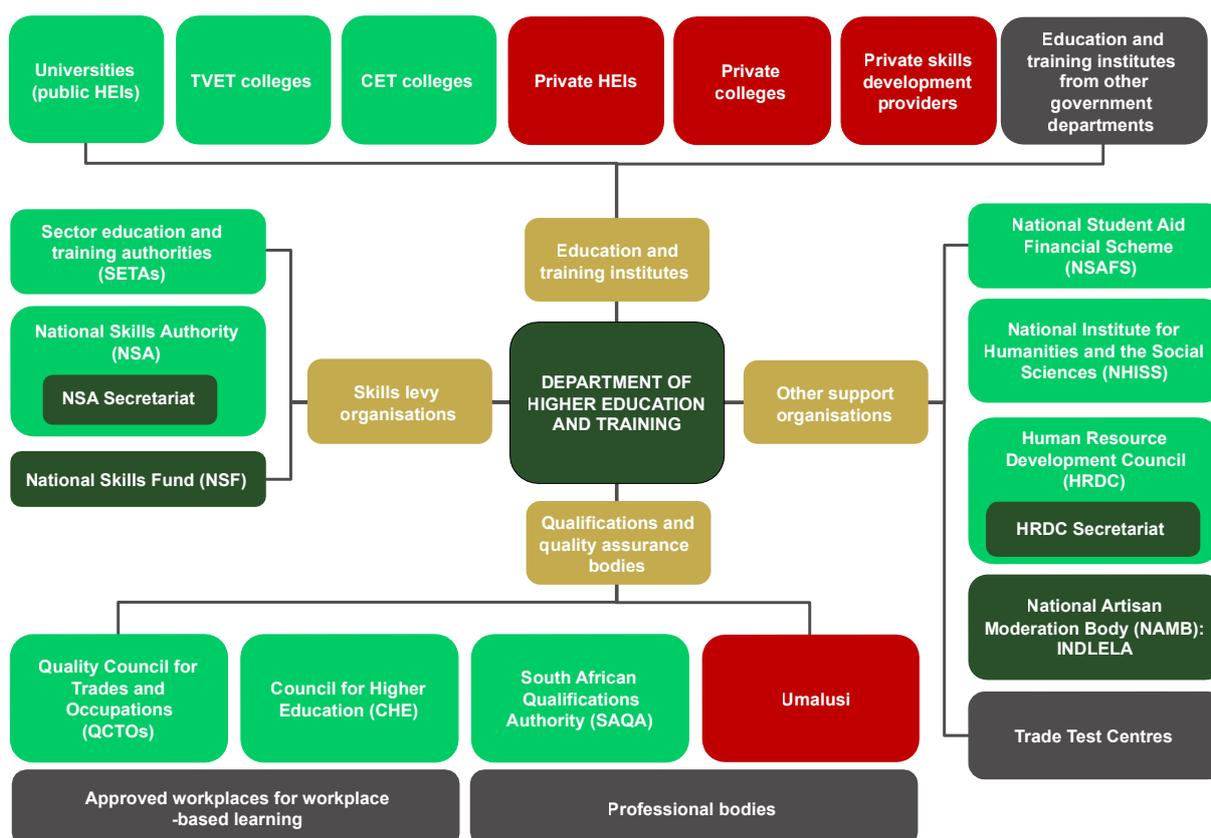
The quality of a qualification is assured by a particular body, depending on the type of learning being offered. The QCTO manages the occupational (vocational) qualifications sub-framework in order to set standards, develop and quality assure national occupational qualifications for trades, occupations and professions. A key focus of the QCTO is navigating the fit between skills being trained and those required by the workplace (Gqili, 2016), that is, actively working towards "closing the skills gap" (QCTO, 2019a, 4). The CHE regulates all academic qualifications, and advises the Minister of Higher Education and Training on matters pertaining to higher education and research. As such, the CHE has responsibilities pertaining to quality assurance and accreditation, and discharges this through a permanent committee (as required by the Higher Education Act), which is referred to as the Higher Education Quality Committee (HEQC). The CHE quality assurance function includes institutional audits, programme evaluation, quality promotion and capacity-building. Additionally, the CHE is responsible for monitoring and evaluating the state of higher education in South Africa, which means tracking to what extent the DHET's vision, policy and objectives are being realised. Finally, the CHE must contribute to the development of higher education through the development of reports, holding conferences and conducting research (Bailey, 2014). Umalusi sets and monitors standards for general and further education and training in South Africa. Its functions, like those of the other two quality councils, include developing and managing the general education framework, quality assuring qualifications and curricula, ensuring that assessments are fair, valid and reliable, developing the necessary quality assurance skills and capacity and, finally, supporting research that helps them address the issues they face (Umalusi, 2019).

Other support organisations

Other support organisations include the National Student Financial Aid Scheme (NSFAS), the National Institute for Humanities and Social Sciences (NIHSS), the HRDC, the NAMB and Trade Test Centres. The NSFAS provides financial aid to students from poor and working-class families. The NIHSS carries out a range of functions to enhance and coordinate scholarship, research and ethical practice within the field of humanities and social sciences. The HRDC facilitates the “optimal participation of all stakeholders in the planning, stewardship and monitoring and evaluation of human resource development activities in the country” (HRDC, n.d.). The NAMB contributes to the development of artisans in South Africa by supporting the National Artisan Development Programme, providing support to learners to gain workplace experience and managing the National Artisan Database. Trade Test Centres carry out trade tests to enable artisans to receive certification.

Figure 2 indicates how stakeholders are clustered and linked to the DHET. Organisations presented in dark green are located within the DHET. Organisations in light green, while located outside the DHET, receive DHET funding which is sourced from the fiscus and the skills levy. Organisations in red are located outside of and do not receive DHET funding. However, the DHET is still required to carry out particular legislative functions for these organisations. Finally, organisations in grey do not receive DHET funding, and the DHET is not responsible for any legislative functions that relate to them; however, DHET entities may have responsibilities in relation to these organisations. For instance, quality councils will have to quality assure formal programmes provided by other government departments. The roles and responsibilities of DHET stakeholders as well as developmental targets are defined in the DHET’s plans¹⁴ and policies.¹⁵

Figure 2: PSET ecosystem role players (DHET, 2019d, 2)



14 <http://www.dhet.gov.za/SitePages/DocStrategicPlans.aspx>

15 <http://www.dhet.gov.za/SitePages/DocPolicies.aspx>

At this stage, the DHET plays a central and critical role in the development, management and oversight of the PSET system. Ultimately, the DHET is working towards supporting socio-economic development in South Africa. This includes developing a graduate cohort that has market appropriate qualifications and is demographically representative of the South African population. This includes working on (DHET, 2020):

- Improved integration and coordination between PSET system role players and programmes;
- Promoting and supporting improved access and participation in the PSET system through the creation of a sustainable student financial aid system, expansion of staff capacity and training infrastructure, amongst other initiatives;
- Becoming more responsive to the market and student needs, including exploring partnerships and promoting skills needed for sustainable livelihoods;
- Improving the quality of teaching, learning and research by investing in infrastructure, promoting a culture of learning and the continued professional development of staff;
- Creating the mechanisms and processes necessary to ensure optimal use of resources in the PSET system including addressing student drop-out rates.

Influencing, shaping and building the capabilities of South Africans, “the primary focus of the DHET” (DHET, 2020, 4) is a complex problem that needs the entire sector to work together. It is for this reason that collaboration and cooperation with the DHET is seen as critical for the PSET CLOUD initiative. In order for the PSET CLOUD initiative to be realised, stakeholders will have to find a way of creating a portfolio of collaborative initiatives that span the continuum from encounters to substantial engagements (Rajab, 2020). The success of any new intervention depends on individuals being able to suspend their own positions and self-interest long enough to develop the trust required to develop a mutual understanding and shared worldview.

To generate the advances required, South African citizens need to engage in initiatives that support innovation in all sectors. The PSET CLOUD project supports an innovation that promotes:

- The development of tools and datasets that allow stakeholders to generate new services, seamlessly coordinating and leveraging existing initiatives;
- Connecting more directly to the learners and other users of educational-sector data and providing a space where they can offer feedback and solutions;
- Sharing insights, expertise and learning between stakeholders so that incremental improvements can have a wider, more lasting impact.

Social realities

While we acknowledge that the PSET sector is a complex system with a vast array of actors, we recognise that the schooling system is contributing to rising numbers of unemployed youth with an incomplete secondary education and a lack of skills sufficient to guarantee employment (Bhorat & Kimani, 2017). As a response to high unemployment rates and, more particularly, unemployed youth in South Africa, the aim of the National Skills Development Strategy III (NSDS 3) is to improve the skills development system so that it is more responsive to labour market needs and social equity requirements. The 2019 Organisation for Economic Co-operation and Development (OECD) report, *Getting Skills Right: South Africa*, identifies that there is a need in South Africa:

- For more data, monitoring and behavioural pattern analysis bridging the gap between education and employment;
- For improvement in the quality of the PSET system through funding, bridging programmes, better alignment of programmes to the workplace, more workplace-based training opportunities and closer monitoring of the different education paths people take;
- For greater support of lifelong learning; and
- For better coordination and cooperation between all stakeholders.

Although there is a strong motivation to explore the development of the PSET CLOUD, we also need to take cognisance of some disturbing trends in the South African PSET system identified in the 2019 OECD report:

- Although we are seeing an increase in post-school educated individuals, the number of tertiary educated individuals is dropping.
- There are growing skills shortages, with a growing number of employers reporting difficulty in filling positions.
- Employers are increasingly employing people who are underqualified for their positions.
- There is a mismatch between the qualifications and the occupations people hold.
- There is limited information on the field-of-study for a large part of the South African population.
- There is inadequate data and information on firm-level workplace training needs and outcomes.
- Data and information on changing, transforming and new occupations and skills is inadequate.

These point to a mismatch in the supply and demand of skills development and job requirements, which may be partly related to the inadequacy of accurate and complete

labour market data. Students' choices of which HEIs to attend are driven by a need for support – both in teaching and learning practices as well as financially – and not by the institutional reputation (Penceliah, Konyana & Maharaj, 2016). Moreover, only a small percentage of students who have had a smooth schooling journey are guided by the programme offering, international linkages and recognition. For most, the potential pathway to employment that a tertiary institution provides is more important.

The South African Youth Panel Survey (SAYPS), a longitudinal panel study of South African learners initiated in 2011 to explore educational transitions through and beyond school, revealed that for the majority of learners in South Africa, schooling is not a smooth transition from enrolment in preschool or primary school to secondary school and tertiary education. The latest report of the SAYPS (Isdale, Reddy, Winnaar & Zuze, 2018) indicates that only a small cohort of learners' transition into tertiary education without some sort of interruption or repetition in their schooling. These learners typically come from a background where their parents are able to support them in their schooling or are able to leverage the independent school system which has a better track record of supporting its learners in being accepted for tertiary training. If these learners do progress into the PSET system, their immediate priority is to obtain qualifications in order to gain employment so that they can improve their social welfare – the subject choice is less important than avoiding the desperation of falling into the 'not in employment, education or training' pool.

The implication of this situation is that we need greater transparency and support to track, understand and develop pathways that help learners from all backgrounds to choose and access development opportunities, with the necessary support to ensure the accumulation of credits and qualifications that make it possible for them to find employment or create employment for themselves. What we need, therefore, is to find a more dynamic and adaptive way of matching the skills acquired at institutions to the skills required by the economy. The PSET CLOUD could provide this solution in the long term.

Key interactions

Underlying the ambition of the PSET CLOUD outcome is a view of the employment ecosystem as one where effort and energy is spent in helping four distinct areas which will gain value from working together. These are:

- Investments in people and training: improving the quality and quantity of educated South Africans;
- Matching efforts: helping qualified workers find, choose and secure available jobs;

- Improved management practices: shifting mindsets and management practices to help organisations become more viable and more supportive employers;
- Making improvements to the wider employment ecosystem: this includes better early childhood education, healthcare, social services and benefits.

Systemic cooperation and synergy

Currently, the link between the Department of Basic Education (DBE), the DHET and the Department of Labour (DoL) is the most formal and organised as this is seen as the primary pipeline to help South African citizens become participants in the economy. What still needs to be explored further is whether more information sharing and increased coordinated action will have a greater impact on bridging the gap between supply and demand of skills. It is envisaged that using the data already gathered in studies such as the SAYPS and creating a more visible, dynamic view of peoples' transition into the workplace will enable better identification and management of the social determinants of work and foster more cross-sector and inter-departmental collaboration.

The DHET has divided its mandate of supporting and developing PSET into four clear streams, as discussed in the first section of this chapter. Delineating the mandate so clearly has created sharp boundaries between the people responsible for each of the streams and their singular approaches mean that the work within the DHET is vulnerable to becoming siloed and the potential synergies, cooperation and movement between the streams are not being explored sufficiently.

In addition, the management of these streams is split into many different directorates. The most complex is possibly the TVET stream, which has 11 directorates managing the sector.

There are many directorates required to manage TVET colleges, as seen in Figure 4, and questions arise as to whether these directorates are all adequately funded and have the human resources required to execute their mandates effectively. It certainly complicates the interaction a single TVET college may have with the DHET. A specific college would primarily interact with the DHET through a regional office. The extent to which this regionalised presence helps or hinders support for the development of the sector is unknown and seems to depend on the strength and initiative of the regional office staff. It may well be that the need for support from TVET colleges varies from college to college as the skill levels and capabilities within the colleges are not consistent.

The university sector is a more mature and stable sector; hence, there are fewer directorates and each university builds a direct relationship with the National Chief Directorate for Universities.

The skills development stream is one that appears deceptively simple. Its complexity, however, lies in the policy relationship between the skills development policy, labour market and the economy. Skills development legislation and related regulation historically, prior to the establishment of the DHET, was and still is subject to review by and consultation with the National Economic Development and Labour Council (NEDLAC). NEDLAC was established along the lines of a social partnership model of business, involving organised labour, community and government as a forum for labour market and economic consultation and policy-making and skills development policy-making. Social partners, inclusive of government, view the mandate of skills development institutions under the DHET as central to the supply of labour market skills for economic development. This positions these institutions as neither strictly education, nor employment creation, nor economic growth and development institutions (CSIR, 2019b). The core mandate of the main skills development institutions, the SETAs, is to research, monitor and report economic and labour market skills demand and put in place sector skills development plans, which are then implemented by education and training providers (inclusive of employers, private training centres and PSET institutions) through projects and programmes. The role of the SETAs in implementation is to provide

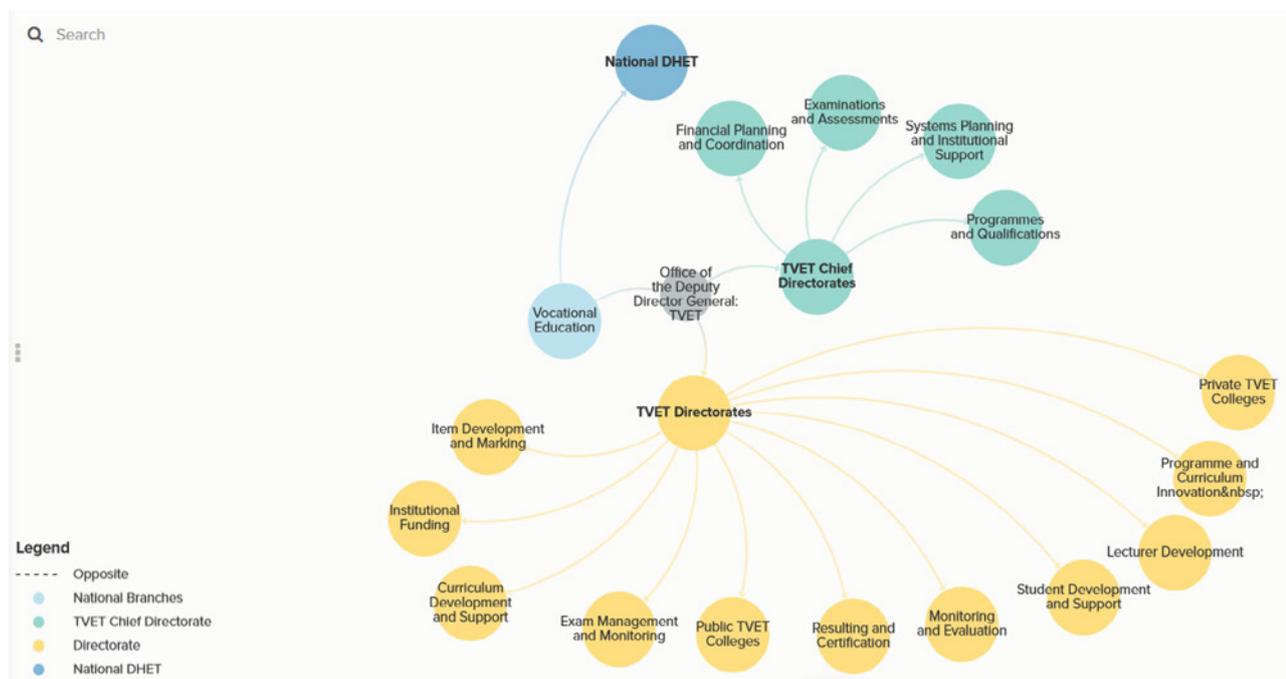
resources to implementing agencies and organisations. The mandate of the SETAs shifts between the needs of the various social partners' interests, depending on prevailing competing priorities of either the education department, the training providers, the existing skills of the labour market or the demand from business and the development of the economy. SETAs, as responsible for the skills development of both the employed and unemployed, are tasked with resourcing the education of unemployed youth; in addition, SETAs are responsible for resourcing the re-skilling, up-skilling and trans-skilling of those in employment to mitigate job losses in declining sectors and/or to meet the changing demands of digitisation.

Furthermore, decision-making is dispersed between the accounting authorities (boards), which are directly accountable to the Minister as his/her appointees, and operations staff, who are responsible for the execution of functions and the implementation of the Minister's skills development strategy as well as sector-specific strategies of the accounting authorities and report to the Director General of the department. Learning supported by the SETAs ranges from skills programmes to qualifications and from work-based learning/work experience learning to institutional based learning offered within HEIs and colleges (CSIR,2019b).

Figure 3: The social services cluster (CSIR, 2019b, 26)



Figure 4: The TVET system: A DHET management view (CSIR, 2019b, 30)



However, the sector faces particular challenges with regards to the provision of work-integrated learning (WIL). One of these is that many National Diploma students have been unable to complete their qualifications due to lack of opportunities for WIL. Graduation of these students may be delayed due to the time taken to secure WIL placements in the workplace. A three-month delay is rare, while a year or more is the norm. SETAs may pay grants for WIL, but the administrative burden deters most companies from accepting students. Therefore, agreements are required between the SETAs and TVET colleges and universities (comprehensive and of technology), where these institutions manage the execution and monitoring of WIL. The DHET's iWIL website¹⁶ enables students and employers to register for WIL/workplace-based learning (WPBL) placement and acts as a brokering service. Each of the 21 SETAs has its own learner management information system (MIS) that is not linked to those of the other PSET institutions.

