Embracing the Fourth Industrial Revolution: Risk-based perspectives of the South African TVET college sector

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ABSTRACT

A country's skills levels define the extent of innovation and abilities. Accordingly, Technical and Vocational Education and Training Colleges (TVET) are significant establishments in provisioning post-school education and training to fulfil the skills expansion in South Africa. These colleges are plagued by student protest actions and pass rates, that impact on the vision and mission of the educational sector. Amidst these challenges, the Fourth Industrial Revolution as a contemporary phenomenon provides new forecasts for consideration where Information and Communication Technology (ICT) are underpinning functions to strategically align objectives in the TVET college landscape. With a case study focused on secondary literature and policy structures of the Department of Higher Education and Training (DHET), this article explores the state of readiness of ICT innovation in supporting education provisioning in the TVET sector by examining current and potential risk perspectives. Through a bibliographic analysis, challenges of risk management, regulation and risk governance are foregrounded within the college sector, and arguably point towards innovative and creative ICT functions supported by an effective risk-based approach, positioning the TVET sector as an enabler of the Fourth Industrial Revolution.

Key phrases

ICT; Fourth Industrial Revolution; innovation; risk-based approach and risk management

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1.   INTRODUCTION

South African colleges are vital to delivery of post-school education and training, and a sector of strategic importance by the DHET. Colleges afford a form of education primarily for those who completed secondary school or not, and to those who intend pursuing vocational education or completing their schooling towards grade 12. These colleges offer education and training to communities advancing expertise for industry, commerce and public sector organisations (White Paper for Post-School Education and Training, November (2013[8]:11).

The TVET structure comprises of 50 multi-campus colleges with over 260 delivery sites for education and training in South Africa. These colleges are legislated by the Continuing Education and Training Act 16 of 2006[4] as amended, a national competency and obligation of DHET, as highlighted in the White Paper for Post-School Education and Training, November (2013[8]). The Further Education and Training Amendment Act 3 of 2012[7] transferred legislative college authority to national competency.

This article commences with a background on post-school education via TVET Colleges, followed by risks and challenges experienced in this educational sector. The research aim and methodology is presented, and literature contextualising the Fourth Industrial Revolution in relation to the college sector is reviewed. ICT and digital transformation are explored with college preparedness in the digital era. Following conceptualisation of risk management, interconnectedness and innovation are discussed. The article models the risk management framework emphasising six key aspects, including risk environment, risk identification, risk assessment, risk control, risk monitoring and risk reporting as significant risk elements for consideration. Pertinent recommendations are made regarding sufficiency of resources that could impact on the TVET sector to implement digital strategies, demanded by Industry 4.0. The article concludes on a contribution to risk governance in terms of the Fourth Industrial Revolution. Literature is developing and evolving in this field, with information referred to as the Fourth Industrial Revolution, Industry 4.0 or 4IR. In this article, literature appears as per the earlier two perspectives used interchangeably.

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2.   BACKGROUND TO TVET COLLEGE SERVICE DELIVERY MANDATE

TVET colleges are responsible for provisioning of general, engineering and business studies programmes on National Qualifications Framework (NQF) levels 2 to 4. The purpose of the legislation Continuing Education and Training Act 16 of 2006[4] as amended is to:

- Stimulate National Certificate: Vocation (NCV) programmes, as well as National Technical Education programmes in Engineering, Business and Utility studies;

- Respond to country's labour market and community needs;

- Add value to country's Skills Development Strategy;

- Afford opportunities, create knowledge and development of high level skills for academia and technical quality demands of the country;

- Create access to work opportunities and higher education; and

- Establish a coordinated TVET system offering programme-based vocational and occupational training (Continuing Education and Training Act 16 of 2006[4] as amended).

The college embraces public administration in education management and service delivery. As a public institution, the college is required to uphold the values as stipulated in section 195 of the Republic of South Africa (RSA) Constitution, 1996[1]. These values contribute to the processes that are efficient, economic and effective in resource management.

The Director-General for Higher Education and Training, MF Qonde (2015:7), emphasised in an overview of the DHET Strategic Plan 2015/6-2019/20[9], that the system should "cater for different needs and produce highly skilled individuals". He further stressed that DHET's strategic plan was informed by the White Paper for Post-School Education and Training (2013[8]) as well as socio-economic imperatives identified in the National Development Plan (NDP). The White Paper for Post-School Education and Training emphasises the critical role of information and communication technology (ICT) in provisioning of education and training towards advancing sustainable development for the country.

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3.   RISKS AND CHALLENGES FACING TVET COLLEGE SECTOR

According to Loynes (2016:4), TVET colleges are the country's primary source for the training and development of artisans and are key institutions to realise the objectives of the Human Resource Development strategy. This view is supported by Mpondomse (2016:4), who submits that, "The TVET system holds the key to unlock the human resource development challenge, and by extension unemployment, which ultimately contribute to broader objectives of socio-economic transformation and a more equal society." Mpondomse identifies the challenges in the TVET sector, as "poor delivery of teaching including poor management and administration of institutions".

