

# **Towards a new philosophy for Repositioning, and Repurposing Technical and Vocational Education and Training for Industrial Engineering and Operations Management Systems and Development in Africa: A Case of Zimbabwe. Harare Polytechnic**

**Dr. (Ph.D.). FZwIE. PrEng. Tafadzwa Mudondo**

**Principal**

**Harare Polytechnic in Zimbabwe**

**Zimbabwe**

[t1mudondo@gmail.com](mailto:t1mudondo@gmail.com)

## **Abstract**

This paper anchors and grounds the culture, and architecture of Technical and Vocational Education and Training in Africa which was vibrant and later drowned by colonization. African governments failed to domesticate and embody decolonization curriculum strategies and deploy budgets to promote and enhance heritage based TVET educational philosophies. The TVET DNA architecture in Africa was grounded in various cultural settings from creation. The Creator (God) illustrated the power and philosophy of TVET when He created the universe with all the plethora of living and non-living, Genesis 1. The Universe is typical example of Industrial Engineering And Operations Management System. Nations are built and sustained through TVET Industrial Engineering and Operations Management Systems. The researcher will argue that the tenets of African TVET philosophy were intercepted, interrupted and bastardised by slavery and colonization. Resultantly foreign-centric technologies and culture permeate and perpetuate dependency syndrome to the detriment of African Industrial Engineering and Operations Management Systems. Africa is now a vast warehouse for everything foreign inclusive of the education, health, industrial, technological and engineering systems. Paradigm paralysis is domiciled in Africa to the extent that industrialisation appears to be a distant cousin having been relegated by slavery and colonisation. Drucker (1985) notes that a knowledge society is one in which the quality of life is dependent upon the primary production of knowledge as a resource instead of capital and labour as was the case in the agrarian and industrial economies. The researcher submits, and proffers possible gateways to circumvent some of these challenges from an Afrocentric can perspective. The research is a mixed mode approach necessitated by the need to unbundle and unpack ontological reality, epistemological and existential shortcomings and shortfalls in the developmental agenda as exhibited by unsupported TVET policies in Africa. Zimbabwe will be at the core of the study.

## **Keywords**

Architecture, Culture, Creator, Colonization, Endogenous, Exogenous, Epistemology, Heritage, Knowledge Management System, Ontology, Technical Vocational Education and Training.

## **1. Introduction**

### **1.1 Background to the Study**

The TVET DNA architecture for Industrial Engineering and Operations Management Systems in Africa was embedded in cultural settings from time immemorial and was more pronounced during the Timbuktu era and the construction of the Great Zimbabwe superstructure during the 12<sup>th</sup> and 14<sup>th</sup> century BC respectively. This was the way of life for Africans. All the traditional activities were based on TVET architecture for Industrial Engineering and Operations Management Systems with properly structured and segregated norms and values. TVET was grounded and anchored on politics, fire making, hunting, great hunter (hombarume), medicine, farming, great farmer (hurudza), engineering (Umhizha), mining, blacksmithing, basketry, weaving and geometry. All these were suppressed during slavery and later colonization as foreign education systems were superimposed on Africans. Hence, initiatives and innovations of African origin were suppressed or ignored or stolen or intellectually burglarised to this very day.

African governments have generally ignored indigenous TVET Knowledge systems in favour of foreign-centric technologies which have perpetuated the dependency syndrome to the extent that Africa is now a vast warehouse of

everything foreign inclusive of political systems, education systems, health systems, industrial systems, farming, living systems and technologies. Extractive raw materials, intellectual and social capital have continued to be drained and shipped out to sustain foreign industries to this very day. This characterised the developmental chaos now dominating and haunting Africa through perpetuation of dependence syndrome. Why is Africa in marriage with abject poverty but overwhelmed by abundant natural and human resources? No sound Industrial Engineering and Operational Management Systems can be dreamt of if all the best resources and human capital are shipped to fire foreign industries. African governments are at the mercy of thorough re-colonization through technology systems, educational systems, political systems, and health systems among others which are generously embraced without interrogation at times. The curricula systems (Tacit and Explicit) studied in various educational institutions across Africa are built and anchored in foreign-centric philosophies of particular communities for specific purposes and designed and developed to produce and perpetuate a certain cultural orientation. This is a great threat to African Industrial Engineering and Operations Management Systems.