The final stream of PSET in South Africa is community education. As the most recent addition to the DHET, the Community Education Directorate is still in the throes of meeting its ambitious targets. In 2015, the first nine CET colleges were opened, one in each province, clustering the existing 3 276 public adult learning centres (PALCs). The PALCs were renamed Community Learning Centres (CLCs). The nine colleges serve as administrative hubs,

whereas the CLCs are delivery sites for CET. The long-term goals are to have a CET college in each of the 52 district municipalities and a CLC in each of the 226 local municipalities. The role of the CET sector is to “to promote lifelong learning and offer skills (in addition to general education programmes) that could contribute to sustainable livelihoods outside of the formal sector” (NPC, 2020a, 11). This would be achieved by enhancing personal, social, family and employment experiences and assisting “community organisations and institutions, local government, individuals and local businesses to work together to develop their communities, building on existing knowledge and skills” (DHET, 2014, 22) in a way that is responsive to the immediate needs of the community.

Matching efforts: Khetha Career Development Service

One of the current interfaces or portals in the PEST system for individuals and organisations is the DHET's Khetha Info Hub.¹⁷ A key focus of the site is the provision of career development services and the site links to the Career Development Services (CDS) Info Hub, a collaborative tool designed for career development practitioners and for seekers of career information such as the public and employers (CSIR, 2019b).

16 <https://webapps.dhet.gov.za/iWIL>

17 <https://www.careerhelp.org.za/content/infohub>

The site was designed so that career development practitioners are enabled “to share knowledge, information and advise each other on how best they can provide career advice and counselling services to their respective clients”. It provides a “one-stop-shop for career related information which also empowers the participants to easily locate information within the source by themselves”.¹⁸ This site links to the Employment Services of South Africa (ESSA), which is hosted by the DoL.¹⁹ ESSA provides a free platform for the development of employment seekers’ curricula vitae (CVs) and advertisements by organisations of employment opportunities. A drawback of the site is the slow process of capturing work seekers’ and employers’ information at the DoL’s Labour Centres. While data capture should ideally be speedy and digitised, the current process is that information is captured first on paper and is then digitised before being uploaded and matched with employer demand and requirements, the capture of which is likewise paper-based (CSIR, 2019b).

The lack of security features on the site is a major problem. Users can create an account using their identity number and chosen password. Once logged in, the user is directed to a DoL site to create a CV. This CV is pre-populated with

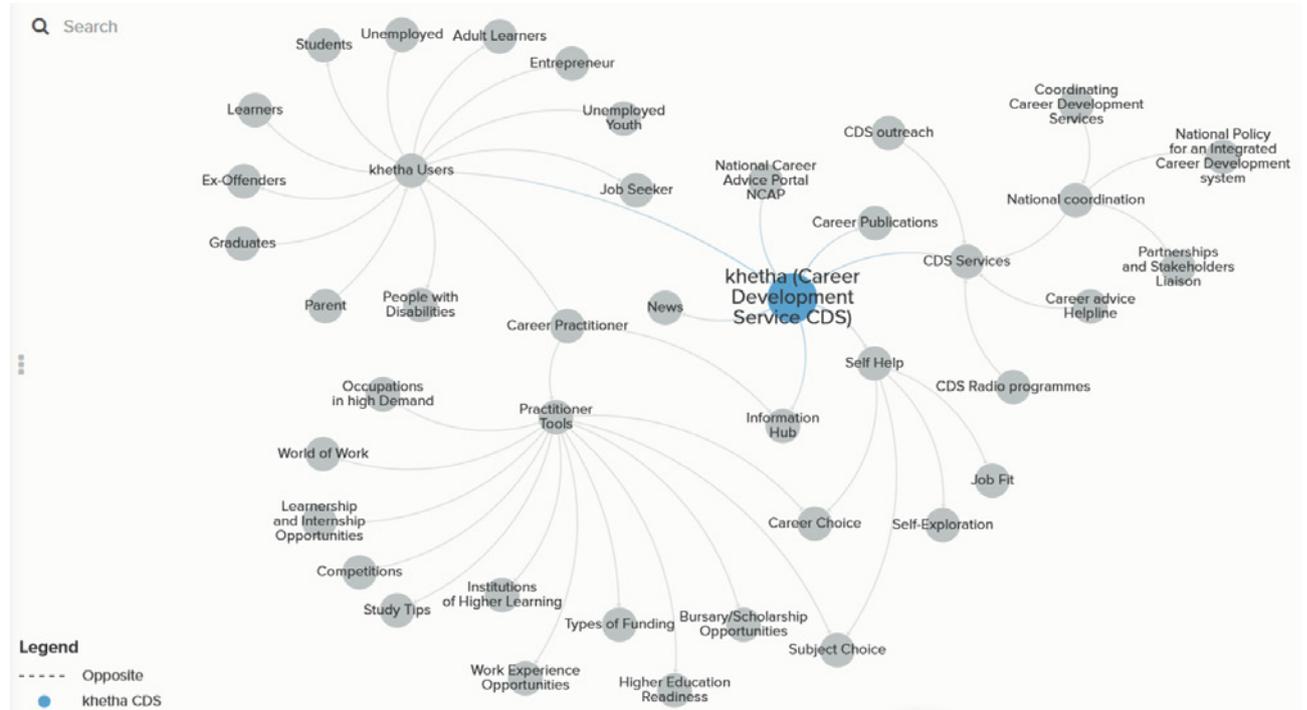
information from the South African Revenue Service from tax certificates that have been issued by employers. These tax certificates reflect a record of employment, including also “piece jobs” which attract an honorarium, for example, examining post-graduate dissertations and theses and moderation of examinations. This illustrates that the relevant information may already exist in other databases so that information could simply be validated and updated if the Labour Centres had internet access (CSIR, 2019b).

The site also links to:

- The National Career Advice Portal (NCAP), an online self-help tool designed to facilitate informed career- and study decisions;
- Career Practitioners Khetha Career Development Services Radio Programmes, which cover career-related matters from choosing subjects in high school to making informed career decisions.

Major components of the Khetha website are shown in Figure 5.

Figure 5: Career development services and targeted users of Khetha (CSIR, 2019b, 36)



18 https://www.careerhelp.org.za/information_hub/about-career-development-services-cds-information-hub

19 <https://essa.labour.gov.za/EssaOnline/WebBeans/>

Management practices and employment

A major gap in our understanding of the bridge from education to employment is incorporating and engaging potential employers. Shikweni, Schurink and Van Wyk (2019) found that talent management within certain industries in South Africa is low. Employers reportedly feel constrained to pursue growth of their businesses by employment equity and labour protection laws. Moreover, economic growth is being hampered by a difficult economic climate characterised by a lack of local re-investment, innovation and diversification and the electricity shortage, not to mention COVID-19.

However, SETAs report that it is difficult to truly engage with employers, and a criticism of the LMIP is that the trends and needs identified concerning skill shortages and future developments is out of synch or slow to be compiled. Powell & Reddy (2016) report that some of the challenges faced in skills planning are:

- No coordination of labour market/skills planning data in the DHET;
- Some directorates have good data, but others have none;
- Many providers produce data;
- Some SETAs have limited capacity and no support for data collection and data analytics;
- Limited understanding of how the labour market is changing;

- No continual monitoring of demands for occupations (current/changing/transforming/new) in high demand.

Avenues and channels for including and engaging industry role players (employers, labour and other stakeholders) need to be explored more closely in the context of:

- Providing planning tools to employers and workers;
- Aggregating data sources from banks and consultancies;
- Engaging the civil society sector, particularly around support for community development initiatives.

A major benefit of interoperable platforms is that they promote autonomy, flexibility and choice (Palfry & Gasser, 2012), not only for the end-users but for providers as well, by unlocking distribution channels and reducing the barriers to development, thereby allowing providers to concentrate on creating niche, differentiated offerings that fit market needs better. The current structure of the PSET sector makes it difficult to collaborate, and any initiatives need to navigate a complicated maze of gatekeepers acting as intermediaries whose function, while vital, has been reduced to being administrative information conduits. The PSET CLOUD has the potential of turning these directorates into more strategic drivers of progress for South Africa.

A major benefit of interoperable platforms is that they promote autonomy, flexibility and choice

Opportunities for collaboration

Generally, as indicated by the stakeholders interviewed through the CSIR study, including those from SAQA, the QCTO and the CHE, there is support for the development of the PSET CLOUD, and stakeholders were open to opportunities for collaboration. The DHET in particular, as the central coordinating body, has expressed its interest as shown in the table below.

The cost in time, effort and resources for collaboration within the PSET sector seem to pose a barrier and current planned collaborative initiatives seem to be limited to;

- Negotiating urgent supply and demand mismatches at the planning stage of strategic skills development initiatives or to mitigate a sectoral crisis;
- Using collaboration to unlock more funds.

This has led to stakeholders operating in a more competitive and guarded manner, even though the policy and oversight bodies would like to foster a more collaborative approach. Using technology to simplify access to data, reduce the cost of collaboration and amplify the benefits of collaboration is one of the main drivers of the PSET CLOUD project, which aims to enable greater access, diversity and openness in the initiatives amongst stakeholders.

The different types of collaborative processes requiring exchanges of information and data sharing in the PSET sector are discussed next.

Table 1: Analysis of support for the development of the PSET CLOUD (adapted from CSIR, 2019b)

Degree of support	Yes/No	Reason for Yes/No
Being part of a forum that developed the required organisational structure and systems for this initiative.	Yes	
Providing technical and organisational support required to develop and operate this initiative and systems.	Yes	High level system design support could be provided. However, only very limited technical support can be provided.
Making a financial commitment for the development and operation of the initiative and systems.	No	Funding is very limited. The operating budget currently is R200 000, and most of this goes on printing reports.
Contributing data/aggregated data to populate the system on an ongoing basis.	Yes	This service is already provided.

Supply and demand

The matching of supply and demand requires a great deal of interchange of information between the skills development supply system (including the various training institutions) and the assessment of skills demand from the market (or development requirements), and the funnel at the bottom end in Figure 6 indicates that there is a need for more research of a strategic nature. Most of the information collected is bureaucratic information relating to monitoring of the operations of supply-side entities. Strategic information analyses are produced in annual reports and bi-annual statistical analyses by the DHET and LMIP. The knowledge base on the matching of supply and demand for skills is small, updated at a low frequency and not widely accessible. The DHET's requests for information about private education are often met with slow responses. The DHET has, to a large

degree, centralised control over public education service providers and is able to guide the provision of training and development in a way that students should have access to and be guided to pursue qualifications that lead to needed occupations (in conjunction with the NQF and employers).

The DHET engages in centralised planning through the Skills Planning Unit which interprets national development objectives and macro-economic development plans and compiles a National Skills Development Plan (see Figure 7). This strategic-level plan in turn guides the tactical-level plans for the SETAs and is incorporated in sector skills plans and the operational enrolment and training plans of PSET institutions. Overlap in the skills development sector has led to SETAs signing inter-SETA memoranda. In some cases, we are also seeing SETAs initiate projects together.

Figure 6: Planning and coordination in the PSET sector (adapted from CSIR, 2019b, 43)

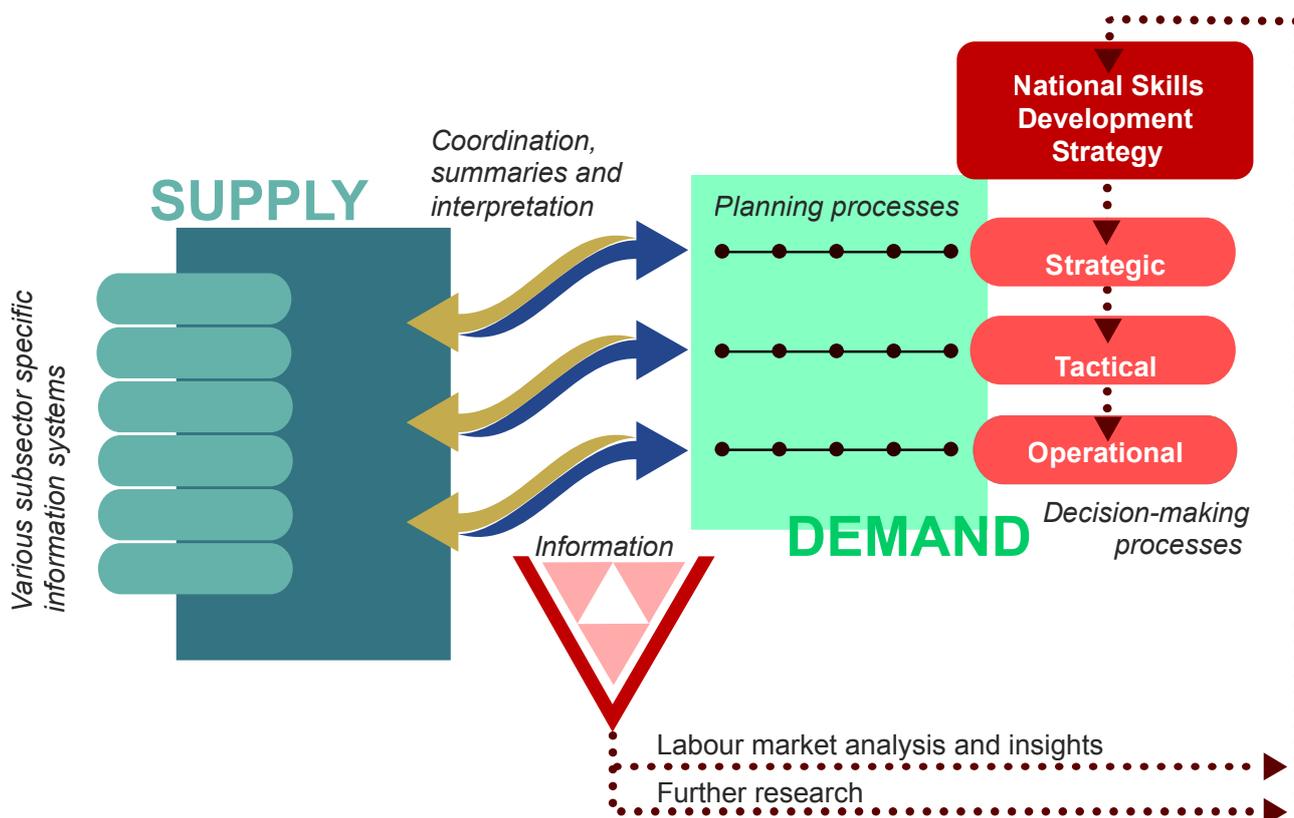
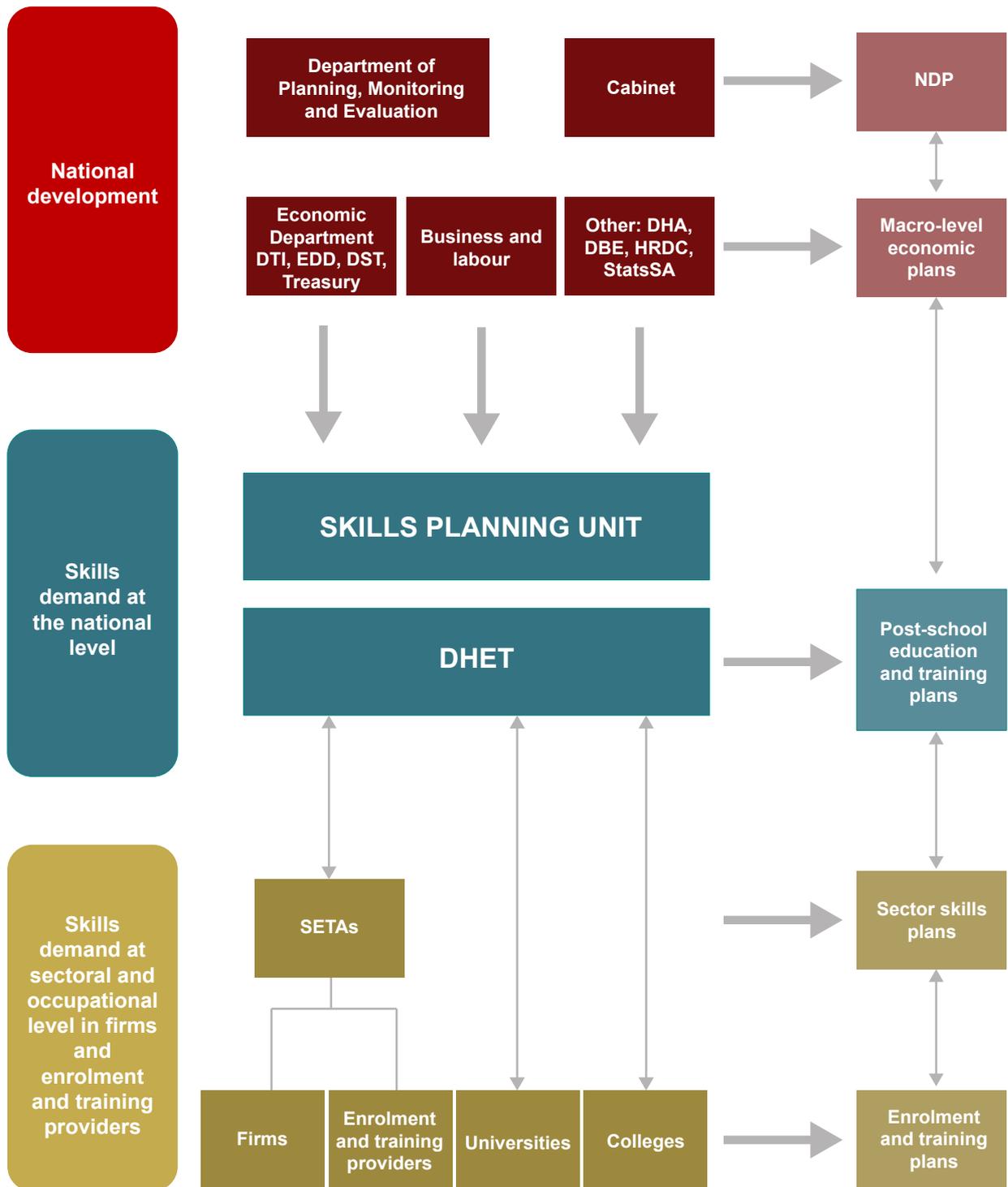


Figure 7: The skills planning architecture within the Department of Higher Education and Training (DHET, 2019b, 16)