Moloi (2016a:56) emphasises that South Africa's institutions of higher learning are facing "major challenges". The author stresses that these undesirable effects on institutional objectives warrant mitigation and risks to be reviewed, managed and reported to relevant stakeholders. According to Adams (2017:13), "South Africa's economy is burdened with an oversupply of low level skills, contained at all costs. It is clear that the capability of manufacturing facilities is based on the level of skills of people who occupy them." This dilemma of Adams is countered by the White Paper for Post-School Education and Training (2013a:xii), which propositions TVET colleges as education centres of choice for "skilling the nation".

It is identified in the Department of Higher Education and Training's Position on Online Programme and Course Offerings (2017:3) position paper, that the traditional method of teaching and learning through "face-to-face" techniques is unsustainable in the TVET Colleges. It currently operates as a resource-limited environment, and it is suggested that innovative open-learning approaches be considered to eliminate potential risks to effective resource management.

4.   RESEARCH AIM AND METHODOLOGY

The research aim of the article was to examine to what degree TVET college ICT innovation in education and training has embraced the strategic approaches of the Fourth Industrial Revolution or Industry 4.0. The case study examines contemporary secondary literature and policy structures of the Department of Higher Education and Training, aimed at exploring the state of readiness of ICT innovation in supporting education provisioning in the TVET sector. Through bibliographic analysis, the article concludes that an innovative and creative ICT

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function is supported by an effective risk management approach, thereby positioning the TVET College as a significant and necessary participant in the Fourth Industrial Revolution. The article provided a TVET college ICT perspective regarding innovation systems with the prospect of supporting imperatives of the Fourth Industrial Revolution. ICT innovation in the TVET college landscape is viewed as a stimulus for economic development in South Africa (DHET Budget Vote Speech 2017[14]).

5. ENVISIONING THE FOURTH INDUSTRIAL REVOLUTION *VIS-À-VIS* EDUCATION PROVISIONING OF TVET COLLEGES

Literature is reviewed amidst the digital revolution envisioned through the Fourth Industrial Revolution and the state of readiness of ICT innovation in supporting education provisioning in the TVET sector.

5.1 Macro underpinnings of ICT vision

The preamble of the Republic of South Africa (RSA) Constitution, 1996[1], states that the purpose of this supreme law is to "improve the quality of life of all citizens and free the potential of each person". One of the values of the RSA Constitution, 1996[1] under Section 1, is the achievement of equality, human dignity and the advancement of human rights (Cloete 2013:9). Chapter 2 in the RSA Constitution, 1996[1] proclaims the Bill of Rights in Section 7-39 as follows:

According to the RSA Constitution, 1996[1], the legislative authority is vested in Parliament, where laws are interrogated and sanctioned, and in this case, support performance management and service delivery in the public sector.

In support of the above RSA Constitutional democratic rights of South Africans, the Integrated ICT White Paper (2016[12]) references the strategic intent of the National Development Plan 2030, advising that the ICT sector can play a progressive role in addressing socio-economic challenges such as:

- Unemployment whereby ICT can address employment potential and enhance Small, Medium and Micro Enterprise expansion;
- Poor education levels in the education landscape can improve through ICT innovation through e-learning and educator up-skilling;

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- Spatial divide and reducing topographical divide between regions by connecting people facilitating inclusive development and participation;

- Poor public service can be supported digitally by encouraging participation of citizens; and

- Unequal South Africa promoted by building of the citizenry with access to data and information provided by government.

These suggestions for ICT underpin socio-economic development for the country through a connected society in order to realise the full potential of all South Africans.

Information and Communication Technology implementation in the public service is provided through the Integrated ICT White Paper (2016[12]) (IICTWP). The purpose of the White Paper is the provision of the "overarching policy framework for the transformation of South Africa into an inclusive and innovative digital knowledge society." The policy has the following goals:

- "Cross-government leadership and facilitating multi-stakeholder participation in the drive for inclusive digital transformation;

- Interventions to reinforce fair competition and facilitate innovation;

- Protect the open Internet;

- Interventions to facilitate digital transformation of society; and

- Mechanisms to promote growth in ICT" (Integrated ICT White Paper 2016[12]:4).

These intentions recognise the ICT *milieu* to stimulate national objectives as identified by the National Development Plan (NDP) and the Industrial Policy Action Plan directed at sustainable development of the country.