African countries need to anchor and ground Technical Vocational and Education and Training Knowledge Management Systems (TVETs) on indigenous ethos to compete successfully in the Rapid Global Economic Technological Metamorphosis and Industrial engineering. Technical Vocational Education and Training (TVET) play critical role in implementing and promoting resilient and sustainable development. TVET institutions are major providers of workforce who are at the forefront in dealing directly with sustainable issues which must encapsulate four pillars: economic, socio-cultural, technological and environmental development. The salient preconditions for sustainable development proposed by Bagnall (2007) include the level of understanding, ownership, the will or commitment, and capacity of the policymakers and practitioners to create a conducive operating environment. Elevated and appreciated Technical Vocational Education and Training Knowledge Management Systems (TVETs) requires not only capital investment, but also a work force that has the flexibility to acquire futuristic skills for new industries, being innovative as the structures of economies and occupations mutate. TVET Knowledge Systems must produce skilled and innovative workers, technicians, technologists, engineers and PhD graduates who are key determinants for national socio-economic development and Industrial Engineering and Operations Management. The practical dysfunctional and displacement of TVET demonstrated in African countries are contrary to the cardinal tenets of creation were God significantly and epitomely laid the foundation for TVET skills appropriate for industrial engineering and operations management during creation.

### **1.2 Motivation/Problem Area**

The study is motivated by the need to inform policy and policy makers on the invaluable pracademic nature of heritage based Technical Vocational Education and Training and the ontological role of TVET to socio-economic development, Industrial Engineering and Operations Management.

### **1.3 Research Objectives**

This research study investigated Technical Vocational Education and Training Knowledge Management practices for National reskilling, Industrial Engineering and Operations Management Development in Africa anchored on the following underlying research questions:

**Objective 1:** To provide an overview of the sources and characteristics of indigenous Technical Vocational Education and Training Knowledge Management Systems in Africa for reskilling, Industrial Engineering and Operations Management for National Development.

**Objective 2:** To analyse the degree of achievement of TVET knowledge-based outcomes in Technical Vocational Education and Training Knowledge Management Systems in Africa.

**Objective 3:** To understand the main drivers contributing to implementation of reskilling, Industrial Engineering and Operational Management Systems through Indigenous TVET Knowledge Management Systems in Africa.

**Objective 4:** To provide recommendations to African institutions on how to capitalise on Africa indigenous TVET Knowledge Management Systems to develop heritage based Industrial Engineering and Operations Management Systems.

## 2. Literature Review

According to the United Nations Human Development Reports (2016), a developing economy can be explained in terms of the underdeveloped countries of the world which are characterised by low Human Development Index (HDI) rates signifying low levels of education, poor health facilities and low levels of economic growth. Such economies have dysfunctional industries where industrial engineering and operations management are non-existent or still defined by pre-conventional methodologies.

El-Ghannam (2002) described the developing economy in terms of the following characteristics:

- Chronic absolute poverty
- High levels of unemployment and underemployment
- Wide and growing disparities in the distribution of income
- Low and stagnating levels of industrialisation (de-industrialisation)
- Antiquated and inappropriate educational and health systems
- Severe balance of payments and international debt problems
- Substantial and increasing dependence on foreign aid and technologies.

The foregoing exposition summarises serious and choking constraints be-setting Africa due to economic de-industrialisation and human capital brain-drain. These countries are classified as Third World countries due to their economic underdevelopment. Africa fits into this category and the big question is why?

The biggest challenge faced by Africa is that of borrowed technology, knowledge, skills and expertise. Heritage based Technical Vocational and Education and Training was relegated to the peripheral of socio-economic development and such shortfalls and shortcomings are a manifestation of a yawning gap in technology development from an African perspective. The African Union Agenda 2063 set out the following as trademarks for development.

### **African Union, Agenda 2063: Our Aspirations for the Africa We Want**

1. A prosperous Africa based on inclusive growth and sustainable development
2. An integrated continent, politically united and based on the ideals of Pan Africanism and the vision of Africa's Renaissance
3. An Africa of good governance, democracy, respect for human rights, justice and the rule of law
4. A peaceful and secure Africa
5. An Africa with a strong cultural identity, common heritage, values and ethics
6. An Africa where development is people-driven, unleashing the potential of its women and youth
7. Africa as a strong, united and influential global player and partner.

**Source: African Union, Agenda 2063 – The Africa We Want (August 2014).**

The forging aspirations are very bold for African government as they pronounce Pan Africanism and the vision of Africa's Renaissance grounded on strong cultural identity, common heritage, values and ethics. This brings to the fore the need for African TVET Knowledge Management Systems that can foster Industrial Engineering and Operations Management.