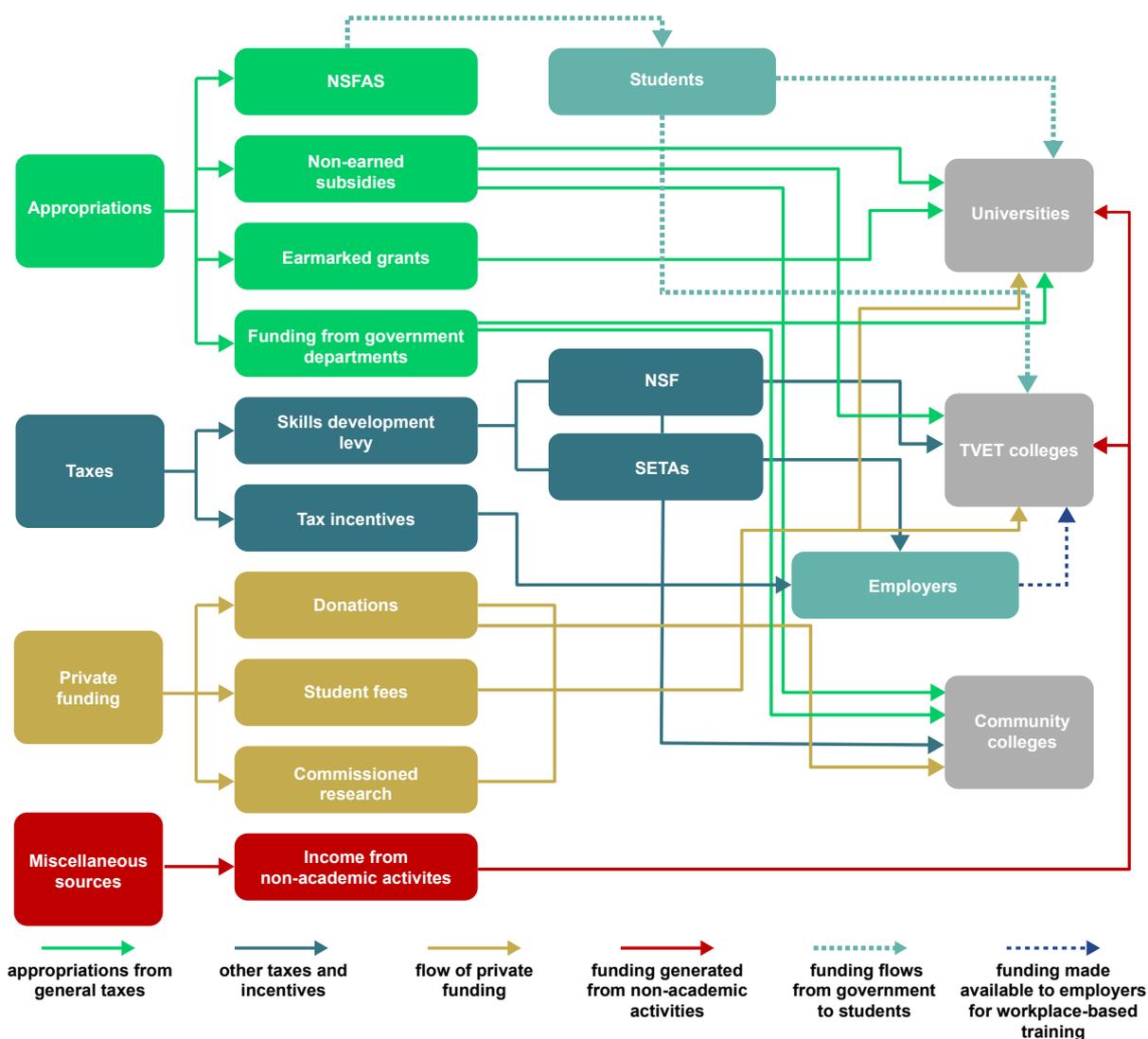
Funding as a driver for collaboration

Another key driver for and determinant of collaboration or seeking contact with other stakeholders is funding. Public funding of the PSET system's education institutions includes direct allocations from the fiscus and indirect allocations from the NSFAS and the skills development levy via the SETAs and the NSF. The five main channels for public funding are:

- Block grants to universities and TVET colleges, over which they mostly have spending autonomy;
- Earmarked grants to universities and TVET colleges, over which they have limited spending autonomy;
- NSFAS funding on the basis of an institution's enrolment of qualifying students;
- Funding from SETAs to universities and TVET colleges in support of students and other projects such as curriculum research and development;
- NSF funding for infrastructure development, training programmes or allocations to the NSFAS.

In particular, SETA funding from the skills development levy has been an interesting driver of partnerships in the PSET sector. The SETAs and implementing partners (and to a lesser extent the NSF) have been unable to spend their funds for some years, allowing large reserves to accumulate, some of which are surpluses. This is partly as a result of a systemic delay brought about by SETAs not approving projects timeously. The collection of the levy is simply faster and more direct than the approval process on projects. SETAs reserves are committed funds that are reserved for the implementation of committed, approved, multi-year programmes and projects. To unlock these reserves, the regulations governing excess funds were repealed and these funds may now be allocated to discretionary projects. This has led to SETAs engaging in partnerships with universities and TVET and CET colleges as well as promoting partnerships with public and private providers and civil society to improve skills development.

Figure 8: The main funding flows (GTAC, 2016, 5)



Quality assurance and standards

A cooperative approach is at the heart of effective quality assurance. Preconditions for effective quality assurance include:

- A National Qualifications Framework (NQF) and registration of qualifications;
- The accreditation of quality assurance bodies and service providers;
- The tracking of individual learner progress.

The National Learners' Record Database (NLRD)²⁰ (SAQA, n.d.) caters for the above aspects and includes information on (inter alia):

- Accredited providers;
- All qualifications and unit standards;

- Qualifications and unit standards that have passed their registration end date;
- Fundamental unit standards and unit standards with general applicability;
- Registration of Trades.

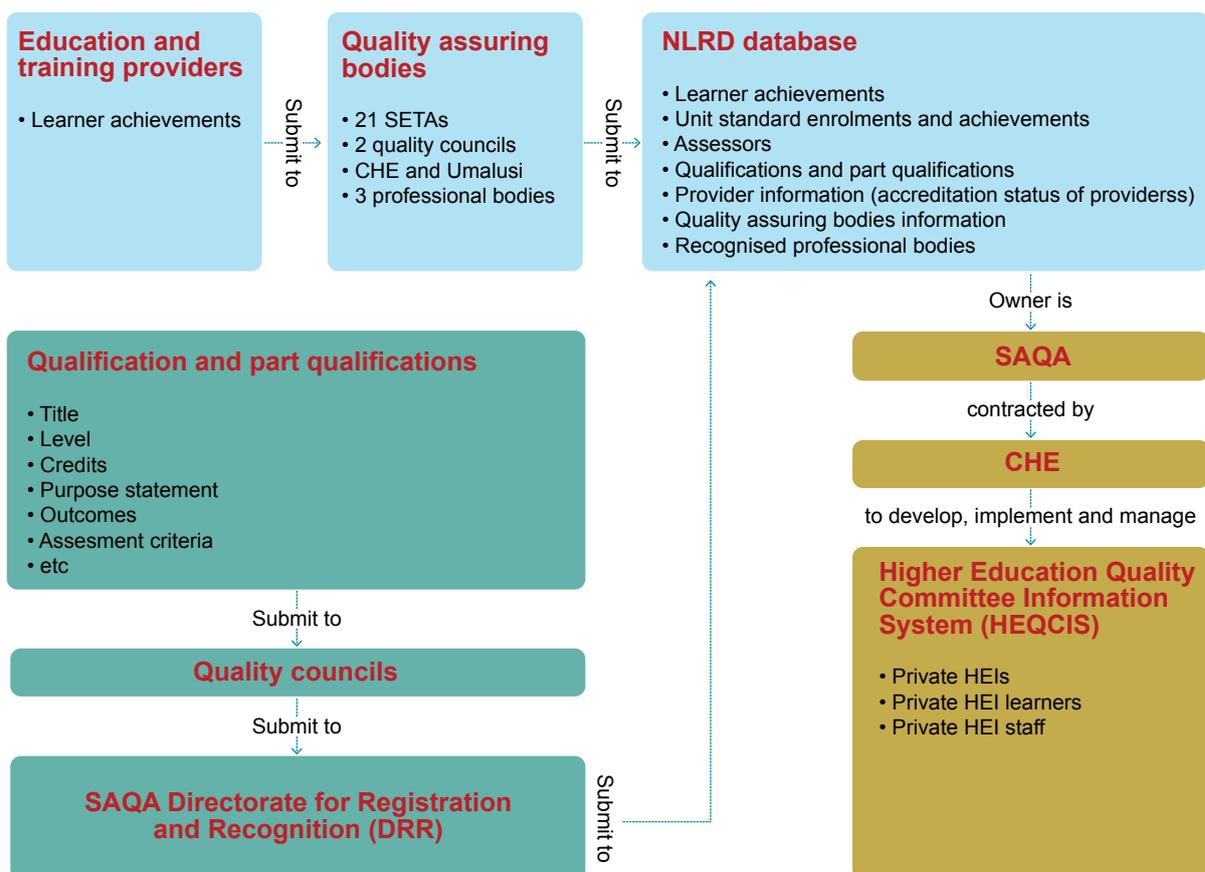
The NLRD does not include learner achievement records for non-formal learning or skills programmes.

Quality councils

The major quality assurance bodies in the PSET sector which make use of the NLRD data are the QCTO, the CHE and Umalusi. Since Umalusi deals with basic education results, it is not discussed in this report.

The data flows of the NLRD are shown in Figure 9.

Figure 9: Data flows of the National Learners' Records Database (CSIR, 2019b, 28)



²⁰ The NLRD is discussed in more detail on page 50.

Quality Council for Trades and Occupations

The quality assurance function of the SETAs falls under the QCTO, which has the mandate to oversee the implementation of the Occupational Qualifications Sub-Framework of the NQF. The QCTO is responsible and accountable for the quality of occupational qualifications and the quality assurance of the implementation of these types of qualification through a variety of learning sites including SETA-managed workplace/company learning and training sites, skills development providers, TVET colleges and CET colleges. The mandate of the QCTO is to maintain the quality of the occupational qualifications, from design to delivery, whatever the site of delivery. However, the QCTO has budget and resource constraints²¹ and hence has put in place a system of delegating quality assurance functions to SETAs through service-level agreements. SETAs, therefore, continue to maintain learner achievement records, supplying information directly to the NLRD, and associated provider information. The NLRD also maintains the QCTO MIS. Obtaining older records is a slow process as the digitisation of paper records from 1983 onwards is still in progress. It can take several months to provide a customer (job applicant, HR agency, company HR department) with the relevant records (QCTO, 2019b, 28).²²

The skills development provider (SDP) accreditation process is also slow and it can take two to three years for an SDP to obtain an accreditation letter that specifies the qualifications that they can offer. The QCTO has to check the qualifications of the teaching staff and the physical address of the SDP and inspect the teaching facilities and equipment. A major problem is the proliferation of low-cost, non-accredited SDPs that offer affordable fees to parents who are desperate for their children to be trained to improve their chances of being employed. To ensure the quality of the skills training provided by these SDPs, the accreditation process needs to be faster and thorough and the QCTO's lack of resources is a major constraint in weeding out low-quality non-accredited and previously accredited SDPs. SDPs are accredited based on their institutional compliance (including legal validity and tax compliance) and their readiness to deliver a particular programme; as such, accreditation is linked to particular programme offerings and needs to be renewed or updated one year before the accreditation runs out or if the programme is changed (QCTO, 2019a).

The provision of learner achievement records is also slow, and this is largely a paper process. The SDPs have to provide a formal letter of learner achievement which includes academic and workplace experience. The skills assessment centres produce paper records that need to be converted to text files for use in the MIS. The large SDPs use bespoke learner management systems provided by companies such as Deloitte and Praxis. The smaller SDPs (e.g. the CETs) do not have this capability, and hence they use paper-based processes to register learners. In order to speed up the process, the Occupational Qualification Learner Management System (OQLMS) provides a portal for registering learners via a web-interface. The process was implemented in 2019 with the release of the first module that deals with learner registration information, assessment, progress reports and the final statement of results (OQLMS, 2019). The statement of results allows learners to proceed to the External Integrated Summative Assessment for the registered qualification (OQLMS, 2019). The SDPs pay R2 500 per year for access to the portal, and this is part of the accreditation fee. Of benefit to the SDPs is that the system interfaces directly with the QCTO MIS, making the process of engaging with the QCTO MIS seamless.

The relationship between the QCTO and the Institute for the National Development of Learnerships, Employment Skills and Labour Assessments (INDLELA) is important: INDLELA's primary role is to assess artisans and provide training for artisan trainers, assessors and assessment moderators. Assessment results provide information on the quality of the SDP training. The relationship between the QCTO and the NAMB is equally important, since the NAMB has a closer working relationship with employers and can channel employers' experiences of the quality of newly qualified artisans' skills to the QCTO and INDLELA. The NAMB also maintains a Provincial Artisan Development Monitoring and Evaluation System to capture data regarding artisan training (NSA, 2017).

Council on Higher Education

The CHE is responsible for the Higher Education Quality Committee Information System (HEQCIS). The CHE has contracted SAQA to develop, implement and manage this system, which includes mainly information from private higher education institutions (PHEIs) including qualifications offered, learner enrolment and staff information (SAQA, n.d.).

21 The QCTO's annual budget is approximately R140–150 million and it has a staff complement of 89.

22 Interview with QCTO, 29 April 2019.

Data usage and sharing

As public institutions open vast and complex datasets, the underlying expectation is that the lives of all citizens will improve as a consequence of data being made publicly available. However, one of the interviewees in the CSIR study (2019c) warned that there are several stumbling blocks in the path of extracting the benefits from open data. As pointed out by Van Schalkwyk, Willmers and Schonwetter (2015, 3):

On the side of the provider, these barriers may include: the effort and cost required to convert closed data to open data; the cost of providing a user-focused context to ensure the uptake of complex datasets; poor data quality; absence of legal and policy frameworks; a lack of capacity to implement and sustain open data practices; and resistance by data custodians to opening data. On the part of data user, barriers include: lack of internet access; low levels of data literacy; lack of human, social and financial capital to

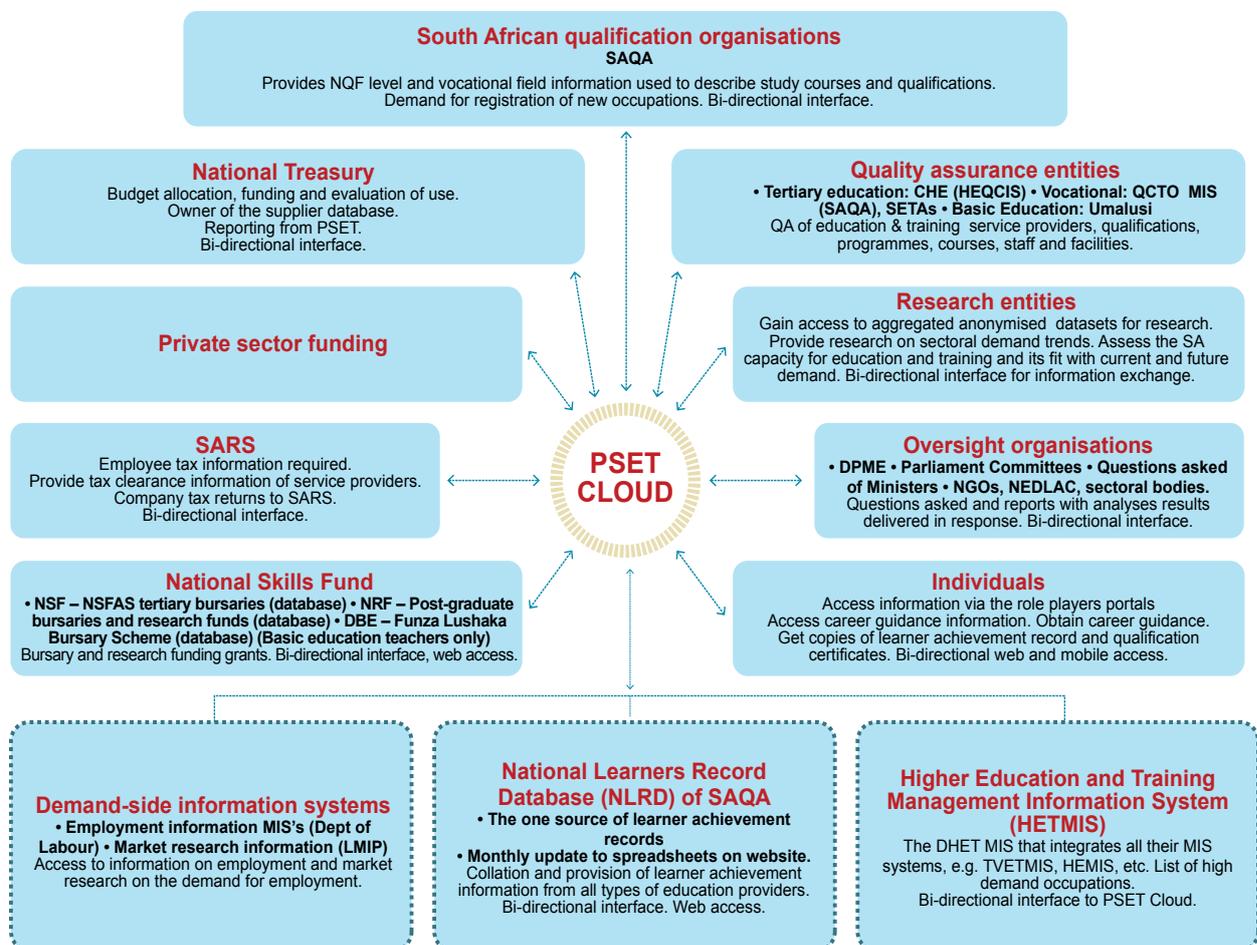
effectively use open data; and the lack of capacity to open and combine several datasets that together can create value.

To remove some of these barriers and, in so doing, unlock the potential of data for all, data intermediaries play a critical role in linking complex open datasets with user needs, particularly for users in grassroots communities.

Data-driven decision-making

The complexity of the PSET CLOUD system is clear: it involves diverse role players and stakeholders – from financial institutions, qualifications bodies, employers, organised labour, education service providers to oversight organisations – in addition to a range of databases, as shown in Figure 10. The complexity is heightened by possible competing priorities and differing world views. We can, however, identify a number of key drivers which shape and advance change within the system, and these are: planning, funding and reporting.

Figure 10: PSET CLOUD stakeholders (adapted from CSIR, 2019b, 20)



Planning as a driver for data usage

In planning, the critical question centres on how we determine priorities. A number of studies in South Africa have been identified that can assist the PSET CLOUD initiative as the work that lies ahead takes shape.

The Centre for Researching Education and Labour (REAL) is located in the School of Education at the University of the Witwatersrand and strives to bridge the gap between education demand and supply. REAL's focus is on "Rethinking the politics, practices, and policies of the post-school sector" and its three main areas of research are (REAL, n.d.):

- *Rethinking skills and economic development for a just future;*
- *Knowledge and pedagogy for meaningful and decent work;*
- *Understanding and strengthening post-school institutions.*

Two current research projects are of particular interest to the PSET system as they address the evaluation of NDS-III and the relationship between knowledge, curriculum and employment. The NDS-III evaluation includes: a literature analysis; interviews with stakeholders; a tracer study; and case studies of various sectors. The tracer studies focus on service providers and learners that have been funded by the NSF and SETAs. The case studies examine the availability of skills, for example, green skills, research and innovation as well as the nature of support for rural partnerships and SMMEs.