IICTWP identifies digital and mobile technology and infrastructure are forms of engagement where all citizens are able to acquire any information anywhere and in real time, thereby providing equal opportunity for all. This leads to an increase in economic growth and employability, revolutionising how people interact with government in the delivery of service. Key requirements to inform the South African digital transformation are:

- Digital access for effective participation of citizens to improve their quality of life;

- Digital transformation of government in fulfilling the development aims and increasing efficacy through demand for internet access and boosting the economy; and

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- Digital inclusion ensuring all South Africans are beneficiaries of the digital and knowledge society.

These pillars of the digital revolution will transform the manner of people communicating and interacting in society, with government and the economy. This will affect the manner in which government provides services, and how people access such services and goods.

In support of the initiatives of IICTWP, the Department of Higher Education and Training's Position on Online Programme and Course Offerings (2017[13]) (DHETPOPCO) has been formulated to strengthen ICT demands of the Fourth Industrial Revolution. The article recognises the evolving role of ICT for enhancing education and training in the TVET sector. The DHETPOPCO, 2017[13] has identified the importance of online learning as a convenient method of learning to engage students in learning processes at any given time or place. In this process, students become familiar with the technology used. The DHETPOPCO, 2017[13] is in support of AbuMezied (2016), where it emphasises the need for the PSET sector to respond to the global phenomenon of Massive Open Online Courses (MOOCs), online programmes and multi-institutional online education courses, promoting cross-border education and commercialisation of education.

Online learning represents a collection of learning approaches accessible on the Internet. Online learning includes "support for learning in a variety of forms, delivery of content, learning resources, interactive learning activities, formative and summative assessment and the recording and analysis of achievement data" (DHETPOPCO 2017[13]:2). It has an advantage, especially with large numbers of students to be trained. There would be a reduced need for lecturers in the teaching-learning process. The net result is a saving in provisioning of education and training resources.

While there are many advantages of online programmes, there are realities to be considered such as ICT infrastructure. Connectivity and software demands intensify operational costs. Capability of lecturers to implement new technology and programmes and adapt to the new training requirements is fundamental. Material development is another consideration to factor into the modern provisioning. It is crucial that a credible online assessment system is devised to provide assurance regarding the integrity of the programme being offered. The DHET emphasises the significance of providing the supporting *milieu* for institutions to deliver superior online programmes through policy development and funding mechanisms (DHETPOPCO 2017[13]:22). In support thereof, DHET intends to collaborate with the

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Department of Telecommunications and Postal Services and the Department of Science and Technology, to improve ICT access by increasing bandwidth and reducing costs for educational purposes.

Given that learning is supported by online platforms for more efficient service delivery, ICT infrastructure needs to be explored in establishing how TVET colleges can further enhance their teaching and learning strategies.

5.2   TVET college ICT institutional response

It is indicated by Schwab (2016), that the world is "on the brink of a technological revolution that would fundamentally alter the way we live, work and relate to one another. In its scale, scope and complexity, transformation would be unlike anything humankind has experienced before." Schwab (2016) further posits that the Fourth Industrial Revolution is different from the previous transformations characterised by "velocity, scope and systems impact". In response to these propositions, the previous minister of DHET, Dr. BE Nzimande, observed that the Fourth Industrial Revolution was an opportunity to speed up economic development and develop skills for industrialisation. He further questioned what kind of institutions is required in the post-school system, and in particular TVET colleges. Critically, colleges needed to yield individuals that are "agile and adaptable to the rapid technological changes" (DHET Budget Vote Speech 2017[14]). These initiatives therefore, need to be supported by the physical and technological environment in order to transform TVET colleges into "attractive institutions of choice for school leavers" (Ndhlovu 2016:34).

In support of these declarations, the DHET Strategic Plan 2015/6-2019/20[9] outlines the following planned initiatives:

- Realisation of connectivity and e-learning vision;
- Objective implementation of the White Paper for ICT; and
- ICT strategic plan implementation over 5 years.

The goal of these initiatives is to realise connectivity implementation as seamless across the TVET landscape between DHET and respective colleges. The Budget Vote Speech (2017[14]) by the DHET minister outlines a commitment to ICT innovation through the TVET Connectivity Project under the auspices of the South African National Research Network to 267 TVET campuses. Further to this, DHET has outlined challenges that may impede the rollout of ICT initiatives, delineated as follows:

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- Deficiency of data, reliability and integrity of ICT systems;
- Unstable examination information technology;
- Absence of effective monitoring and assessment of TVET enrolment data; and
- Inaccurate information infrastructure and technology.

Emanating from the above discussion, it stands to reason, that the DHET Annual Performance Plan (2016) acknowledges that the current ICT plan is under-funded and it is imperative for the ICT environment to be well resourced for optimal functionality, (DHET Annual Performance Plan - 2016/17₁₁). This therefore re-enforces the idea that DHET is fulfilling its role to ensure that TVET colleges, as well as its own administration environments, are compliant with the demands of the Fourth Industrial Revolution.