### **2.1 TVET Knowledge Management Systems in Africa**

Around the 12th century, the University of Timbuktu had an enrolment of 25 000 students in a city which had a population of 100 000 people. The students came from all corners of the African continent in search of excellence in knowledge and trade. From the foregoing information, it can be noted that TVET Knowledge Management System has been with and in African for a very long time.

African astronomers did not follow the European leap to a sun-centred solar system, but they sprang far ahead in the mathematics of calendar writing and far ahead in trigonometry. The writings detail astronomic events six hundred years ago. Scholars, racing to translate this huge trove of literature wondered how these ancient African scholars knew of medicine, botany, chemistry and climatology. Indigenous Knowledge, whether institutionalized or not, structured or unstructured, has specific implications for democratization, community empowerment and nation building. It is argued that it also has implications for sustainable development, capacity building and intellectual development in Africa, in the 21st century. Industrial engineering and operations management implicitly has been with Africa from time immemorial.

### 2.1.1 The Black Revival of Learning

Chancellor Williams (1987) noted that the University of Timbuktu structure consisted of:

- (1) Faculty of Law,
- (2) Medicine and surgery,
- (3) Letters,
- (4) Grammar,
- (5) Geography, and
- (6) Art. Art had to do with such practical training as manufacturing, building and other allied crafts which points to the narrative of Industrial Engineering and operations Management. After the basic training, the expertise went through the traditional apprenticeship system in the various craft guilds. The narratives also mention a large number of scientists, doctors, lawyers and other 'scholars at the University' without giving the exact number-perhaps not considered necessary in the 15th and 16th centuries. Africa needs to research and reflect on the nature of industrial engineering and operations management that existed then and harness the foundation for the development of Africa.

Chancellor Williams (1974, 1987) noted the following:

- 1) Blacks were among the very earliest builders of a great civilization on this planet, including the development of writing, sciences, engineering, and medicine, architecture, religion and the fine arts, which points to early foundation of Industrial Engineering and Operations Management.
- 2) The story of how such an advanced civilization was lost is one of the greatest and most tragic in the history of mankind and should be the main focus of research studies in African history. This would assist to rebuild the African TVET system for national development, Industrial Engineering and Operations Management Systems.
- 3) The forces behind the continued splintering of small groups and even the breaking up of kingdoms and empires, followed by the equally endless migrations, including the steadily increasing death of the soil and the advance of the deserts, the drying up of lakes and rivers, along with the attending change of the climate and the always certain internal strife-all combined with invasions and famine to become a way of life have terribly destroyed African as its indigenous TVET Knowledge Systems were thrown into the dustbin.

Africa in the 20th century was afflicted by two major externally derived economic models of exploitation, namely, the colonial model of exploitation and neo-colonial models aimed at recolonization through various forms of aid-related economic and education assistance. The economic and epistemological or knowledge oriented aspects of those models were aimed at exploitation and mal-development to keep African education system down so that they would not realise the importance of application of Indigenous TVET Industrial Engineering and Operations Management Knowledge Management Systems.

Built into those models were negative and unwholesome presuppositions about race, gender and segregationist policies, and discriminatory models of allocation of space, resources and infrastructure prevailed. Export-oriented growth, monoculture and outward-bound programs for the export of first stage mineral and agricultural extraction, were the dominant trends in most parts of the continent and still remains the vehicle through which Africa has remained indebted. Such models have suppressed Africa's initiatives in Industrial Engineering and Operations Management. The fundamental missing link is the indigenously designed, deployed and employed TVET curricula systems which would be instrumental in dislodging the centric curricula systems. Zimbabwe in 2018 christened and baptised heritage-based curricula education 5.0. which includes Research, Teaching, Community Service, Innovation and Industrialisation. This entails the production of goods and services as the fundamental objective of the new curricula and the interlinkage of education with industrial.

### **Zimbabwe Heritage Based Education 5.0 (*Research, Teaching, Community Service, Innovation and Industrialisation*)**

Zimbabwe, Minister of Higher and Tertiary Education, Science and Technology Development, Professor Amon Murwira in 2018, pronounced a paradigm shift to heritage based education systems. This is premised on the concept of remodelling and refocusing Zimbabwe education curricula to improve competitiveness of local higher and tertiary qualifications. The education philosophy is coined 'a heritage-based doctrine'.