The second project is research on the relationships "between knowledge in curriculum and knowledge used at work, as well as qualifications used in labour markets" (REAL, n.d.). Potential areas of collaboration at the PSET system level are modelling for forecasting of skills and economic growth, improving access to information and the identification of success measures for the system. Using the learning that has been developed by REAL and other researchers could help us develop a more rigorous model or even algorithm to assist in shaping the PSET sector's transition to data-driven planning.

Funding as a driver for shared data usage

The *National Plan for Post-School Education and Training* (DHET, 2017a) identifies the need to revise the funding formula for the sector, noting that the "current system of input funding has led to massification without the necessary student support, resulting in poor throughput" (DHET, 2017a, 73). There also seems to be hesitancy from employers and labour to allow the redistribution of SETA funds for the improvement of the PSET system overall,

stemming from a distrust that current allocations and spending are producing the expected or desired results.

The *Consolidated Report on the Costing and Financing of the White Paper on PSET* (DNA Economics, 2016) identifies the need for:

- Adjusting the funding formula in the PSET system to emphasise quality more and throughput less;
- Clarifying the purpose of the skills development levy, and finding ways of making its allocation more effective for the employed and unemployed in the labour force.

The report also identifies the fact that there is:

- A limited understanding of the cost drivers in the PSET sector and the need to develop a standard chart of accounts for all implementation channels – this includes a need to benchmark salaries;
- A need to explore alternative funding mechanisms (such as a graduate tax);
- A need for an integrated funding model.

That funding effectively shapes the development agenda is clear, and what has also become clear is the need to track real-time costs, quality and impact as inputs when seeking to refine a funding model.

Another important factor mentioned is that the disbursement cycle often affects the effectiveness with which new opportunities and solutions can be developed.

Reporting and service delivery

Finally, the slow speed at which information is updated is a constraint on service delivery in the PSET sector. The NLRD, specifically, would derive real value from the establishment of the PSET CLOUD since it could increase the speed at which information is received and updated and hence improve the NLRD's services. Updating learner qualification data, especially by public institutions, is in some cases a very slow process (taking up to 18 months), and some institutions are reluctant to provide data. The DHET's TVETMIS is an example of a system which is slow to respond to new information. In other examples such as CETMIS, PCETMIS and SETMIS (see definitions in Table 2, page 43), data has not been submitted to the NLRD, thus leaving the NLRD with incomplete datasets. The PSET project could improve the completeness of the data and provide timely updates on learner qualifications, improving the usefulness of the NLRD to learners and other stakeholders. Real-time data and tracking, which requires up-to-date information, would enable the development of more responsive and adaptive solutions.

In the current implementation of data-driven decision-making, institutional processes, templates and applications used for planning, securing funding and reporting are constrained by a specific format, just so that providers can ensure their own viability and compliance. Opening up the system and facilitating simpler, more direct reporting, with support for different partnership or collaboration models and more customised training approaches, would enable the PSET sector to rekindle sector-specific services and initiatives.

Data sharing practices

The analysis of the CET and TVET systems highlighted some key challenges in the practices relating to data sharing (see Figure 11), which are further borne out in the detail of some of the data structures discussed in the next section, where we see some role players still using paper or spreadsheets.

The factors influencing the sharing practices include:

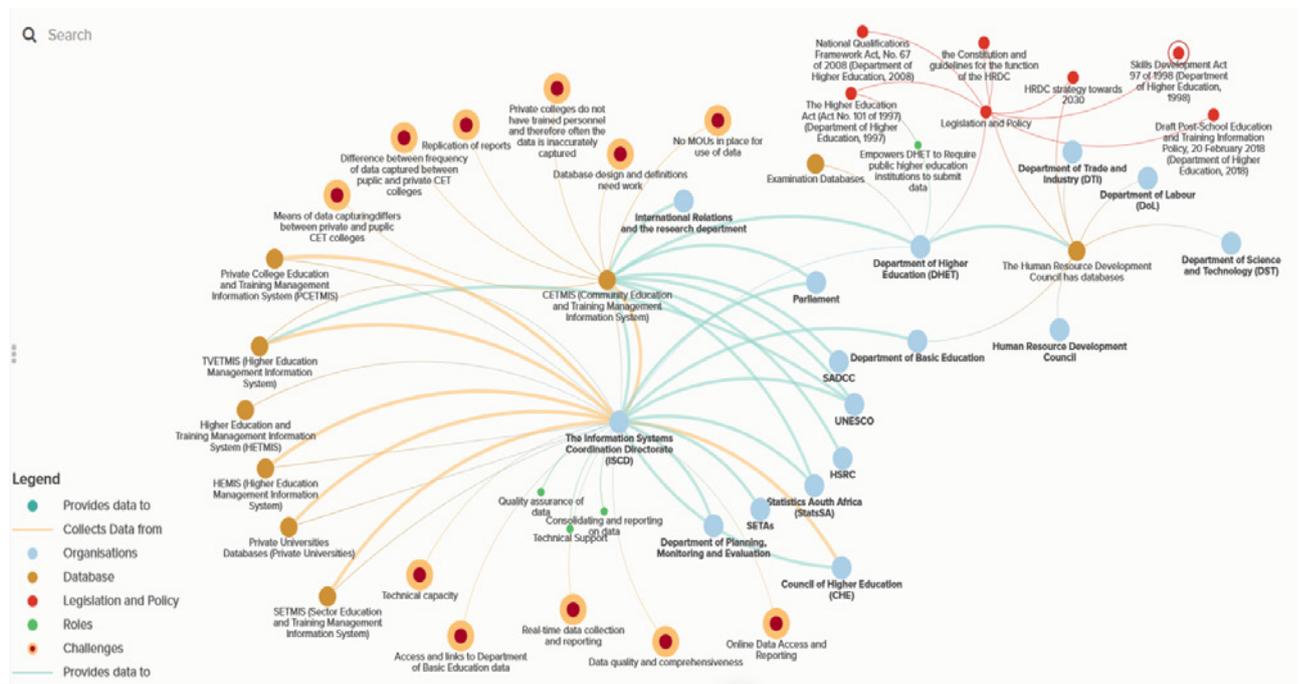
- The technical and data capturing capacity within the department or the college;
- Variable quality in the design of the databases, with some definitions and designs needing cleaning, updating and restructuring;

- A lack of data sharing policies and memoranda of understanding (MoUs);
- Difficulty in replicating and sharing reports;
- Limited consistency in the means, process and frequency of capture across the role players.

There would clearly be significant benefit in rolling out a cloud-based platform solution that offers the colleges, skill development providers and universities standardised tools and interfaces which can be customised to their individual needs. However, more work needs to be done to explore how real-time data collection and reporting and the use of big data management techniques to address the data quality and comprehensiveness can be implemented.

Each of the DHET branches has its own MIS. All the systems under management of the DHET are listed in Table 2. These systems represent the first level of integration of data from the individual institutions, and this is coordinated and controlled directly by the DHET, through a file-based submission process shown in Figure 12 and Figure 13. This information is mostly used to compile annual performance reports, but at this stage how much additional information is collected by the institutions and how that could be used to provide a richer analysis of performance or feedback on observed trends is unclear (CSIR, 2019b, 17).

Figure 11: The CET and TVET systems and some of the major challenges (CSIR, 2019b, 30)



As noted in the CSIR (2019b, 18) report, “These first-level MISs enforce the standards of DHET and SAQA to comply with the relevant laws and ensure data quality through data verification processes.” However, there should be scope to improve the data collection and analysis to suit the needs of additional stakeholders.

Data sharing practices have highlighted some challenges for the PSET CLOUD initiative. These include:

- **Security:** the assumption is that creating an interoperable platform with many points of access to open data is increasing the vulnerability of the system. However, the CSIR investigation into current practices found that security protocols are being implemented. An interoperable system could reduce the vulnerabilities by ensuring stricter, more unified implementation of such protocols.
- **Privacy:** the current practice of capturing and recapturing identification information as well as a reliance on paper or spreadsheet-based systems has introduced multiple points where

an individual’s privacy could be compromised. The interoperable PSET CLOUD could enable the development of anonymisation and aggregation services that reduce the number of times identifying information is captured and shared.

- **Reliability:** variations in the skills levels of data capturers and other factors such as the organisational maturity and the repeatability of its processes have meant that there are differences in the degrees of reliability of the data in the current PSET system, and the diversity of architecture and software solutions in use mean that it is difficult to provide assistance and training to data capturers. Creating a more unified interface and architecture would simplify the support and training requirements and make it possible to develop generic support materials that could be made available on demand.

Risks inherent in the development of the PSET CLOUD as a whole are discussed in more detail in Chapter 6.

Table 2: Databases managed by the Department of Higher Education and Training (CSIR, 2019a, 29)

Abbreviation/ acronym	Name	Status
HETMIS	Higher Education Management Information System	Database, updated by public universities submitting encrypted files
TVETMIS	Technical and Vocational Education and Training Management Information System	Database, updated by public TVET colleges
CETMIS	Community Education and Training Management Information System	Database, updated quarterly by CET colleges
SETMIS*	Sector Education and Training Management Information System	Database, updated quarterly by SETAs
PCETMIS	Private College Education and Training Management Information System	Database, updated annually by private colleges, but poorly
Private Universities	Private Universities Databases	Database, updated annually by private universities, but poorly
SETMIS*	Skills Education and Training Management Information System	Database, updated quarterly by SETAs
PHEIs	Private Higher Education Institutions Database Student and Staff Data	Spreadsheets, updated annually by PHEIs
HEQCIS	Higher Education Quality Committee Information System	MS Access database

*Note that there are two separate databases known as SETMIS, both updated by the SETAs.

HIGH-LEVEL PSET ARCHITECTURE SUMMARY

The key databases, data sources and information systems that exist within the PSET sector are the HETMIS, the TVETMIS and the NLRD and are described below.

THE HETMIS

The HETMIS²³ coordinates and collects the supply-side data from all post-school entities, institutions and information systems into an integrated central information system. It is able to achieve this through integration with the information systems shown in Table 3, which also indicates the sources of the data in each system:

Table 3: Information systems linking into the HETMIS (summarised from CSIR, 2019b, 18–19; 2019c)

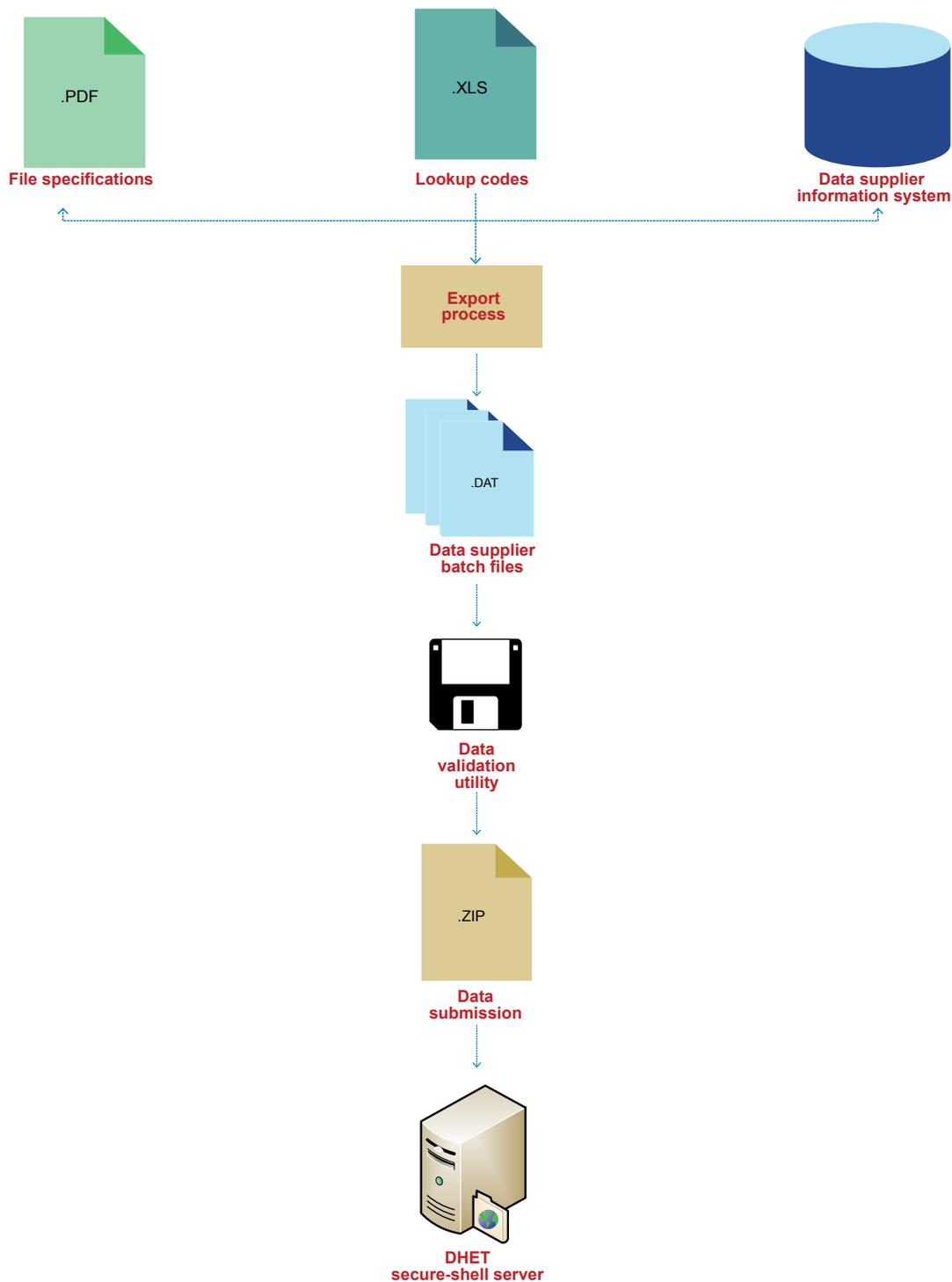
System	Description
HEMIS	The Higher Education Management Information System contains data provided to the DHET by public HEIs (universities and universities of technology).
TVETMIS	The Technical and Vocational Education and Training Management Information System stores and maintains unit records of TVET college data related to colleges and their campuses, programmes, subjects, staff and students. The data in the TVETMIS is primarily maintained and supplied by TVET colleges: the colleges create electronic data submission files in standard formats and transmit them to the DHET for uploading into TVETMIS (Barth, 2014; DHET, 2017c).
SETMIS	The Sector Education and Training Management Information System is a unit-record-based information system that stores and maintains unit records of SETA data related to skills education and training including participating employers, providers, assessors, learners and skills education and training programmes. Further, SETMIS stores and maintains unit records of SETA data related to skills demand including data on employers, sectors and occupations. The data content of SETMIS is primarily managed and supplied by SETAs using electronic data submission files that are extracted in standard formats and transmitted to the DHET for uploading into SETMIS (Barth, 2014; DHET, 2018).
PCETMIS	The Private College Education and Training Management Information System is a unit-record-based information system of private colleges that are accredited by Umalusi and registered with the DHET to offer Report 191 programmes (commonly known as NATED or N-Programmes) or National Certificate Vocational (NC(V)) programmes. The data content of PCETMIS is primarily maintained and supplied by private colleges. The data submission process of this system is similar to the SETMIS and the TVETMIS systems (DHET, 2017c).
CETMIS	The Community and Training Management Information System is also a unit-record-based information system that functions in a similar manner to the systems above. The only difference is that it stores information from community colleges.
HEQCIS	The Higher Education Quality Committee Information System is also a unit-record-based information system that stores information from the HEQC.

²³ <https://webapps.dhet.gov.za/>

Data submissions to the HETMIS are governed by set specifications. These specifications allow for uniformity, which in turn enables easier batch-processing of data received from multiple systems. The strict specifications referred to are detailed in specification documents that are publicly available to download from the DHET website.²⁴ These documents outline the standard layout, content

and encoded business rules that the administrators of the institutions must follow when capturing and submitting data to the HETMIS. Submissions to HETMIS are not accepted unless they comply exactly with the specifications. Once compliance is achieved, submissions are validated and processed. Figure 12 depicts the process.

Figure 12: Data submission process for legacy qualifications (DHET, 2015, 2)



²⁴ <https://webapps.dhet.gov.za/>

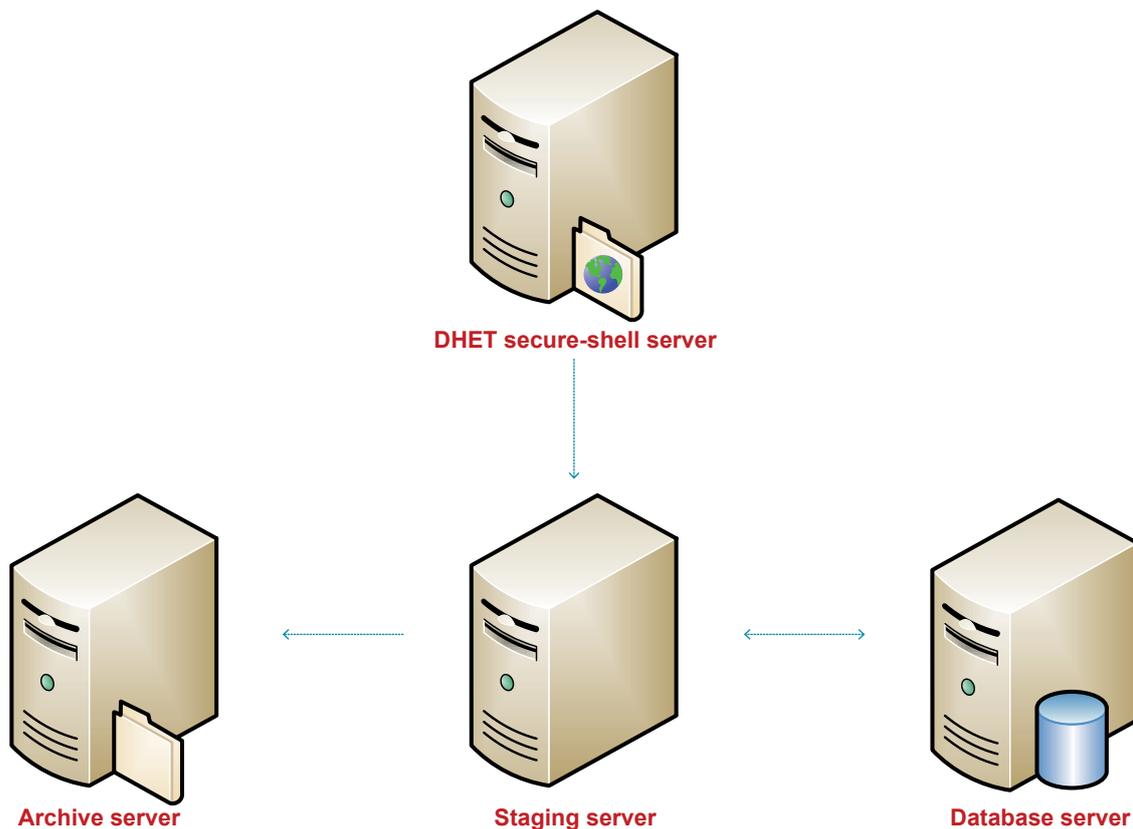
It must be said that the reliance on manual exports and the current approach to the curation of data that is valid means that data is often rejected or needs to be repeatedly submitted before it is accepted. Feedback on whether or not the submission has been successful is delayed and dependent on an administrator with the DHET providing the necessary guidance. In recent years, we have seen more near-real-time synchronisation and more fluid data validation which allows for:

- Earlier identification of threats and trends;
- Quicker management responses and interventions;
- Identification of issues around data capture and validity which can be addressed through training or process improvements.