In the context of TVET education, the customer service process relates to the provisioning of education and training to the primary client, who is the student. Critical to the service process concept, is the manner in which the delivery of education would be transformed. The consequence therefore, is that education delivery within the TVET landscape is an aspect that is affected by the influence of the characteristics of the Fourth Industrial Revolution, as the need for education is connected to mobile device applications and varied digital platforms, as affirmed by AbuMezied (2016).

Chao (2017) states that the establishment of information and communication technology has brought about changes as reflected in the social, cultural and economic spheres of life. The authors further opine that the Fourth Industrial Revolution is characterised by "virtual reality, cloud technology, big data, artificial intelligence, the Internet of Things and other technologies", which have significantly affected how learning and re-educating occurs in preparation for the changing social, cultural and work environments. Aspects of cyber security are also gaining momentum amidst the increase of electronic theft of information posing serious threats and increased risks.

The authors have emphasised the speed at which change is taking place in all spheres of life as influenced by technological advancements and equally, the need to educate in order to accommodate the transformation in teaching and learning sectors. The discussion highlights the relevance for TVET institutions to "bridge the digital divide" and utilise new approaches in the education system. This means that learning programmes need to be flexible and supported by the relevant technology such as open education resources, mobile learning and e learning, where access is increased. This allows more people access to

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educational function and has importance and relevance where people are remotely located, such as in the rural areas of South Africa. Avril (2015) supports the view that ICT systems need to be connected with the resolve of providing "widespread access" to the TVET system. Avril (2015) supports Chao (2017), and points out that "open education resources have the potential to expand access lifelong learning opportunities and achieve a quality education".

As highlighted by Vosloo (2017), TVET colleges can achieve success through the usage of mobile technology, which enhances vital communication in a teaching and learning environment. Mobile technology supports access to "peer-to-peer" learning activities and immediate assessments and feedback from anywhere. Educators can provide remote support to students who engage in blended learning processes in the comfort of their homes, where learning can occur at any time. Vosloo (2017) accentuates that mobile technology makes provision for "learning on-the-go having just-in-time access to the necessary study material". Such innovations in the digitisation of the education delivery connects the divide regarding scale, speed and access to quality learning, to provide the current generation of learners with appropriate skills and knowledge to confront the demands of the Fourth Industrial Revolution that has affected all spheres of life.

According to the Center for the Fourth Industrial Revolution (2018), humans have been out-numbered by connected devices where it is projected to exceed 20 billion by 2020, aided by connectivity, storage and plummeting costs of computing. The Internet of Things (IoT) continually spreads and affects all aspects of life. Resulting from this is the aspect of regulation such as governance protocols, policy frameworks, security of data and privacy. The IoT has resulted in MOOCs, where learning can be accessed across the globe with 35 million students envisaged as participants in this format of learning. There is a progressive stance by education institutions to digitise its courses (AbuMezied 2016). This is an opportunity for TVET colleges as part of their progressive compliance to Industry 4.0 that is supported by DHET's Position on Online Offerings (2017[13]).

In 2005, the prioritisation of TVET digitalisation was enhanced when DHET collaborated with CINOP Global, a Dutch governmental authority, to develop and implement two ICT systems, namely, Business Management System (BMS) and Learner Support System (LSS). CINOP Global (2017:5) stressed the importance of TVET colleges as the "primary driver of the future of young adults and sustainable development", hence the implementation of the project. BMS was designed to better understand student performances in National

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Certificate (Vocation) programmes where targeted training of lecturers was identified as part of the improvement exercise. The LSS project encompasses a modern web-based support environment where each college is responsible for lecturer support. Through the LSS system, curriculum support material is downloaded to enhance the teaching and learning process. Both systems have had an enormous impact and have been incorporated as part of the DHET department system. The BMS project has enabled all student, human resource, asset and financial management functions to operate within a single system. Information can be accessed online without the need of individual colleges of investing in costly infrastructure to manage such a function, (CINOP 2017). However, by 2016, only 21 out of 50 TVET colleges had successfully operationalised BMS and LSS.

In support of TVET digitalisation creativity, DHET has been part of numerous ICT conferences at the various TVET colleges. At The Future Managers International North South TVET ICT Conference in 2016, the DHET representative highlighted the department's opening learning and ICT initiatives for the TVET sector, while emphasising the strategy for online learning (Theron 2016:21). At another conference focusing on ICT and Entrepreneurship that was held in April of 2016, the conference purpose was to advance the quality of teaching and learning through the "sharing of innovative ideas, technologies and best practices". Delegates were encouraged to discover the "new and exciting world of technology" to support creative methodologies inside or outside the lecture room (Ndhlovu 2016:34). Such support for innovation has led to ground-breaking achievements. Makhaphela (2016:42) reflects on a Gauteng TVET college implementing new strategies for registration applications, termed 'Applications before Enrolment' and 'Online admission and registration', where students enrol online in advance to complete their registration process. This has enabled the college to effectively manage long student queues while providing effective career guidance and placement.