### 2.2 Heritage-based Doctrine

Education institutions are challenged to redesign curricula that fosters for the production of goods and services anchoring on modernisation and industrialisation of Zimbabwe. The emphasis is in the design stage where one either wins or

looses. The heritage-based philosophy should guide Zimbabwe in its quest to advance science and technology for Industrial Engineering and Operations Management development.

Heritage-based science and technology development uses the most cutting-edge competitive knowledge STEM; knowledge from anywhere in the world which is applied and situated in the local discourse. A typical example is Great Zimbabwe Monument that was built using local resources (stones) that were around. Therefore, heritage based education science should use the local resources in order for the advancement and development of Zimbabwe. For example Saudi Arabia is developing based on its oil heritage as such is developing industrial engineering and operations management systems based on the available resources.

Science, Technology, Engineering and Mathematics (STEM) must be applied to provide solutions related to the local environment and this should result in industrialisation and modernisation of Zimbabwe. Implementing STEM in Zimbabwe higher and tertiary institutions should use heritage-based philosophy to innovate using local resources. Development is never imported but should be a product of its people, Professor A Murwira (2019) at a sustainable development conference in Victoria Falls Zimbabwe.

Production based curricula is the curricula in which the learning processes are designed and developed in conformance with the production process as a learning medium. The primary purpose is to introduce students to real world of working environment married to the production of goods and service. Production-based curricula implementation model, should witness students go through experiential learning in industry related working environment. Such exposure assist students to create mind mapping platforms in terms of Industrial Engineering and Operations Management Systems from an endogenous and exogenous perspectives. A rush to adopt alternative systems often means that local needs, values and ways of doing business are relegated to second place and that informal learning and informal economies that produce transferable skill sets are overlooked.

Dr. Dennis Magaya, in his article titled 'Digital Innovations: the Vision 2030 Real Deal', summarises the dark vicissitudes Africa went through:

Emphasised the importance of the three economic pillars for Zimbabwe in particular and Africa in general, from a historical perspective. He noted that Africa requires an economic model that mitigates colonisation and slavery legacy which resulted in missing development milestones. Africa missed the first industrial revolution due to slavery, and then the second industrial revolution happened during colonisation (while) the third industrial revolution happened during liberation struggles for independence. And already Africa is lagging behind in terms of the 4<sup>th</sup> industrial revolution as result of sanctions and undemocratic technological operating space. This basically means that in terms of industrial engineering and operations management Africa is lagging behind.

Colonisation wiped out cultures and knowledge systems that built the likes of (the) Great Zimbabwe and the pyramids of Egypt. Colonisers stole wealth and built insurmountable competitive advantage using resources from Africa. Maddison (2007), attempts to identify the reasons why certain parts of the world have grown rich while others remain poor, points out that both Western Europe and Africa had a \$450 GDP/capita in 1000 A.D., but by 1998 Western Europe had become 13 times richer than Africa. Africa is under pressure to replace pre-colonisation functional political systems, educational systems as well as technological systems for the benefit of who?

Zimbabwe, therefore, needs an educational model that leverages traditional culture and values while innovating from progressive and advanced nations. Zimbabwe with heritage based curricula needs to leverage on agriculture, mining, and tourism through digital innovation by developing technological innovation ecosystem that uses natural resources to offer appropriate services thereby attracting global economies of scale as the best foot forward. This should witness footprints and imprints in the development of local Industrial Engineering and Operational Management System grounded in national discourse.

Zimbabwe education institutions have been challenged to innovate and industrialise through critical thinking, system thinking and problem solving, curricula review and overhaul to embody heritage based philosophies. An education system that cannot technologise and industrialise is barren and wasteful. Dependence of foreign Industrial Engineering and Operational Management Systems is detrimental to well being of Africa development agenda. Japan, Germany, China and India respectively looked around their heritage to develop globally competitive Industrial Engineering and Operational Management Systems. As Booker T. Washington on September 18, 1895, counsels to former slaves, there is no need to search for deliverance elsewhere:...sink your bucket where you are.