Once the data has been submitted, it is distributed and archived via the architecture shown in Figure 14. The complete data submission process (Figure 13 and Figure 14) is discussed in detail in the 2015 archiving standard.²⁵

Essentially, for information exported by skills supplier organisations (colleges, universities and other training providers) from their databases to get to the target information system (HETMIS) within the DHET, multiple processes are navigated and the information is transferred between multiple servers, which increases the current system’s complexity and reduces the process of traceability.

Figure 13: Data submission process for non-legacy qualifications (DHET, 2015, 4)



²⁵ <https://webapps.dhet.gov.za/Documents/SubmissionProcessingArchivingStandard20150407.pdf>

This layered approach has created a slow, monolithic, bureaucratic system – which has triggered similar systems on the supply-side. This means that, all in all, the current information systems make information sharing restrictive (strong format adherence), expensive (to setup and maintain), slow and indirect (too many layers) and complex and obscure (due to the proprietary, closed data structures).

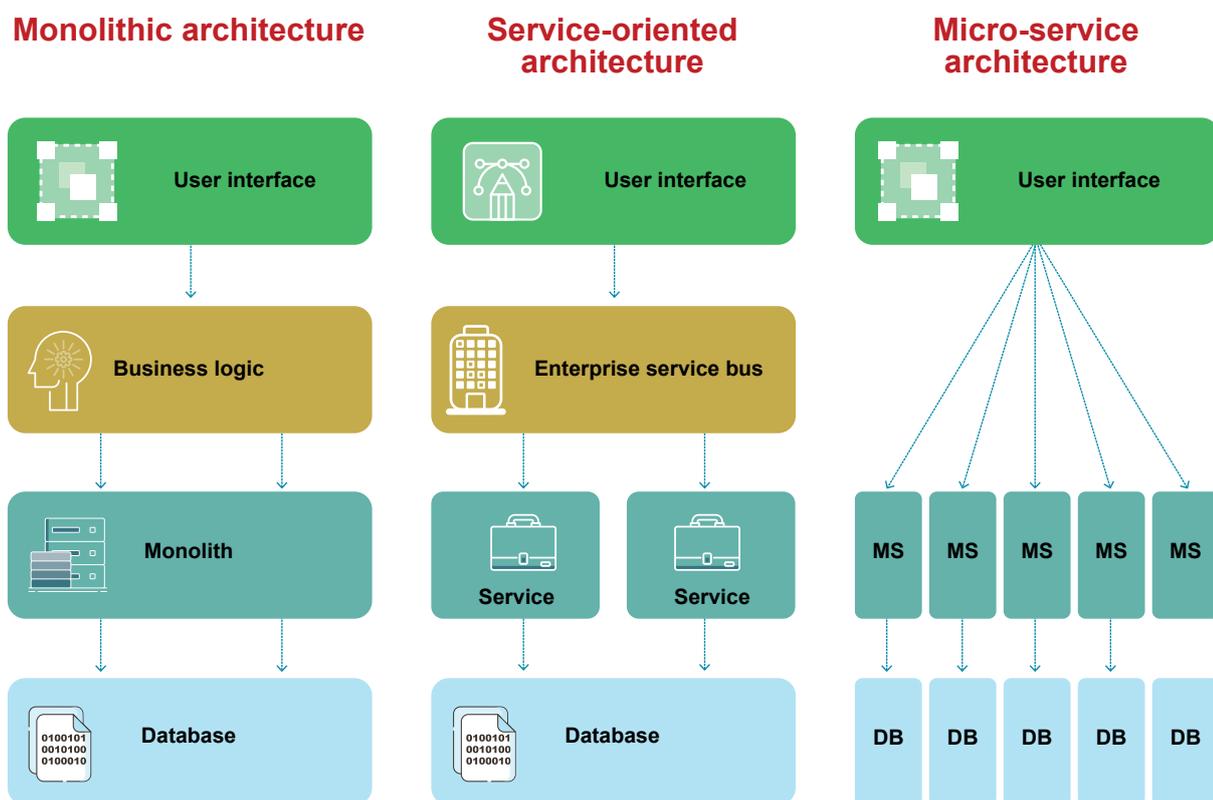
To combat this, a more fluid and open system architecture would be recommended.

In a nutshell, the availability of new technologies, including big data integration and management tools, and greater flexibility in application architecture means that rather than being constrained by the encoding of a particular

business logic (as is the case in the current system), the PSET CLOUD could explore more flexible and reusable logic structures such as a service-oriented architecture or even the move to micro-services to bundle information into higher value offerings for different stakeholders. Such different architectures are illustrated in Figure 14, which indicates the systematic deconstruction of the monolithic database through a service bus in the service-oriented architecture, to an eventual distributed database in the micro-service architecture. Ultimately, what architecture should be pursued will depend on the business case and value propositions developed for the PSET CLOUD.

This report constrains itself to understanding the existing systems.

Figure 14: Comparison of monolithic, service-oriented and micro-service architectures (RubyGarage, 2019)



The TVETMIS

Figure 15 indicates the vital role of the TVETMIS as a system that enables the first level of data integration from all of the relevant TVET institutions. This process supports the population of the NLRD with learner achievement data. The linkages to the two SETA information systems enable the processes of placing learners in learnerships, apprenticeships and WIL for college and HEI learning programmes.

The TVETMIS also provides feedback reports to the TVET colleges based on the information received from them. Data on TVET college infrastructure is also collected to ensure that the colleges are equipped to offer the courses

and training required. The TVETMIS also enables oversight organisations such as the quality assurance bodies to perform their roles, both in defining what data is required and using the data to analyse the performance of the TVET colleges.

Table 4 provides an example of the contents of one of the databases, namely CETMIS. There is significant overlap with the information collected in the TVETMIS, SETMIS and HEMIS.

Additionally, information pertaining to the PSET system is stored in other databases not controlled by the DHET such as the NLRD and the OQLMS.

Figure 15: TVETMIS context diagram (CSIR, 2019b, 18)

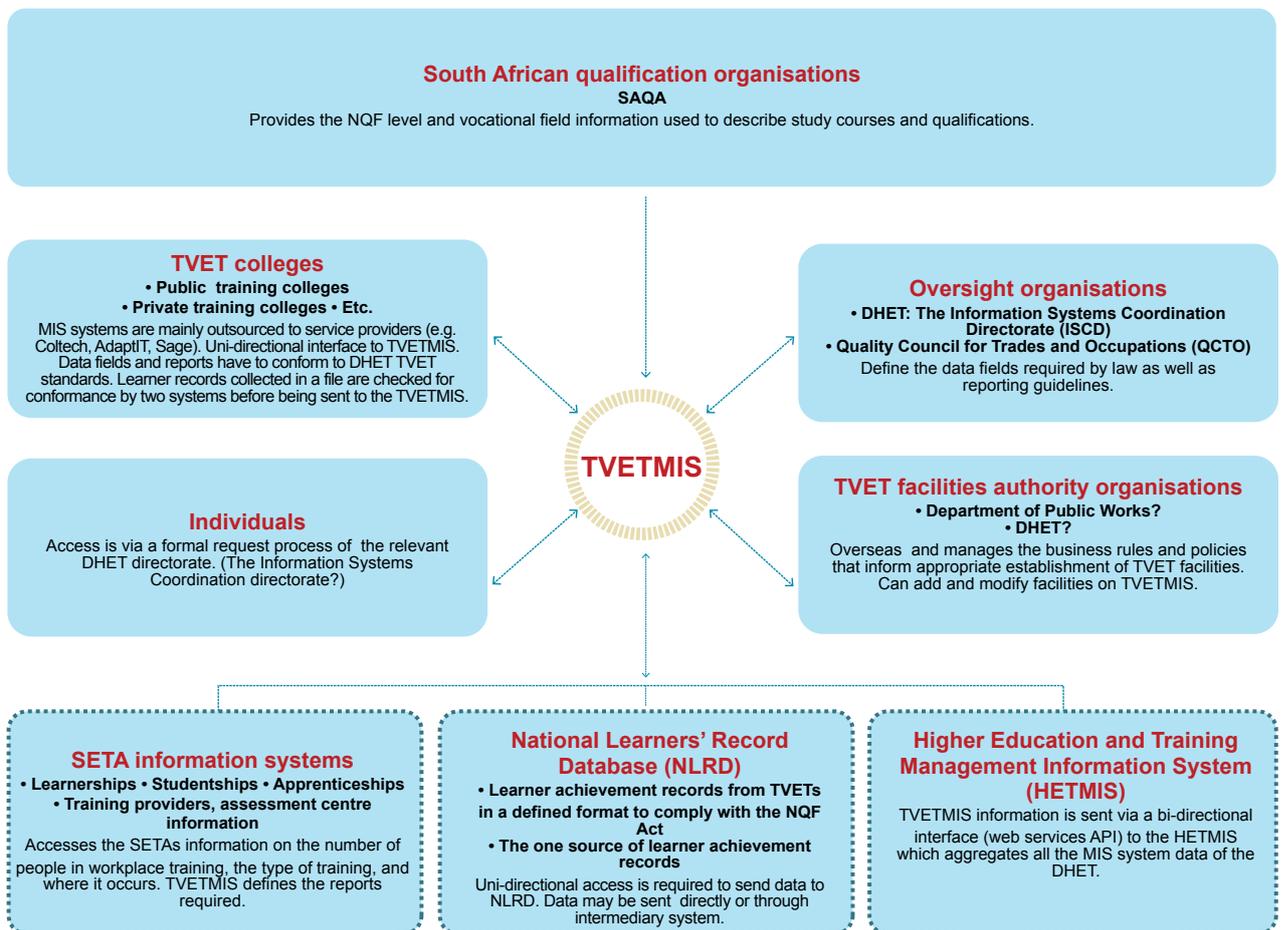


Table 4: Example of database fields in the CETMIS (DHET, 2017b)

Database field	Description
Programme	This file describes programmes that are offered at the college that do not have a SAQA Qualification ID. This file is a modified version of NLRD File Number 22.
Subject	This file describes subjects that are offered at the college that do not have a SAQA Unit Standard ID. This file is a modified version of the NLRD File Number 23.
Person	This file describes people that have either enrolled in or completed programmes/subjects at the college, or people that are employed at the college.
Staff	This file describes the staff members of a college. This file is a modified version of NLRD File Number 26.
Staff qualification type	This file describes the highest types of qualification attained by the staff members.
Staff subject	This file describes the formal training and teaching experience that staff have attained by subject.
Programme enrolment	This file describes learners' enrolments in programmes and their achievements. This file is a modified version of NLRD File Number 29.
Subject enrolment	This file describes learners' enrolments and achievements by subject. This file is a modified version of NLRD File Number 30.

The NLRD

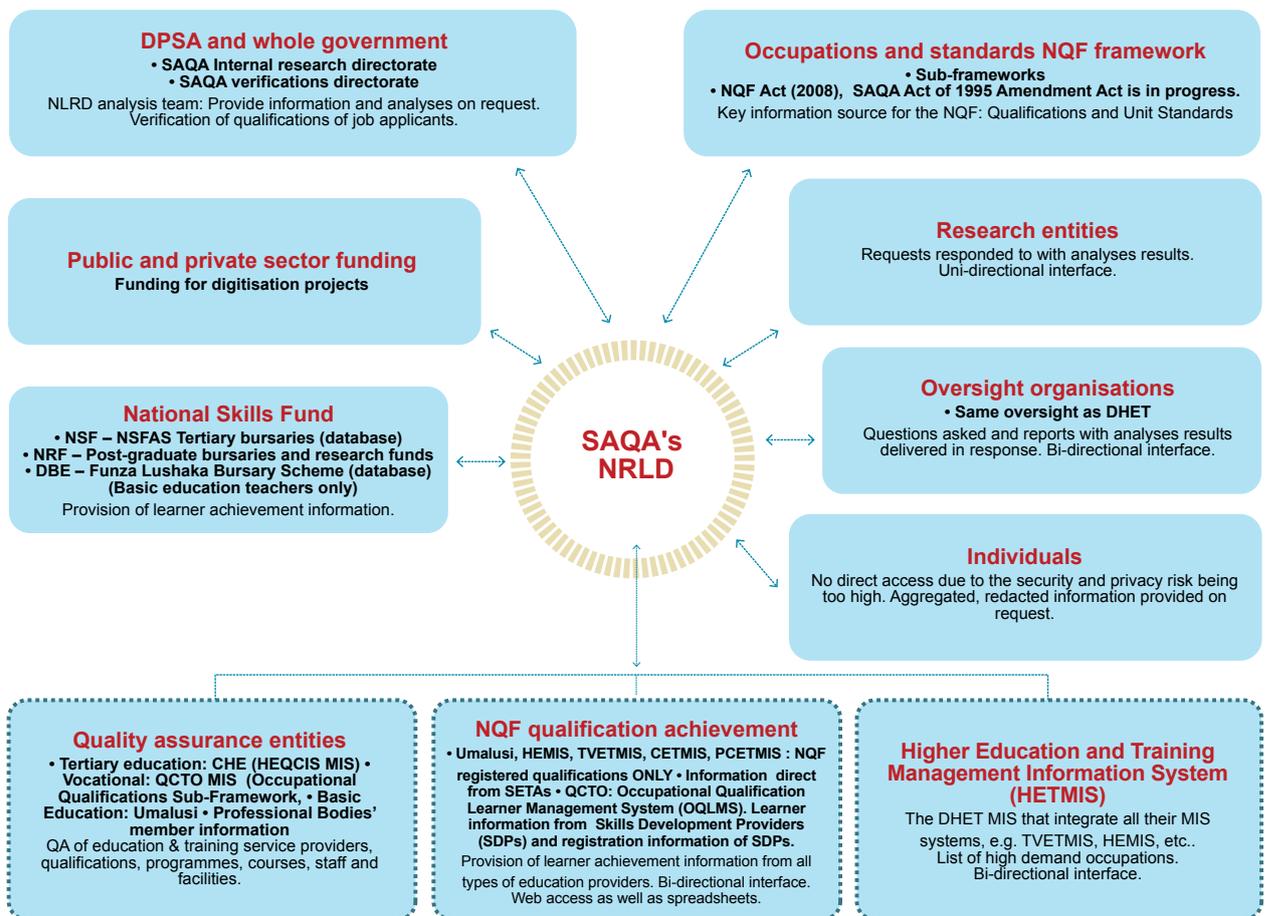
The SAQA website describes the NLRD:

The National Learners' Records Database (NLRD) is the management information system of the National Qualifications Framework (NQF). The NLRD holds records of SAQA and its sub-structures; Quality Councils; NQF sub-frameworks; qualifications and part-qualifications (including unit standards) registered on the NQF; accredited Quality Assurance bodies and their accredited providers; registered assessors; and individual learners and their achievements. The NLRD provides decision-makers with comprehensive information, especially in the fields of labour market trends, education and training, as well as proof of qualifications obtained by individuals in South Africa.²⁶

Just like the HETMIS, systems that submit information to the NLRD also follow strict specification guidelines that inform data capture and submission of data to the system. These specifications are also publicly available on the SAQA website.²⁷ Figure 16 from the CSIR mapping report indicates which bodies and systems the NLRD interacts with and details the type of relationships the system has with those bodies and systems.

The emphasis of the HETMIS and the NLRD on specifications is justified: these two systems form a critical part of the PSET CLOUD because they are the central systems, fed by several subsystems within the PSET sector. Vast amounts of key information vital to the success of the PSET CLOUD are stored in these two systems.

Figure 16: Bodies that use and change data in the NLRD (CSIR, 2019b, 19)



26 https://www.saqa.org.za/nlrinfo.php?language_content_entity=en

27 [https://www.saqa.org.za/nlrinfo.php?language_content_entity=en#:~:text=The%20National%20Learners%20Records%20Database,National%20Qualifications%20Framework%20\(NQF\).](https://www.saqa.org.za/nlrinfo.php?language_content_entity=en#:~:text=The%20National%20Learners%20Records%20Database,National%20Qualifications%20Framework%20(NQF).)

ADAPTATION AND DEVELOPMENT OF DATA ARCHITECTURES

In the late 1960s, Melvin Conway (cited in McManus, 2019) and Herbert Simon and James Thomson (cited in Colfer & Baldwin, 2016) proposed that there is a mirroring between an organisation's structure, its management systems, the structure of the products it develops and the IT systems it uses and builds. According to MacCormack, Baldwin and Rusnak (2012, 2) this "dynamic occurs because the organisation's governance structures, problem solving routines and communication patterns constrain the space in which it searches for new solutions".

The CSIR study (2019a) reveals a similar correlation between the ICT systems currently in use and the structures within the PSET system for which they were developed. The rapid advancement of technology and the continual

organisational drive for innovation, improvement and adaptation has seen this dynamic change. Software is now part of the way we "deliver the organisational capabilities needed to compete in a dynamic and uncertain world" (MacCormack, Lagerstrom, Mocker & Baldwin, 2017, 2). In short, not only are organisations shaping what software we use and how it functions but we are seeing the software and software architectures influence how we structure our organisations (Leo, 2020).

For the PSET CLOUD, it will be important to use big data technologies and other distributed architectures to challenge how appropriate the current practices and processes are for developing a competitive PSET ecosystem. Similarly, recognising the value and stability of the existing structures assists in identifying what is important and what needs to be protected. However, as more extensive stakeholder engagement is sought, some clear gaps in the data available and feedback processes may lead to new opportunities for development of the system.



INTERNATIONAL PRACTICE

Shiohira and Dale-Jones (2019), in their international review of data ecosystems, suggested that there are “three primary opportunities to leverage technological developments in the service of education: platforms; the creation of interoperable data systems; and artificial intelligence” (Shiohira & Dale-Jones, 2019, 2). They identified the development of a “Reference Open Source Community to focus on pooling of resources, component-oriented architecture and coverage of the data cycle from creation of data products to dissemination” (2019, 33) by the Statistical Information System Collaboration Community (SIS-cc) as an example of a framework for an integrated data ecosystem, illustrated in Figure 17.