Schmidt (2016:19) submits that based on bandwidth improvement, these strategies are supported for increased internet access, as Western Cape TVET college has experienced an improved trend in distance learning prospects. The option of education provisioning was favourable to those who were employed in a full-time capacity or were challenged in attending lectures at the college. The learning process is improved through assessments and assignments made available on the college learning management system. It is stated by AbuMezied (2016) that the leadership of learning institutions need to be "less risk averse" in embracing the disruptive revolution brought about by ICT innovation.

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5.3   Risk management conceptualised

According to Gibson (2017:17), the corporate governance structure sets the milieu for organisational risk management by allowing the "authority of the risk compliance functions". Gibson further states that strategy, performance, risk and sustainability are inseparable elements within the organisation. The overall governance model has to strategically monitor and evaluate the risk management framework. Top leadership has a tendency to allocate corporate resources to the risk management programme based on it being effectively articulated.

The Institute of Operational Risk Governance (2015) refers to risk governance as the "architecture within which risk management operates" within an organisation. It recommends that risk governance must deploy a structure for "risk responsibility" throughout the organisation, where everybody becomes accountable for their own risk responsibilities. This notion links to the characteristics of good governance, namely, accountability and responsibility.

Williams (2017) refers to risk management as a "key element of corporate governance". The author further references risk management as a "foundation of an organisation's architecture for strategic and operational success", which needs to be confined within the governance framework as a management process. It is a managerial role targeted at "defending the organisation, which includes its people and assets from physical and financial losses as a consequence of risk". Within corporate governance, Coetzee and Lubbe (2013:45) refer to risk management structures "as an effective tool in assisting management with their responsibilities".

5.4   Risk management and legislation underpinning the TVET college landscape

There is various public sector legislation that influence risk management processes in the TVET college sector. As an illustration, the Continuing Education and Training Act 16 of 2006₄, as amended and the RSA Public Finance Management Act of 1999₂ (PFMA) are referred to in the determination of IT risk management implementation in TVET institutions. These frameworks of legislation provide the impetus to ensure accountability and optimal college functionality. Chapter 5 of the Continuing Education and Training Act 16 of 2006₄, as amended, clearly stipulates that TVET colleges need to implement internal audit and risk management functions.

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According to the RSA PFMA, 1999[2] and section 51(1)(a)(ii) regarding duties of accounting authorities, these accounting authorities must ensure that the public organisation has and sustains well-organised, effective and clear systems of internal controls, financial management and risk management. The Public Sector Risk Management Framework (2010[6]:18) supports this notion by recommending that public service institutions "develop their systems of risk management".

Governance obligations of the TVET College necessitate that the college council decides on the college's risk level and risk 'appetite' in pursuit of its growth and opportunities. As a result of reification of systems integration within the Fourth Industrial Revolution, the TVET College Council must allocate the risk management responsibility to specific individuals, (Handbook for Public FET Council Members 2007[5]:31). In terms of Chapter 5 of the Continuing Education and Training Act 16 of 2006[4] as amended and the PFMA of 1999[2], "the accounting officer must ensure that there is effective, efficient and transparent systems of financial and risk management". In the case of the college, the accounting officer is the rector, having the responsibility of risk management accountability in the college. This responsibility is supported by Andreeva, Ansell and Harrison (2014:342), who state, "risk may affect any part of society and government is expected to respond, implying a need for governance and accountability".

Moloi (2016[b]:40) notes that risk management has not been widely studied in the public sector in South Africa. The authors further observe that the public service risk maturity is not as developed as the risk framework as found in the private sector. Risk management has evolved, leading to it being a central aspect of corporate governance in the delivery of key services to the country. This aspect is achieved through uncertainties mitigated to support strategic aims and objectives.

According to Tupa, Simota and Steiner (2017:1225), risk management is "a comprehensive and systematic way of identifying, analysing and responding to risks" to achieve organisational outcomes. It is mentioned by Carcary (2013:5), that information technology (IT) risks span a wider spectrum that mere security concerns. Apart from IT operations risks, other risks may arise from regulatory and compliance requirements, ethics and policy compliance, IT investments, system failure, IT project cycles, natural disaster and suppliers as IT risk sources. The proliferation of social networking, mobile computing and cloud-based services has exposed organisations to an upsurge of risks relating to data leaks, asset theft and reputational impairment. It follows then, that the capability of organisations to effectively

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accomplish the management of recognised IT risks becomes a vital factor where the optimisation of an IT venture is considered.