The current analysis of the data in the PSET system has confirmed that there is a high volume of data, with a large number of persons passing through the PSET ecosystem. The potential of what information could be collected remains unexplored as the current systems have constrained the data variety (the range of data types and sources) due to the singular focus and historical cost of development of such systems. The data management practices have also shown that there is a need for more real-time enabled processes, with faster update and feedback loops. In addition, the veracity (quality and general uncertainty around the data validity) of the data available has been called into question, as they depend heavily on the administrators’ skills and knowledge.

The establishment of an integrated data ecosystem along the lines of that shown in Figure 17 would allow for the concurrent development of a richer data landscape, in that no single organisation would have to take responsibility for the entire development. Rather, niche requirements could be developed in sectoral ecosystems, regional systems could harness a wider set of resources and exploit synergies between sectors, or even across national boundaries, whereas national systems could remain focused on their own priorities.

At this stage, the PSET CLOUD could act as stimulator for this diversification of the PSET Ecosystem as a whole. By developing niche collaborations to address missing information sets or processes, the PSET CLOUD could stimulate innovation in education practice and learner engagement and management. Adherence to international standards and leveraging of open source references shortcuts some of the thinking and learning required, especially regarding establishing clean data

standards and data publication and protection standards.

The SIS-cc framework responds directly to the needs of the South African PSET system, namely,

- To find a balance between national and regional integration, and national and regional diversification;
- For a common set of tools (digital solutions) to aid in the collection, collation and interpretation of system data;
- To allow sector specialisation;
- For standardised reporting frameworks that can feed into both local and international reporting.

The framework also offers three significant avenues for the PSET CLOUD platform to explore as it enters the next phase:

1. Developing and adapting open source data solutions;
2. Exploring where the structures of the PSET system converge and how we can develop supportive ecosystems;
3. Establishing the appropriate reporting frameworks.

From IT Platform development, metrics to guide and shape the development of the platform are necessary: in the short term, it is important to track and design the platform for resilience (manifold redundancy), scalability (extensible, supportive of growth), and composability (logical pooling and inter-relationship of network resources) (Tiwana, 2013). Creating this environment could significantly enhance the capability of rolling out solutions to understaffed or ill-equipped providers in the CET, TVET and private provider sectors.

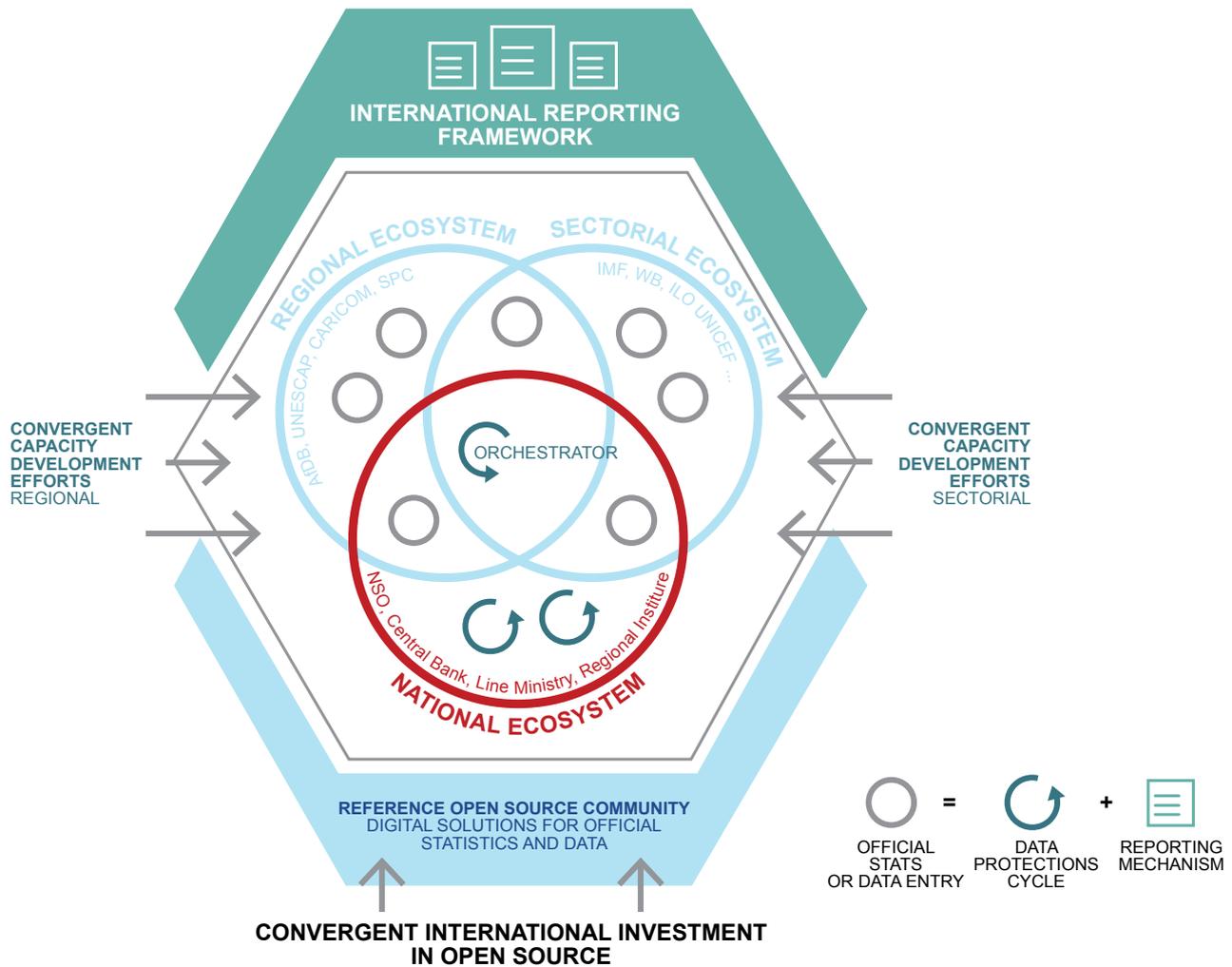
Different players within the PSET system find themselves in different positions (sometimes even multiple positions within their systems) when it comes to how to manage and use the data that drives their organisations. For this reason, it is necessary to develop some coherence in the data landscape by:

- Developing a broader framework for interoperability, which includes not just how we share data but also how we collect, clean, use and reuse data;
- Preparing for the development of the platform by co-developing a user-focused benefit with some stakeholders;
- Seeking initial solutions by leveraging the existing MISs which already collect and aggregate data.

These approaches are in line with the recommendations from the international review by Shiohira & Dale-Jones (2019) and bode well for application in the South African context. Further, this remains consistent with international practice, where projects often engage in a multi-pronged strategy of integrating or rather pooling existing data

sources, while at the same time engaging in niche explorations of how new data sources, technologies and management processes can be leveraged, continuously exploring the fringe for new insights and approaches through controlled prototyping and evaluation.

Figure 17: Leveraging a reference open source community for integrated data ecosystems (SIS-CC, n.d.)



The establishment of an integrated data ecosystem would allow for the concurrent development of a richer data landscape

5

**EXPLORING THE
FEASIBILITY OF AN
INTEROPERABLE
PSET SYSTEM FOR
SOUTH AFRICA**

To introduce interoperability in a complex South African PSET ecosystem within the broader government information and technology policy environment would be challenging. The complexity of the PSET ecosystem is well explained in Chapter 4 of this report. It is, therefore, prudent and necessary to explore the feasibility of introducing the interoperability concept within PSET based on insights, findings and recommendations emerging from several components of research completed in the early stages of the PSET CLOUD project. The research components considered for the initial conception are: (i) the situational analysis, which included an analysis of the policy environment for not only the PSET sector but also of government information and technology policy frameworks; (ii) the stakeholder mapping analysis; (iii) research on international and local practice, trends and opportunities; and (iv) the ToC, with the aim of arriving at a draft conception and high-level approach for implementation to take forward the concept of interoperability.

This chapter is a summary of initial salient recommendations from the analysis and research conducted, as outlined. The recommendations point to the potential feasibility of implementing the interoperability of data and systems to improve the post-school education and skills systems to the benefit of citizens' career aspirations and decent livelihoods.

FEASIBILITY FROM A POLICY FRAMEWORK PERSPECTIVE

Although a comprehensive integrated strategy is yet to emerge from the Presidential Commission on the Fourth Industrial Revolution, the existing framework of policies, strategies and legislation detailed in Chapter 3 lays a foundation for an integrated response to the 4IR. The analysis in Chapter 3 indicates that the existing framework for PSET and government information and technology is enabling, starting with the Constitution of the Republic of South Africa (RSA, 1996), the supreme law upon which all other policies, strategies and legislation is founded. The stipulation in the Constitution of citizens' rights to career choice (Section 22) and progressive access to further education (Section 29[b]) necessitates the need for availability of and access to data and information to enable citizens' continuous learning and informed decision-making with respect to career choices. The Constitution further provides for citizens' rights to privacy and security, issues that will be of key concern with respect to the protection and security of data and information of organisations and individuals in rolling out a system of data and information interoperability.

Of note, emerging from the analysis, are the key thematic areas that will be significant in shaping the PSET interoperable system, namely: the digital transformation of the state's public service delivery systems; the need for systems to communicate and exchange data; the protection and security of systems and data; elimination of duplication; the integration and institutionalisation of ICT corporate governance as a standard for corporate governance within organs of state and public institutions; and inclusiveness and scalability of digital access to all through deeper penetration and reduced cost of broadband and improved skills.

The framework of policies, strategies and legislation for education, skills and the labour market underlines the imperative of data and information availability and the utilisation of technology tools for coherent, integrated delivery of services and programmes that contribute to increasing efficiency and effectiveness in the pursuit of social and economic advancement. The policy framework includes: several strategies such as the *Human Resource Development Strategy for South Africa* (2017), the *White Paper for Post-School Education and Training* (2014), the *National Skills Development Plan* (2019); legislation for the core PSET subsectors of skills development, TVET, CET and higher education and training; and a quality assurance mechanism for learning and qualifications. The key themes of significance in shaping the PSET interoperable system include: the principles of integration, collaboration and partnership – key factors in strengthening efficiencies of the PSET system; regulations on collection and storage of data; and, in the case of the SETAs, the development and implementation of shared services.

The policy framework has also given rise to the establishment of a number of national information systems such as the NLRD, TVETMIS, HEMIS, CETMIS, SETMIS, NAMB and CAS, to name a few. These are national systems essentially set up to consolidate data from relevant subsector organisations or institutions (CSIR, 2019c). Thus, attempts at interoperability do exist, but there is still fragmentation across the various national systems.

The situational analysis also indicated that some of the technologies supporting information systems are somewhat outdated and inefficient (CSIR, 2019c).

CONSIDERATIONS FOR DESIGN

The situational analysis (CSIR, 2019c) identified a few case studies and models that could be used to inform the design of the PSET interoperability system. These include: the Siyaphumelela²⁸ initiative, a project of the South African Institute for Distance Education (SAIDE), which uses data analytics to build evidence-based recommendations to increase student throughput; the Population and Development Information and Knowledge Service of the National Population Unit, which integrates population-related issues into development planning; and the National Integrated Cyber Infrastructure System (NICIS),²⁹ a national initiative of the Department of Science and Innovation, which consists of the South African National Research Network (SANReN), is run by the Tertiary Education and Research Network of South Africa (TENET) and provides research network connectivity, commodity internet services, the eduroam education roaming service and other niche services; the Centre for High Performance Computing (CHPC),³⁰ which provides massive parallel-processing capabilities and services; and the Data Intensive Research Initiative of South Africa (DIRISA),³¹ which provides data management planning and data deposit tools.

The insights from the research into international practice and trends with respect to interoperability and data systems will prove valuable in shaping the design and development of the PSET interoperability system. The research indicates that interoperability does not necessarily mean the integration of systems and data, although interoperability has the potential to lead to integration (Shiohira & Dale-Jones, 2019). This is an important point as organisations in South Africa may not necessarily be attracted to data integration. For some organisations, data integration may be perceived as handing over one's data or losing control of one's data to another entity, with all the underlying implications of loss of privacy, loss of ownership and no control over data security. Other critical insights from the research include the value interoperability has for: standardisation in relation to the interpretation, transparency and accessibility to end-users of data and information systems; leveraging advanced technology tools; and agility and responsiveness to the needs of end-users (Shiohira & Dale-Jones, 2019).

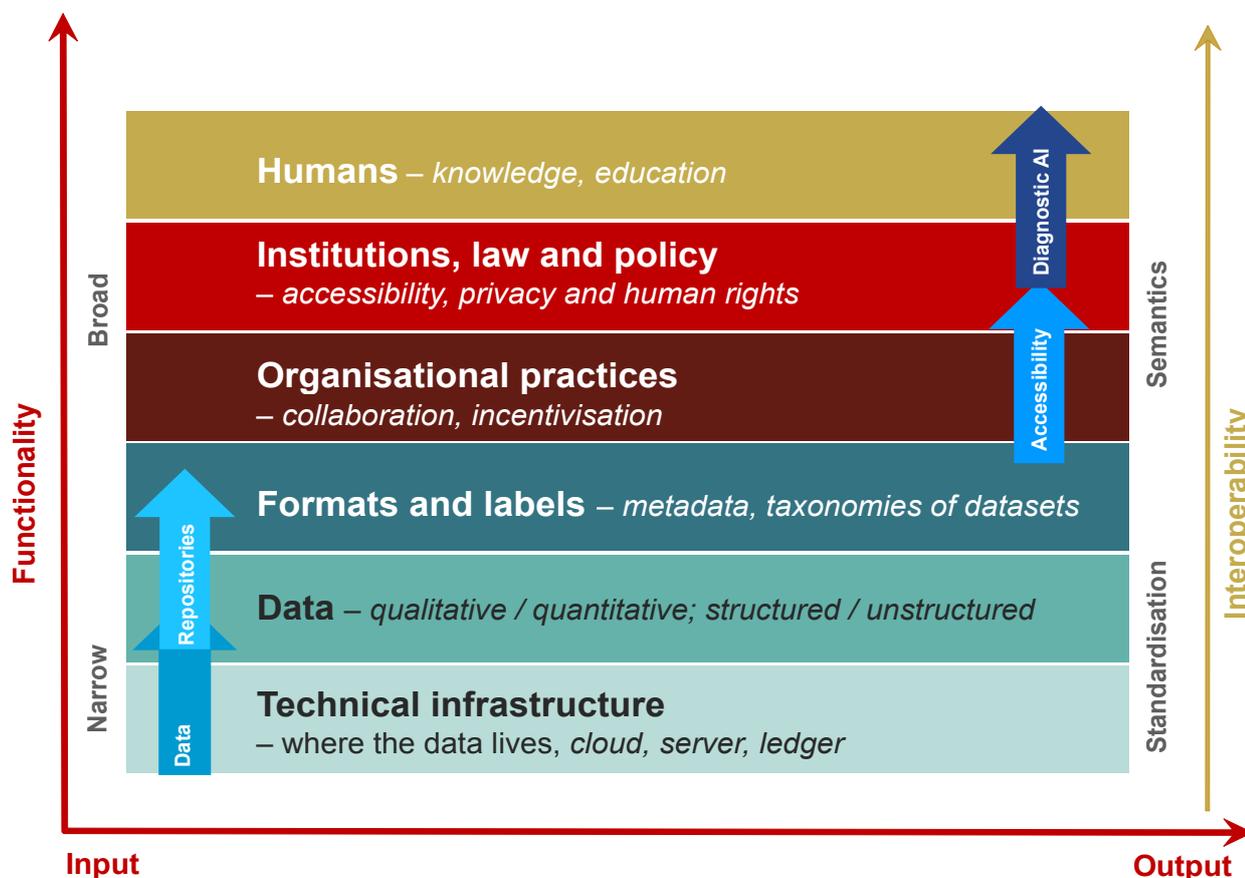
28 <https://siyaphumelela.org.za/>

29 <https://www.csir.co.za/national-integrated-cyber-infrastructure-system>

30 <https://www.chpc.ac.za/>

31 <https://www.dirisa.ac.za/>

Figure 18: Data commons framework (adapted from Goldstein, Gasser & Budish, 2018)



Research into international practice and trends provided conceptual frameworks that could be applied to unpack key elements that the PSET CLOUD system should address. By way of example, the data commons framework (Figure 18) indicates what some of these elements could be.

Goldstein, Gasser and Budish (2018) proposed the “data commons as a promising mechanism that could boost the potential for societally beneficial AI by lowering the barriers to data collection, sharing, and use” and where the diagnostic value is the highest in assisting human understanding of data. The conversation since has deepened into understanding how data could be used for the benefit of all and looking at creating broader, more inclusive datasets that can be used in artificial intelligence (AI) applications. The data commons framework offers a way to relook at data and to assess its use in new contexts, or to promote greater collaboration between players.

In looking at the data commons as a framework for interoperability and data sharing, it will be important to begin with understanding what data is available (what has been collected already – what Goldstein, et al. [2018] call “data on the ground”), and how it is stored and organised (the available repositories). Standards help consolidate diverse datasets – helping individual organisations share

their data with their collaboration partners – without the need to recapture data or the endless sharing of data extracts on spreadsheets, which is sometimes the practice in the PSET sector.

Data exists and has meaning in a particular context and is often seen as an asset. Encoding this context into metadata and taxonomies of datasets enables the reuse, repurposing and the consolidation of data. This may be as simple as understanding the meaning of the labels used to identify data fields or as detailed as understanding how the data was collated and analysed to draw the insight which informed a particular course of action.

Sharing data also brings with it a change in how work gets completed, the priorities being set and the actions being taken. Although most can see the benefit of gaining access to a partner’s datasets, sharing our own data can be more complicated as we come up against policies that separate our workstreams and reporting lines, a siloed work culture and a restrictive data ownership mindset. By highlighting that data can be seen as an asset to the infrastructure or even the services of an organisation that collects and stores data in the first place, we are challenged to critically reflect on who should own and control the data to ensure the most ethical and beneficial use. This involves looking

at who benefits and/or profits from the dataset and who is impacted by its collection and use. We would then also need to rethink who should have access to the data and how accessible it needs to be.

It is at this point that the appropriate policy, legal and ethical frameworks governing the collection, handling, analysis, interpretation and dissemination of data are needed. However, building these guidelines without understanding the broader context and potential uses of the data can see innovation and the improvement of service delivery triggered by data sharing being stifled. Finally, moving towards a more data-driven or data-informed societal model will mean developing the necessary understanding and skills enabling people to be empowered by the data frameworks, rather than becoming overwhelmed by new technologically driven processes.

Our research has clearly shown that successful data-driven collaborations are not solely a technology solution. Organisations should not take the view that by finding or developing the “right” technology solution, all issues around reporting and service delivery will be resolved. Technology is often the least complex part of the solution, and it is easier to establish mechanisms, processes and platforms if these are well understood and navigated within the organisational realities of working together in a mutually beneficial collaboration. In evaluating the potential for data-driven collaboration within the PSET sector, the interoperability continuum (shown in Figure 18) assists in showcasing the dimensions of control that can exist at various levels of governance, standards, data and technology.

In viewing this continuum more closely, some of the questions to be raised and debated would be:

1. Should the governance and management model for the PSET CLOUD be authoritative and centralised or decentralised and participatory?
2. Should standards be closed or open?

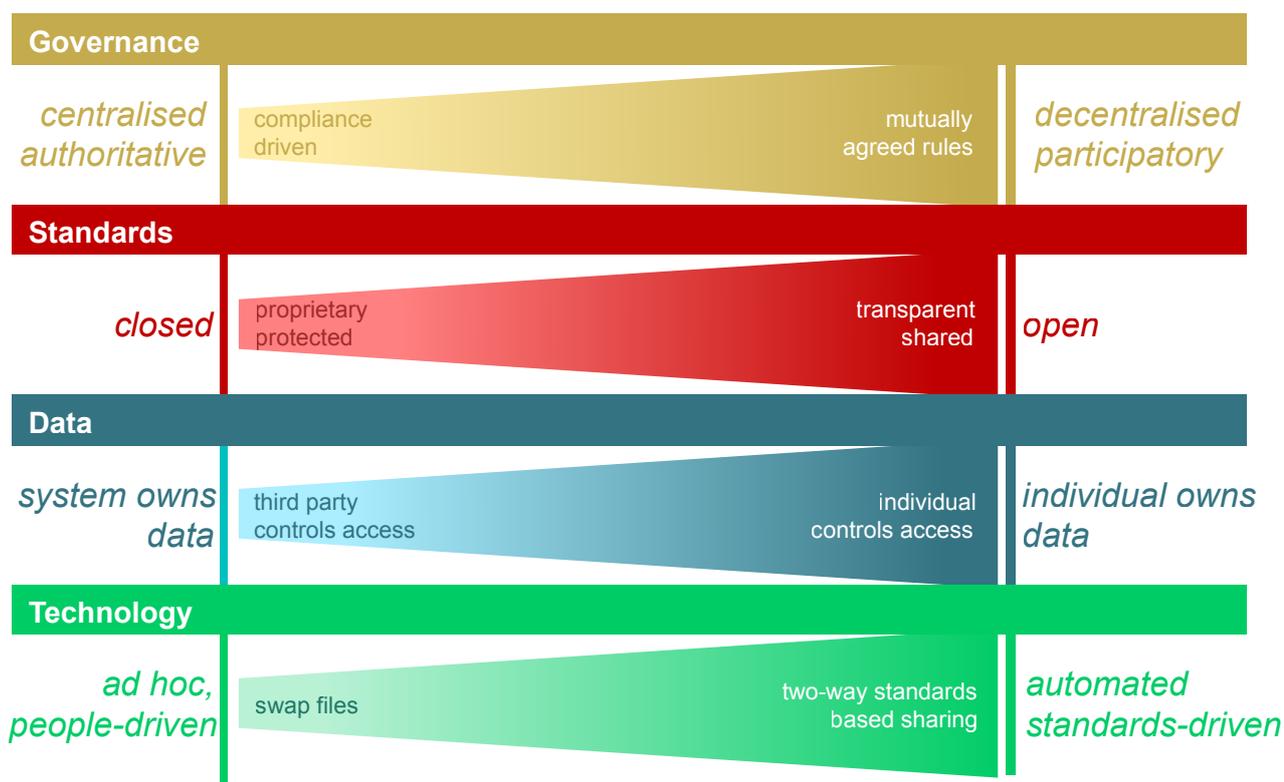
3. Should data be owned by the system or owned by individuals?
4. Should the technology be ad hoc and people-driven or automated standards-driven?

This study indicates that most organisations in the PSET sector find a way to share data if needed, for example, by means of physical file swaps (including reports, spreadsheets, emails and text exports) or through automated server-to-server collaboration without the need for human intervention, except as guardians to ensure that the systems are operational. It is important to assess how most data is shared and understood – an automated system that gets circumvented by emails and the use of spreadsheets is a wasted resource that no longer serves its purpose. At the same time, a more fluid and constructive dynamic ownership model is more desirable. This means that consciously negotiating what ownership model, access control and data security would lead to the use of data that will advance the greater good for all should be a priority.

Technology provides a way of working that allows for data sharing regardless of the nature of the data standards being used. Open collaboration and development using open standards in open source communities advances projects which would normally have been too big for an individual organisation to pursue. What has become clear is the need for declarative protocols which describe how data is to be shared or accessed. In a collaborative context, the mix of standards being used (whether open or proprietary) needs to be disclosed, understood and agreed on. How these agreements and negotiations are completed forms the basis for the final part of the interoperability continuum – the governance layer – where projects and systems can be rule-based (compliance-driven) or negotiated around within a mutual value framework. Important to note is that platforms will migrate along the continuum as they develop and the potential for change always exists.

What has become clear is the need for declarative protocols which describe how data is to be shared or accessed

Figure 19: Dimensions of control along the interoperability continuum (adapted from United States Department of Homeland Security, 2015)



CONSIDERATIONS FOR IMPLEMENTATION

The CSIR feasibility report (CSIR, 2019a) confirmed that interoperability within the PSET system is feasible, given that there are elements of attempts at integration or interoperability, albeit in a fragmented manner, and the technologies supporting such systems would have to be aligned to more advanced and efficient technologies now available. From the exploratory analyses, the principles to frame the design, development and implementation of the system recommended are: (i) building on existing systems as well as bringing coherence to existing systems; (ii) avoiding opting for a single monolithic information and technology system as PSET organisations and institutions have different data needs and systems aligned to particular legislative and regulatory mandates, rather than opting for systems compatibility; (iii) building the interoperable system incrementally and iteratively – designing, testing, learning, adapting, refining; (iv) building and ensuring sufficient resources – skills, capacity, expertise and funding; and (v) acquiring a critical mass of stakeholder buy-in early in the project to catalyse testing and implementation that will show the value of interoperability. As with any

innovation or change, a change management plan to ensure sustained interest, participation and trust in the value of the concept of interoperability of key role players would be of benefit.

An incremental iterative approach could begin with the development of a minimum viable product (MVP) for a part of the PSET system. The MVP would be tested by organisations that would be deemed early adopters to provide proof of concept and value to other role players in the PSET system. For instance, the initial development, testing and piloting of the PSET interoperable system could be incubated in the skills development subsector, involving a cluster of SETAs, employer organisations, labour organisations, the NSF (LMIP), SAQA, QCTO, TVET colleges, HEIs and training NGOs – the latter three groups having a tradition and practice of working within the skills development subsector, particularly with SETAs. The advantage of bringing together a cluster of organisations and institutions as exemplified would also allow for the pooling of resources, availability of real datasets, access to technology tools and data management models to inform the design and development process.

In order to ensure sustainability beyond testing, the PSET interoperability project would need to articulate the nature of skills and expertise required for the system collectively

as well as for organisations and institutions so that this capacity can be developed from the onset of the design, development and testing phases. Initial indications from the analyses and studies conducted point to expertise in a range of occupational and functional areas such as data analytics, information technology, research, and education training and skills development (CSIR, 2019a). Some of these skills already exist within the PSET system and may be harnessed to contribute seamlessly to the PSET interoperability project from the start.

Finally, the COVID-19 pandemic has impacted the coffers of the state and state institutions. With particular reference to SETAs, the four-month skills levy holiday whereby employers were not required to pay skills levies has affected the level of available resources for programmes and projects. Government departments have been cutting budgets as the tax base, and thus the fiscus, is decreasing. In order for the PSET interoperability project to gain traction, it will be important that it is viewed to be of a higher quality and value than the plethora of online research portals and databases owned by organisations that sell data and information to users such as planners and researchers.

IMPLICATIONS

All organisations and institutions would remain responsible for their mandate and legislative compliance requirements and the maintenance of their data and information systems as regulated. Interoperability services would require organisations and institutions to take responsibility for the quality of their data (CSIR, 2019a). Privacy, security and confidentiality of data and information would be key, therefore advanced encryption technology would need to be deployed (CSIR, 2019a). The service envisaged is one that enables sharing and collaboration whilst organisations will maintain control and ownership of their data and information.

Data standards would need to be developed, some of which could be derived from standards of PSET stakeholder organisations and institutions and others from international standards bodies. Guided by the principle of building on existing frameworks, there are a number of local and international standards frameworks that could be considered to enrich the PSET interoperability project. Some of these are: the SASQAF (see page 15); the International Monetary Fund's Data Quality Assessment Framework (DQAF), "which specifies the fundamental principles of official statistics provided by the United Nations Statistics Division" (CSIR, 2019a, 28); Statistical Data and Metadata Exchange (SDMX), "an encoding of

national statistics for harvesting from the websites of national statistical agencies'; and the Data Documentation Initiative (DDI), which is used for describing data-produced research in social behavioural, economics and health sciences (CSIR, 2019 a, 28). The DHET has also released *the Draft Data Dictionary for PSET* (DHET, 2019a) for public comment. A draft document such as this could be put through a deliberate structured process of discussion and refinement among PSET stakeholders to the point of being adopted as a data standards document for PSET interoperability.

The Post-School Education and Training Information Policy (DHET, 2019b) was updated in 2019 and aims to address the wide range of information systems currently within the PSET system and develop standards to make them more effective. It includes improving access to reliable and relevant data and ensuring the DHET gets data from other institutions that adhere to standards. Discussions with DHET role players and stakeholders indicated that, subject to a number of conditions, there is strong support for enabling increased access to DHET PSET data. It is believed that making this data more widely accessible to external stakeholders such as other government departments, education NGOs and education institutions would reduce the DHET's reporting burden and support improved planning, decision-making, integration and coordination. This should, therefore, be addressed explicitly in the PSET Information Policy. The proposal is for the policy to include clauses that confirm the willingness of the DHET to share PSET-related data and outline mechanisms for this process to occur (CSIR, 2019a).

OPPORTUNITIES POST COVID-19

The COVID-19 lockdown in South Africa provides an opportune time for critical assessment of organisational processes and to further assess where digitisation can be implemented. Digital transformation allows businesses to be versatile, resilient and agile in how they respond to new challenges. Generally, the following benefits of a PSET CLOUD were highlighted in the CSIR (2019a, 2019b, 2019c) reports:

- Improved planning;
- More up-to-date data;
- Reduced time spent providing reports and data to external parties;
- Better use and increased dissemination of data.

In addition, technology has one of the most important roles to play in enabling us to meet the challenges presented by the COVID-19 pandemic.

Finally, the PSET CLOUD could give us a system that is supportive of innovation, increases autonomy, flexibility and choice – not just for individuals but for all stakeholders within the PSET ecosystem – and facilitate access of the marginalised.

Linking education and skills to the labour market

The *White Paper for Post-School Education and Training* indicates that the PSET sector should build better links with the labour market (DHET, 2014). Fostering these links could be achieved through cooperation supported by access to up-to-date information accessed through a digital platform. For example, an appropriately designed system could be used by employers to advertise learnerships, internships and jobs; by SETAs to publicise learnerships and funding opportunities; and by colleges and universities to disseminate information about courses. Joint planning between partners could ensure that programmes are coordinated to achieve education and business outcomes efficiently. This type of electronic platform could be supported through the PSET CLOUD project and could be explored through pilot applications.

Access to information

The NDP is critical of the way some government programmes have inadvertently discouraged citizens from taking responsibility for improving their own circumstances. The NDP therefore places a strong emphasis on citizens actively seeking opportunities for their own “advancement, learning, experience and opportunity” (NPC, 2013, 37).

In order for people to seek opportunities, information about these opportunities must be readily available and easy to understand. Within the education sector, this means not only running appropriate education and skills programmes but also ensuring that people can find out about these courses and enrol in them with ease. Here again, the PSET platform could play a role. It could provide a means by which local TVET and CET colleges and SETAs could promote their programmes to targeted audiences. This process could be enhanced through links to social media platforms to ensure that information reaches the appropriate audiences.

Diversity and coherence

A review of PSET policy indicates a recurring interest in creating greater diversity within the PSET system while at

the same time ensuring that it is integrated and coherent (DHET, 2014). Diversity in the way education can be accessed helps to ensure that the system is inclusive and that all learners are catered for. An integrated, coherent system has a framework and structure that provides learners with the freedom to choose from a wide range of educational options and ensures that progress through the system is recognised and accredited appropriately.

While these objectives are desirable, they present significant organisational and administrative challenges. This may result in educational institutions with limited resources making the decision to limit access and reduce options. A well-designed PSET CLOUD system may help address these challenges. A platform which enables PSET institutions to easily upload information on learning options and ensures this platform can be easily navigated can be used to enable students to identify, evaluate and follow personalised learning paths without this becoming unmanageable.

Support to inclusivity

In the last decades, it has become clear that people need to take an active part in and responsibility for shaping the way technology is developed, deployed and enables possibilities for everyone. Rather than leaving standards committees to work behind locked doors, allowing industry players to pursue novel ideas, with standards evolving through adoption, would enable standards committees to develop standards that take into account “inclusivity, accessibility, and credibility” (Grindley, Sherry & Teece, 2017, 42).

Borrowing from, The Next Generation Internet Initiative (NGI)³² of the European Commission, the PSET CLOUD project sees the possibility of shaping the development of a platform ecosystem that places people (humans) at the centre of the internet (NGI, 2019). This could include exploring and supporting particular threads such as:

- Build privacy and trust – giving people back the ownership of their own data, facilitating more conscious and controlled data protection, making sure that datasets are as inclusive as they can be, that algorithms and development approaches are controlled for bias;
- Search and discover – with particular interest in supporting people with disadvantages in the current system, including but not limited to expanding search intelligence to cater for multilingualism, second or even third language English competency, assistive technologies for people with physical impairments;
- Decentralisation and integration of common social platforms to increase accessibility, without increasing the administrative burden (NGI, 2019).

32 <https://www.ngi.eu/>

Further, the PSET CLOUD project could promote greater inclusion by facilitating and supporting greater diversity within the teams that are supporting its genesis, development and management. Providing reference groups, education and technology experts “who understand, or are sensitive to, varied usage patterns” and capable of “supporting the development of a wider array of products, services, and experiences” (Yu, 2020, 12).

At this point it is clear that more work needs to be done to understand the barriers, benefits and drivers of change that would grow the demand for and adoption of the envisaged PSET CLOUD services, in particular with respect to guiding the decision and selection of post-school education options or even linking to bridging services to employment, especially in the context of the most vulnerable communities who have limited connectivity

and support in their own social environments. In doing this work, it will be important that the project employs an expansive framework to address real barriers such as lack of connectivity, electricity, financial and social support that currently stand in the way of education and employment in South Africa for the poor and underemployed (Lolwana & Ngcwangu, 2016; Vally & Motala, 2014).

RISKS

While the opportunities are many, it must also be acknowledged that there are risks entailed in developing an interoperable system such as that envisaged for the PSET CLOUD.

Table 5 provides a risk analysis based on the preliminary research.

Table 5: Risk analysis (CSIR, 2019c and authors of this report)

Risk type	Risk description	Mitigation
Security	Open, unregulated access of the PSET CLOUD could leave the system open to cybercrime.	Implementing cyber security measures such as stringent password policies and periodic User Rights review.
	There are concerns that information could be misused (CSIR interview with CHE, 2019).	Implementing separation of duties in the onboarding of users, i.e. capturing, processing and verifying to be done by different individuals. Implementing stringent IT security processes and protocols.
Legislation	Non-compliance with legislation such as the POPIA and PAIA (CSIR interview with QCTO, 2019).	Implementing a compliance monitoring tool to ensure that there is always compliance with all applicable legislation or hire dedicated compliance personnel.
CLOUD services	Not all major CLOUD service providers have a base in South Africa so there is a risk that sovereign data might be stored on offshore servers without consent from the stakeholders. This poses a threat to the sovereignty of the data and could be a contravention of the POPIA which states that “no responsible entity in South Africa may transfer personal information about a data subject to a third party who is in a foreign country unless the conditions stipulated in the Act are met”.	Implementing a compliance monitoring tool to ensure that there is always compliance with all applicable legislation or hire dedicated compliance personnel.
	In terms of CLOUD service providers, all stakeholders remain responsible for their own compliance requirements and need to understand the regulatory environment, which could be complicated if the CLOUD service provider is located in another country or if the CLOUD services are hosted outside the country, whether permanently or temporally, in full or in part.	Utilising CLOUD service providers that have a base in South Africa such as Amazon Web Services or CLOUD.co.za.

Risk type	Risk description	Mitigation
CLOUD services	The CLOUD service does not remove the participant's obligations regarding the "hygiene" of their data, services or products, and each participant should first conduct a proper internal audit before populating the CLOUD service.	Adopting a top-down approach to management of CLOUD services such as prescribing standard tools and methods from the perspective of PSET as an administrative database.
	The managers of the PSET digital ecosystem need to manage the CLOUD services used, because in general, no CLOUD service is tailored specifically to the needs of the PSET digital ecosystem. This includes identifying the risks and how to deal with them, particularly through internal measures, and understanding in detail the nature and extent of the PSET CLOUD service.	Hiring skilled personnel to manage the PSET CLOUD will mitigate this risk.
	Fears that the owner of the PSET CLOUD will monitor the use of the service and extract metadata (of users, transactions and services) have been highlighted.	Encrypting data before uploading it to the PSET CLOUD; creating and implementing Standard Operating Procedures (SOPs) for users with regards to data review prior to populating the PSET CLOUD. Further to this, the PSET CLOUD should be built with data validation protocols wherever possible to ensure that there is invalid/incorrect datasets are automatically rejected.
Governance	Lack of independence, poor governance and weak governance structures are highlighted as potential risks of the PSET CLOUD development.	Operating the PSET CLOUD like a corporate entity, with institutions such as TENET and SANReN to be used as benchmarks or models.
Adoption	A lack of involved stakeholders to champion the PSET CLOUD might result in a lack of buy-in from other stakeholders.	Engaging in an effective change management process with determined measures of success defined and assessment of performance and progress towards adoption.
Data	Belligerent stakeholders, together with the misunderstanding of stakeholder roles.	Understanding and grouping of stakeholders for targeted adoption procedures to be implemented.
	Too much data and the system becomes cumbersome, too little data and the system becomes simplistic (CHE, 2019).	Analysing the data absorbed into the PSET CLOUD to see if the data is relevant or not.
	Resistance within the PSET ecosystem to sharing data (CSIR interview with Bridge, 2019).	Engaging stakeholders to establish trust between the PSET CLOUD team and the stakeholders; once the trust is established there should be no resistance.
	Delays in establishing data sharing agreement contracts.	Adhering to timelines identified in workplans will prevent delays.
Design	A monolithic type architecture is not suitable, nor is it is feasible for the development of the PSET CLOUD. Such architecture is considered a risk because of its complexity and all or nothing approach to system development.	Doing away with old architecture and building the PSET CLOUD using new design architecture such as micro-service.

6

HOW READY
ARE WE?