5.5   Inter-connectedness of innovation and risk management

The innovative environment is characterised by a "high failure rate" where creativity then becomes relevant. Further to this, risk management could assist in attaining success in innovation projects. It can be suggested that "inappropriate risk management might stifle the creativity which is core to innovation" (Bowers & Khorakian 2014:25). It becomes essential for the risk management process to be strategically applied during an innovative project such as implementing e-learning in the TVET college environment. Innovation as described by Serrat (2009) is "the successful exploitation of new ideas" enabled through a creative process involving the application of specific desirable processes. The authors state that organisational innovation, service innovation and production innovation comprise the main types of innovation categories. Bowers and Khorakian (2014:25) affirm that creativity is the core pillar that thrusts and sustains innovation. The responsibility of risk managers is the identification and assessment of organisational risk instead of limiting creativity with barriers of what needs to be avoided. It is recommended that risk managers perform a facilitative role with management to identify solutions to possible threats while encouraging creativity of innovative concepts through teamwork and collaboration.

The function of risk management pursues the identification of key uncertainties where these risks are addressed proactively by bearing in mind threats and opportunities. Effective risk management and governance embodies creative thinking and innovation in the process of risk identification and control, where the inventive development of the organisation is not stifled (Hillson 2005). The characteristic of innovation presents the elements of risk. Failure to implement Enterprise Risk Management (ERM) activities into organisational innovation processes can lead to counterproductive outcomes. Alexander (2017) points out that ERM is not an obstruction to innovation as it concurrently mitigates risk, thereby supporting the innovation process.

Risk management is where an organisation's ability to be creative and innovative is of critical importance where Business Process Management (BPM) is applied and the organisation models itself on best practice, and evaluates and improves its corporate process. This is undertaken to augment performance management and reduce expenses while facilitating business obligations such as risk and information management. Creativity in BPM can lead

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to particular risks arising, which need the risk manager to identify solutions to multifarious processes necessitating information, rigorous communication and creativity in task facilitation (Seidal & Roseman 2008:1-3). The prosperity of business enterprises is reliant on the exhaustible potency of innovation as it drives production and competiveness. Innovation is perceived as a "double-edged-sword" with features of "high potential, high inputs, high returns and high risks", compelling the management of risks in innovation processes (Guo 2012:21).

This discourse reflects that an effective and strategic risk management function in the environment where technological creativity and innovation needs to thrive in compliance with the demands of the Fourth Industrial Revolution, cannot be overlooked in the current era of business and education management. Information is a strategic resource, and as such, it should be managed, protected and utilised for innovative and sustained business and management functions.

5.6 Risk management in sustaining ICT innovation

Industry 4.0 or the Fourth Industrial Revolution identifies the combined term for technologies and systems of the value chain, which incorporates "Cyber-Physical Systems (CPS), the Internet of Things (IoT) and Internet of Services (IoS), the Internet of People (IoP) and the Internet of Energy (IoE)". Enterprises envisage that through the application of such technologies, they would be enabled to become "truly" digitalised. Digital transformation in the operational environment provides a case of heightened probability of different risks arising, which affects negatively on processes bidding the need for developing innovative methods for risk management. Integration of information technology to enhance the digitising of operational environment introduces new dangers such as "cyber-attack, malware, spyware, loss of data integrity and problems with availability of information". Software criminality affects data reliability and availability (Tupa *et al.* 2017:1224). The discourse provides the scenario of the challenging circumstances the TVET college sector can be placed in, notwithstanding the challenge of funding in the sector. The authors provide a framework of risk management practices that may be applied to curtail the potential of unanticipated technological threats on the TVET operational system, which is elucidated to in the discussion that follows.

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5.7 Risk management framework contextualised to the TVET College

This article models the risk framework according to ISO 31000, an international management standard, which is supported by the Public Service Commission of South Africa (PSC) risk management (2003$_3$) structure. ISO 31000 is a standard that seeks to provide an integrated guideline by considering an "industry-independent approach". This methodology is recommended to be reinforced through the principles of Enterprise Risk Management (ERM)) which has been identified as a "new business trend" (Tupa *et al*. 2017:1226) that has re-shaped the traditional risk management (TRM) approach. The authors advance that ERM is a disciplined and structured approach that "aligns strategy, processes, people, technology and knowledge" in containing risks with determination of crafting enterprise value.

The TRM was constrained by focusing on ad-hoc activities while ERM focuses on a holistic, ongoing activity where risk is part of strategic planning. Butterfield (2017), who mentions that ERM elevates risk management to a strategic level in the organisation, supports this view. ERM encompasses risk monitoring and measurement, collective responsibility, and business-wide awareness of risk containment. In contrast to ERM, TRM concentrates on a fragmented approach focussing on people instead of processes. TRM emphasised attention to financial risks and the internal audit process. The ERM approach outweighs the TRM method as it views the management of risk systematically, with improved coordination between business units with a focus on operations and strategy (Simona-Lulia 2014:276). It is argued by Carcary (2013:5), that the integration of IT risk management into the ERM framework involves a holistic method to IT risk containment, where it is considered as part of the complete risk portfolio.