At the outset of this report we asked whether South Africa is ready for data ecosystems in the PSET sector to become interoperable. We have examined a wide range of local and international sources and elaborated on the situational analysis, stakeholder mapping, and feasibility analysis conducted in 2018 and 2019 by the CSIR (CSIR, 2019a, 2019b, 2019c) in conjunction with an international review on trends in interoperability (Shiohira & Dale-Jones, 2019). During 2020, we supplemented these baseline reports with additional interviews and the meta-analysis presented in this report, while we also started to explore some new innovations (Dale-Jones & Keevy, 2020; Whittaker, Keevy & Rajab, 2020). At the time of the release of this report, in

November 2020, two new partner organisations had also been appointed and were well under way with the second phase of the PSET CLOUD project. The ToC was also reviewed and updated to consider the changing context locally and internationally and to take careful account of the impact of COVID-19 on the project.

In Chapter 6 we pull together the insights and findings from the previous chapters across four areas of readiness: governance; capacity; stakeholders; and interoperability. We try to sketch a self-critical view of the progress made through the first cycle of the project and outline the key elements of the next cycle, now with new partners on board and work well under way.

OVERVIEW OF THE STATE OF READINESS

The state of readiness for the South African PSET sector to adopt an interoperable data ecosystem hinges on various factors such as governance, capacity, stakeholder willingness and commitment to collaborate and cooperate to achieve common and clear objectives with a shared vision.

The situational analysis (CSIR, 2019c), stakeholder mapping (CSIR, 2019b) and international benchmarking study (Shiohira & Dale-Jones, 2019) conducted in 2019 as the initial phase provided findings and insights pointing to the feasibility of establishing the PSET CLOUD. It was found that there is overall support for a PSET CLOUD, with stakeholders envisaging benefits such as: user-centered capabilities and working from users' needs; better use of and increased dissemination of data to drive data-driven insights, knowledge and intelligence; transparency and accessibility; reducing time spent providing reports and data to other parties; better links between education and the labour market and the economy; raised integrity of planning; the availability of up-to-date data; and coordinated, open learning systems for lifelong learning. Some of the issues that would need deeper consideration are: ensuring that the policy and legal environment enables the establishment of the PSET CLOUD; overcoming systemic fragmentation and working in silos; standardisation of business processes; quality complete, accurate and up-to-date data; adequate human, financial and infrastructure resources; and data ownership. Building the envisaged interoperable system would promote integration. It requires an iterative process and continuous cycle of innovation.

So how ready are we? Whilst we have concluded that stakeholders within the PSET sector are in agreement about working towards an interoperable digital ecosystem, more collaboration and partnerships need to be fostered. It is only with transparency that trust can be built. Transparency will come with sharing information for a common purpose.

Governance readiness

An agreement between entities regarding the sharing of information is required as the foundation of interoperability. A clear and shared vision of what the value proposition of interoperability is for all stakeholders is essential. Issues such as the ownership of data, how privacy and security will be maintained, and what constitutes misuse and legal compliance with Acts such as the POPIA need to be resolved. These issues inform the development of rules of engagement between partners. According to the NPC (2020b, 81), "An integrated data

governance framework, within the context of the constitutionally enshrined Bill of Rights, will be essential to developing the trusted framework required for people to use online services."

A governance structure and process needs to be established. This includes the creation of assigning authorities. Given the clear need for a common data dictionary, the identification of assigning authorities is therefore very important. The NQF and the SAQA structures fulfil these functions for occupations and qualifications. Qualifications and course content that have been accredited by quality councils are already identified clearly by SAQA, and therefore interoperability is already enabled, with the major data source being the NLRD. Non-accredited courses such as short courses presented at universities are not included in the SAQA mandate, and hence the sole source of this information is the learning institutions that form part of the supply-side of the value chain.

Capacity readiness

The NDP has a strong emphasis on a "capable and developmental state" (NPC, 2013). The plan acknowledges that developmental objectives may be stifled if government officials do not have appropriate skills and experience. The PSET CLOUD project will require strong ICT skills within government to develop and use the capability of the proposed tool to its full potential. Interviews with stakeholders conducted by the CSIR indicated that current ICT capacity within the PSET sector is weak and will have to be strengthened to enable the potential of the PSET CLOUD project to be fully realised (CSIR, 2019c).

The National School of Government aims to improve skills within the civil service. It runs a range of training programmes for government officials and sets itself the specific objective of developing a professional, responsive, capable public sector (National School of Government, 2019). A review of the skills development courses supported or run by the National School of Government, however, indicates that there is limited provision for the type of ICT skills required for the PSET CLOUD. It is therefore important that the implementation programme for the PSET CLOUD includes capacity development of relevant government officials.

Stakeholder readiness

The fragmentation of information systems means that there is a need for more information sharing, and discussions with stakeholders will serve to bring key role players on board to find solutions together and provide for the structure and design of the PSET CLOUD platform. We have identified this clearly as one of the next steps we need to take.

Interoperability readiness

Standards and frameworks

South Africa has developed several frameworks and standards for strengthening interoperability and integration. These standards are key in addressing barriers such as data quality and integrity, governance, security and privacy. Some of the key standards include:

- Minimum operability standards: allow government data systems to talk to one another and exchange data freely (interview with W. Needham, 2 July 2020). These standards, created by the SITA, will be explored further for purposes of a complex PSET sector with a large number of stakeholders with varied and separate data systems.
- Minimum Interoperability Standards (MIOS): prescribed standards to promote interoperability between systems utilised in government and by citizens to support e-government objectives.
- Minimum Information Security Standards (MISS): developed to address security, privacy, integrity and confidentiality of information transmitted and stored electronically. They have not been updated in a long time and this is a serious drawback given the rapid advances in technology.
- The data quality standards specified by StatsSA in the SASQAF: provide criteria and procedures for the evaluation of official statistics and other data. The adoption of these standards, especially in the public sector, is key for promoting interoperability. The dimensions of data quality highlighted in the framework are relevancy, accuracy, integrity, timeliness, interpretability and accessibility, all critical in promoting interoperability. The extent of the adoption of these standards remains unclear.

Policy and legislation

In the past two decades, the South African government has implemented several policies, laws and strategies aimed at promoting interoperability through ICT infrastructure development, privacy, security, trust and collaboration. The implementation of these policies, however, needs to be supported by strong institutions and institutional mechanisms. Policy harmonisation is also important for strengthening the regulative framework to support the 4IR. According to the NPC (2020b), government needs to develop an integrated digital policy that promotes

digitalisation of the economy across all sectors and society as a whole.

ICT infrastructure

ICT infrastructure such as cloud computing and telecommunications technology such as broadband internet and supporting software all play a critical role in creating a strong basis for interoperability. While challenges such as high data costs and slow broadband penetration still remain in South Africa, creating an enabling environment for broadband extension is pivotal for advancing digital transformation. Although the adoption of advanced technologies such as AI, big data and blockchain has been high, a need in South Africa for skilled personnel to support the adoption and to work with advanced and emerging 4IR technologies has been identified (NPC, 2020b).

LOOKING FORWARD TO 2023

Having examined the various facets of the PSET CLOUD and, more particularly, the PSET sector's readiness to move forward with an interoperable data ecosystem, we need to ensure that the proposed digitisation of the PSET ecosystem is aligned to stakeholder needs and that we are even more ready to embrace the much-needed systems change. Hence, being in a position to engage deeply with key stakeholders to acquire a thorough understanding of the challenges and shortcomings experienced by various organisations at various levels of interoperability within the ecosystem is critical. A well-designed project cycle with clear goals and objectives for each phase is essential. We understand that the project will go through several phases before it is completed. However, an agile and iterative approach is desired. Hence, the process of engagement, establishing relationships and an agreed and shared vision become focal points for the next phase of this significant and long-term initiative. A five-year project cycle is estimated, which includes establishing the conceptual framework and finding potential solutions after reviewing the current practices and systems within the PSET ecosystem as elucidated in this report. Although the report concludes that stakeholders do have an interest in digitisation, more planning, support and commitment through dialogue and engagement is necessary if we are to forge ahead.

Project cycle

In considering the interoperability of data ecosystems, we have identified a complexity of constraints such as technological, social, political, legal and organisational barriers. Although it was not the scope of this study to look at all the barriers, an understanding of them is critical in order to develop context relevant strategies that are responsive to the needs of the PSET system and South Africa in general. A well-designed project cycle can enable specific outcomes to be achieved in the long term, although it will not alleviate the difficult responsibility of making decisions, weighing alternatives or negotiating with prospective end-users. Figure 20 illustrates the project life cycle from Phase 1 at inception with the key partners involved, moving into Phase 2 where alignment within the PSET ecosystem is sought through stakeholder engagement and scenario planning towards a shared vision and any opportunities for possible innovation. One such innovation identified is the concept of self-sovereign identity (SSI). Phase 2 will also seek options that can be prioritised towards the development of an MVP and possible pilots that can be initiated based on stakeholder commitment. Phases 3 and 4 will focus on the design and development of an agile platform once a business case for this purpose is confirmed.

Stakeholder engagement and scenario planning

Stakeholder engagement and scenario planning is a critical component of Phase 2 in the overarching PSET CLOUD initiative. It is seen as a process for facilitating inclusivity, partnerships and deeper consultation, with the purpose of building greater transparency, trust and credibility within the PSET ecosystem and the PSET CLOUD initiative. Reos Partners, appointed for this process, will engage key stakeholders in an exercise of co-creating scenarios and analysing prevailing perceptions which play a significant, but often invisible role, during engagement. The intention of the transformative scenario planning sessions is to make these perceptions more visible. The resulting scenarios will also enable more insights into possible futures in the provisioning and utilisation of human capital in South Africa and the related role of interoperable digital data systems. The results of these engagements will be published in order to share stakeholders' perspectives of the PSET CLOUD.

Minimum viable product

The COOi Studios³³ team will identify the PSET CLOUD solution as well as an MVP within the solution. In order to demonstrate the art of the possible, the team will build

a prototype that will have limited functionality. The team will co-create the MVP with the stakeholders who will be invited to a Design Thinking workshop specifically for this purpose and come up with a shortlist of candidate processes from which a prototype will be selected.

In keeping with an agile approach to the development of software or a platform, the MVP developed will, in the first instance, allow for user-centred design. Possible partners during this design phase are the WEF-UN Global Compact-WITS-SAP, Oracle or Microsoft-Accelerators. The team will design various products based on those selected and prioritised in the Design Thinking sessions which will be held with stakeholders within the PSET ecosystem. These designs will then be illustrated in a wireframe/prototype. The MVP will be developed using wireframe software and tested by stakeholders to gather feedback, which will then be incorporated into the MVP functional specification.

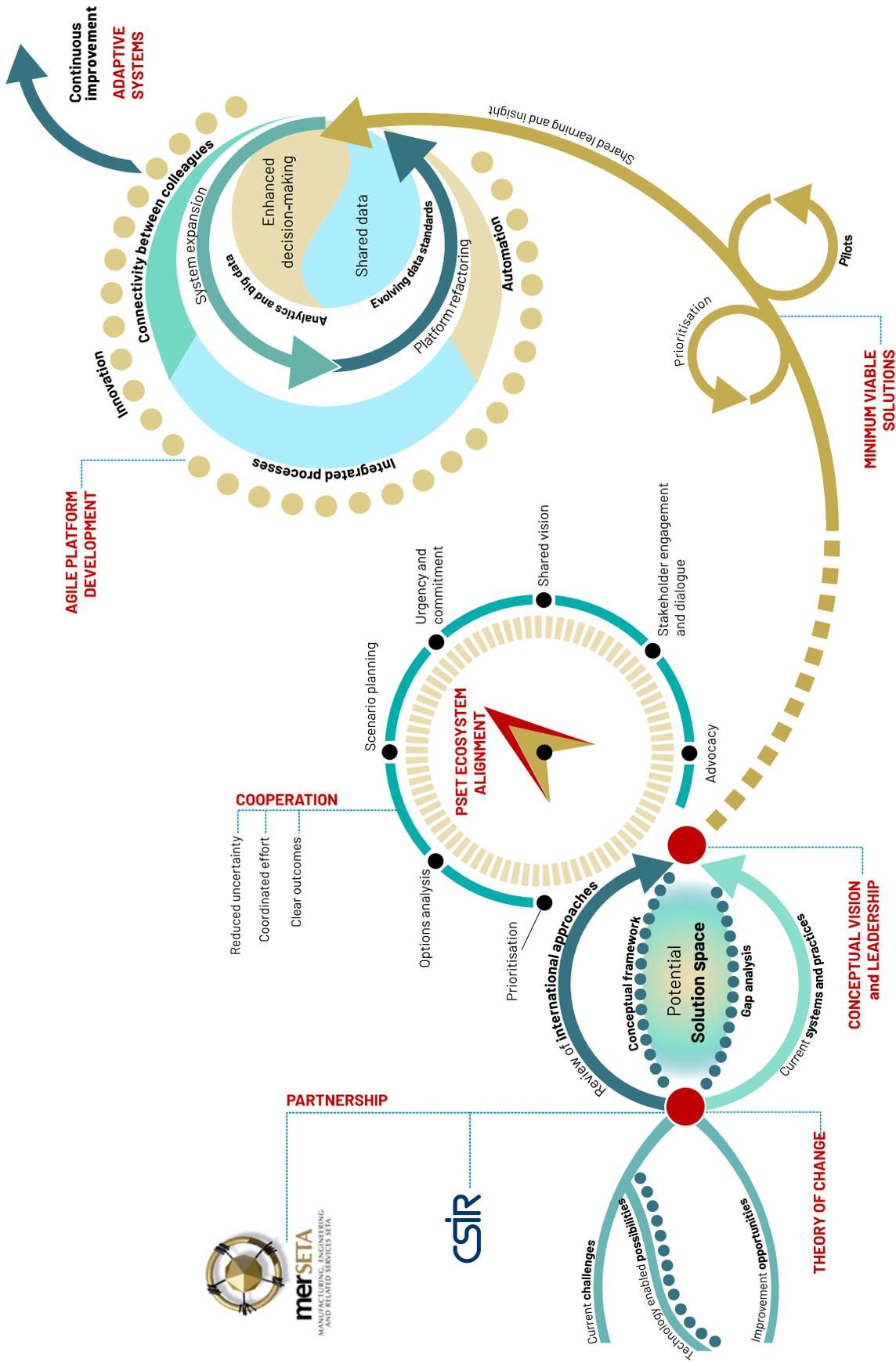
Innovation

Technology advances in the 4IR and the increasing adoption and use of technology by institutions and individuals to collect, process, share and store personal data in the digital society has brought with it increasing concerns around privacy and security. The increased risk of misuse of personal data has also raised trust issues between citizens and institutions such as governments, technology companies and other entities collecting and storing personal data. These concerns are also considered one of the significant barriers to the integration and interoperability of systems for promoting collaboration and the sharing of data to improve coordination, planning and operational efficiency.

SSI, commonly defined as “a digital movement” or as an “identity model”, recognises that the need for individuals to have agency with respect to their identity is an important factor in addressing the issue of trust. New and emerging technologies such as blockchain have made SSI possible: data integrity, security and privacy concerns can be managed through using complex cryptography and decentralisation. SSI, which allows for information exchange between institutions and systems, can be used successfully in education and is relevant to the PSET project; it provides an effective way of issuing and verifying digital transcripts, but its relevance is much broader than that. SSI can be used in supporting and digitising the entire learner ecosystem and is an efficient way of matching labour demand and supply. Finally, it provides a frictionless user experience. SSI requires more investigation for the PSET CLOUD project.

³³ <https://www.cooistudios.com/>

Figure 20: PSET CLOUD project cycle (as presented at the ETF conference in Turin, Rajab 2019)



Advocacy

An important responsibility that has been identified is the need to take all our stakeholders within the PSET ecosystem on the journey with us. For this purpose, the development of a brand identity as well as an advocacy and communication strategy and a standalone website will be pursued as progress is made. This will ensure that stakeholders are kept abreast of the initiative and can engage further with the processes involved.

CONCLUSIONS

We conclude this SOR report with an emphasis on meaningful interoperability. Meaningful interoperability and new technological developments can help organisations operate more efficiently and improve outcomes. Our analyses pointedly indicate that well-defined communication processes between systems are necessary at all levels, from governance to organisational systems and processes towards integration and interoperability. This must include how the receiving systems process data, how all data is made available for system and human use and how interoperability will impact all our current work. Our view is that achieving meaningful interoperability will not be solved by technology alone or by simply adopting a set of standards. Blockchain allows us to envision today the education landscape of tomorrow but the success of its implementation, including interoperability, governance and widespread adoption, will depend on the collaboration and dedication of industry players (Kaplan & Garcia, 2019).

Whilst we are building on the knowledge and lessons learnt from the initial phase of the PSET CLOUD project, we have a clear road map that will allow stakeholder engagement for sharing synergies, challenges and experiences and initiating the breakdown of the common practice of working in silos. The PSET CLOUD project comes at the time when our economy is facing great challenges as a result of COVID-19. We need to make a concerted effort to deeply collaborate on putting in place education and skills development that will contribute to measures for preventing our national economy from collapsing and steer us towards a new economic pathway that includes catalysing the renewal and revitalisation of the domestic economy. To this end, citizens must have access to – and we in the PSET system, as “public

good” organisations and institutions, must make available – education and skills development that is aligned to employment and job creation opportunities, not only in the formal market economy but also in other, non-formal economies such as the social, household and community economic sectors. Our vision is to enable citizens to engage in lifelong learning and realise lifelong career aspirations; it is to enable citizens to make informed career and employment decisions and embark on continuous learning, transitioning from education to work and from work to education along various career pathways that link them to real employment and job creation opportunities, now and in the future, in what will be a period of constant economic and employment change for the times ahead.

Informed choices will come from access to and availability of a vast array of quality economic, employment, occupational and education data, information and knowledge emanating from and held by the full range of PSET stakeholders. Access to and availability of good quality data, information and knowledge also requires deep collaboration amongst PSET stakeholders to share their data; we also need to leverage the latest systems and technological tools to enable interoperability of our systems and technology and thus construct an integrated lens/view for citizens. The notion of interoperability that the PSET CLOUD initiative is developing aligns with the DHET’s notion of “shared services”, the main tenet of which is bringing to bear different capacity and capability within the PSET sector to raise the quality of the services public good organisations deliver to meet the needs of employers and workers (self-employed, employed and unemployed; youth and adults) in a collaborative, coordinated and consolidated manner. Interoperability, through enhancing the availability of real-time quality data and the sharing and exchange of data, information and knowledge to benefit both employers and workers, can facilitate clear alignment between the needs of the economy, employment and job creation opportunities and the supply of educated, skilled citizens. The building of an interoperable system will be incremental, iterative and agile to allow for testing and continuous improvement. All modern organisations in this era of growing digitisation recognise that data, information and knowledge are assets to be used for continuous improvement by individuals and organisations as they strive to realise their aspirations, and, as role players and organisations in the PSET system, we should not be left behind.

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