5.8 Elements of risk management for effective risk governance in the TVET sector

Based on these deliberations, the holistic risk management framework considers six key aspects, which includes the risk environment, risk identification, risk assessment, risk control, risk monitoring and risk reporting as significant risk elements. Regarding the risk environment, Ruzic-Dimitrijevic and Dakic (2014:139) comment that the organisation needs to "set goals and define internal and external parameters which are important to risk management". The authors further position that internal parameters include the "organisational structure, policies, culture of the organisation, information systems, data flow

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and process of decision-making and standards and regulations" implemented in the organisation. This view is supported by Tupa *et al.* (2017:1227), who state that an Information Security Management System (ISMS) policy be established with associated processes, objectives and procedures for the management of IT risks and enhancement of information security and associated technologies in accordance with the colleges' over-arching policy objectives.

According to Young (2006:54), risk identification is a proactive approach to managing operational risk, which includes IT risks; an organisation would then be in a situation to nullify or minimise the negative impact of a risk occurrence when it does occur. The concept of Industry 4.0 identifies new categories of risks because of the increase of vulnerability and threats. The relationship between cyber-space and technologies where outsourcing is concerned is a major factor for the increase in vulnerability. Common risk factors have been observed in information security where for instance, the TVET colleges' servers can be hacked. Cyber-attacks, loss of data, errors in data processing, under-skilled staff and problems with availability of reliable information, are risks to be considered as endorsed by Tupa *et al.* (2017:1227).

Risk Assessment, according to Jackson, Sawyers and Jenkins (2009:5), is that a business should implement measures to identify and assess risks that can hamper its ability to successfully undertake business operations. Tupa *et al.* (2017:1227) recommend that the assessment of risks be undertaken by considering the ICT policy and objectives. Culp (2013) asserts that "risk scenario analysis" encourages results to provide anticipation of possible operative threats in the innovation environment. Proactive risk assessment diminishes exposure of the IT risk effect (Carcary 2013:9).

Risk control is a process recommended to be set at the same time as the risk is identified, aiming at the mitigation of risk events, as observed by Blunden and Thirlwel (2010:83). Some control measures include management oversight roles, the introduction of policies and procedures and other monitoring processes. 'Best' practice implementation is also a control measure as practised by organisations. The financing of potential risk is a factor in the process of risk control. In the risk management design framework, Tupa *et al.* (2017:1227) recommend that controls through preventative and corrective actions be applied to achieve continual organisational enhancement. Culp (2013) states that controls enable organisations to embrace risk tolerance, creating a "safe" condition for innovation to thrive.

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Risk monitoring is a process of observing the progress and effectiveness of risk controls through the application of action plans, is termed risk monitoring. It is vital that this critical function is embedded within business processes, and is part of the risk management culture of the organisation. Risk monitoring is like "an early warning" system that enables the business to become more aware regarding new risk exposure, as alluded to by Valsamakis, Vivian and du Toit (2013:143). Risk monitoring is an ongoing process of "identification and management of new risks". Such risks are tracked and its "planned responses" are reviewed for effectiveness by including additional actions where required (Cagliano, Grimaldi and Rafele 2014:236).

Risk reporting is a process, as emphasised by Gibson (2017:57), as the objective to "make sure that all risk events are tracked and responded to effectively and efficiently". Reporting takes place through the structure of the organisation in various formats and following technological trends such as intranet communications. Gibson is in support of Ile, Eresia-Eke and Allen-Ile (2012:147), where it is reflected that reporting is the final function of the monitoring process. Reports provide an account of events observed, investigated or heard of; they provide an awareness of what has transpired internally and externally to the organisation. These risk elements are supported by ISO 31000, an international standard for risk management.

6.   KEY FINDINGS AND RECOMMENDATIONS

Though major advances have been made with regard to "keeping the pace" with technological advancements in the TVET sector, ICT development in the Fourth Industrial Revolution remains a challenge. In the DHET Annual Performance Plan (2015/16[10]), it reflected that ICT plans experienced funding constraints. This judgement is supported in the Budget Vote Speech (2017[14]) and echoed in subsequent recent years. The previous DHET Minister acknowledged that the principle challenge was the necessity to deliver financial resources to create a vibrant TVET college sector. Lack of financial resources impacts on the TVET sector to implement digital strategies, as demanded by Industry 4.0. It follows that infrastructure and person capacity development, connectivity, access, localisation, customisation and content development would be impacted upon (Avril 2016). These views are supported by Chao (2017), who states that "social infrastructure" has been slow to adjust to the technological changes where education has become a requirement. Vosloo (2017) affirms the views of other authors by submitting that the greatest hindrances in South African

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TVET colleges are deficient ICT infrastructure, high cost factor of devices and challenged access for students. The author maintains that learning material and programmes have not matched the pace of technological advancement. Higher education establishments are facing internal and external influences affecting their mission and objectives: these influences being risks. Toma, Alexa and Sarpe (2014:242) highlight strategic, financial, operational, academic and reputational risks as key threats to institutions of higher learning.

The purpose of the article was to establish the extent to which the TVET college sector is embracing progression of the Fourth Industrial Revolution. In the literature review, in-depth analysis was undertaken to examine elements that constituted the fundamentals of Industry 4.0. The TVET college landscape was assessed with the purpose of determining the macro vision of government. Specifically, the Department of Higher Education and Training was viewed in creating the enabling environment for TVET colleges to embrace the advancement of the Fourth Industrial Revolution, thereby keeping abreast of innovative global and digital trends. Through the research undertaken, the Department of Higher Education and Training has shown commitment to embracing the dynamics of the Fourth Industrial Revolution through formulation of the "Department of Higher Education and Training's Position on Online Programme and Course Offerings". Through this position, TVET colleges are provided with a framework for ICT implementation innovation as a service to clients.

Apart from the above, ICT innovation and advancement has been identified in the DHET's Strategic Plan (2015/6-2019/20[9]) and Annual Performance Plan (2015/6[10]). Government further has shown support for the Fourth Industrial Revolution through generation of the Integrated Information and Communications Technology White Paper. Various TVET colleges have embarked on online registration and e-learning processes, as reflected in the TVET College Times. In the Budget Vote Speech (2017[14]), the previous DHET Minister, Dr. Nzimande, acknowledged that the Fourth Industrial Revolution was an opportunity to speed up economic development and advance skills for industrialisation, where TVET colleges necessitate yielding individuals who can embrace change brought by technology. Further, the TVET college sector collaborated with a Dutch governmental stakeholder CINOP Global, to enhance digitalisation innovation. The article presented the necessity of risk management in the implementation of innovation ventures projecting their inter-dependency. Increasingly, organisations focused on strategic advancement encompass the implementation of innovation combined with a vigorous risk approach.

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Organisations with dynamic risk management functions are assured of "proactively managing IT risks" as advocated by Carcary (2013:11). In general, the pay-off with ERM implementation contributes to lower risks, financial savings and improved sustainability with increased stakeholder confidence, as noted by Butterfield (2017). Through the preceding discourse, it has been observed that ICT innovation and risk management are linked, as Culp (2013) argues, affording these disciplines as resources to assist the TVET college sector in pursuing IT opportunities for the benefit of the communities it serves. Some concerns raised conversely by author Schwab (2016) in Shava and Hofisi (2017:209), include issues of customer expectations, product enhancement, collaborative innovation and organisational reforms, which are raised for significant consideration by the TVET college sector.

The Fourth Industrial Revolution technologies create new forms of engagement. It is therefore, recommended that the TVET Colleges consider online courses, virtual classrooms and innovative platforms for communication in its educational focus, as emphasised by Menon and Fink (2019:16). According to Caruso (2018:381-2), it can be said that digitised information has become a strategic resource with the arrival of the Fourth Industrial Revolution, and is evolving at an exponential rate rather than a linear pace. A key recommendation put forward is that effective risk governance is underscored by a risk-based approach, a view upheld by Aydos, Vural and Tekerek (2019:2). This is followed by the reduction of market entry barriers for young entrepreneurs trained at TVET Colleges together with the promotion and development of technological and digital skills, as suggested by Schäfer (2018:10). A longitudinal research study be undertaken to establish the diversity and depth of ICT innovation implementation in TVET colleges, while functioning in an infrastructure and funding *milieu*. This is critical since TVET colleges need to accomplish the ICT vision of both the White Paper for Post-School Education and the National Development Plan 2030, in creating a capable and equal society in a changing digital and global context.

7. CONCLUDING REMARKS

Implementing optimised risk management strategies in the ICT environment would benefit the TVET Colleges by providing protection against the impact caused by uncontrolled risks. Exposure to IT security and sabotage can be reduced. Data protection, IT investment security and information privacy can be ensured. There are increased prospects of achieving

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scope, cost, time and quality targets of IT developments by effectively managing IT risks. Compliance and regulatory obligations to policies both internal and external to the organisation are warranted. Based on infrastructure and financial constraints, as well as fragmented implementation of online applications, as cited earlier, the TVET sector has made slow progress. The view is supported through the CINOP Global (2017) reporting that only 21 of 50 TVET colleges achieved complete management information system functionality spanning 11 years. This article contributes to risk governance in terms of the Fourth Industrial Revolution. It concludes that the TVET college sector sought to "embrace the vision" of the Fourth Industrial Revolution, as part of their education and training agenda. Developing an effective risk-based approach with risk regulation and governance strategy are significant enablers and a radical paradigm shift for the TVET College in the current digital era.

DECLARATION OF CONFLICTING INTERESTS/FUNDING

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