Africanisation of the curricula for successful Tvetisation and Cbetisation of the TVET Knowledge Systems for Industrial Engineering and Operations Management Systems can only be improved, changed or technologised if Africa is able to produce its own appropriate and relevant technologies. Consolidation of Africa's self-sustaining networks of local researchers, repurposing and revitalization democratically engaged in indigenous TVET Knowledge Management Systems compatible with community values, aspirations and goals is pivotal for developing African grounded Industrial Engineering and Operations Management Systems. In Africa, educational content and technology are taught in the context of foreign centric paradigms that carries along with it, disdain, stigma, disrespect and arrogance about African Knowledge Systems and intellectual prowess.

Engineering is important for the creation of infrastructure to alleviate poverty, accelerate Industrial Engineering and Operations Management development that enable better healthcare, manufacturing systems and the development of an attractive environment for foreign investment. The democratisation of the technological landscape is fundamental if African engineers are to play a pivotal role in developing appropriate and relevant Industrial Engineering and Operations Management Systems.

Industrial Engineering is vital to addressing basic human needs, improving the quality of life and creating opportunities for sustainable prosperity on a local, regional, national and global level. More young people need to be persuaded to enrol in Industrial Engineering and Operational Management courses necessary to unpack and unbundle Science, Mathematics, Technology, and Engineering (STEM) to enable Africa to play a significant role in the discourse of Industrial Engineering and Operational Management Systems.

UNESCO Director-General Bokova (2013), estimated that 2.5 million new engineers and technicians are required in sub-Saharan Africa to achieve the Millennium Development Goals of improved access to clean water and sanitation. "If we look across the African continent, we can see evidence of growth and development – Africa is rising, indeed. But to sustain this rise requires investment in the skills and talents of Africa's young people, especially in girls and young women. (...) In Namibia, Zimbabwe and Tanzania, there is one qualified engineer for a population of 6,000 people -- compared to one engineer per 200 people in China. Through its Engineering Initiative, UNESCO is working with Africa countries to put science, technology, engineering and mathematics (STEM) education at the heart of national development strategies". *Irina Bokova, UNESCO Director-General, during the UNESCO/IGU Workshop on Women in Engineering in Africa and the Arab States, December 2013.* An overhaul of African education system to infuse Industrial Engineering and Operational Management would translate into increased productivity output for the continent as a whole.

The importance of skills development for Africa's youth thus must not be overlooked. It represents one of the key drivers of innovation on the continent. To benefit from this relationship, the African workforce must start preparing today for tomorrow's jobs through reskilling and recrafting community based solutions. The potential of Industrial Engineering and Operations Management Systems in Africa can bear meaningful results if the discourse, dichotomous and dissonance of African education system are reconfigured, oriented and grounded in heritage based education philosophies. Africa's competitive advantage in Industrial Engineering and Operations Management Systems cannot be debated or compared because the tools for the processes are products of foreign engineering. Africa's engineering professions have remained mere machine minders grounded in repair and maintenance philosophy. Lack of collaborative cooperation condemned Africa into semi-permanent consumer of other nations' products and services. This is despite the fact the Africa is imbued with plenty of natural resources which constitute the majority of the raw materials.

### **2.3 Repurposing African Education institutions: Higher and Tertiary and Research Institutions.**

Nyerere (1968:28) observed that the (education) purpose is the liberation of Man from the restraints and limitations of ignorance and dependency. Education has to increase men's physical and mental freedom to increase their control over themselves, their own lives, and the environment in which they live. Education institutions in Africa must reorient and repurpose their strategic role in Africa's development agenda if African driven technological Industrial Engineering and Operations Management System are to be realised. Application of indigenous knowledge and research capacities in Africa is fundamental. Dependence on foreign knowledge and technologies have the tendency of projecting Africa as a second class continent on this planet. Overhaul of training, research, knowledge management systems, value chain, production, information transfer, and technology development is a must if rebuilding and regenerating capacities through these education institutions are to materialise so that they enable Africa to leapfrog development agenda and participate fully in the global engineering discourse.

The fulcrum and catalyst are pivoted on capacity building, funding educational institutions, creation of collaboration, technology transfer, strategic planning and management, research and knowledge generation, relevance of curricula, upgrade and face-lifting of infrastructure, infrastructure and inforstructure to create resilient, conducive and sustainable educational facilities. This may entice African academics who have gone abroad seeking greener pastures to revert home.

The technoprenurial ecosystems can be supported by well-grounded private sector who may receive concessionary rebates or tax holidays from governments. Provide opportunity for engineers and researchers to abstract, synthesize and superimpose genuine technological innovations into reality. Technological and industrial hub centres provide avenues to share best practices in operations and business models for cross-pollination and cross-fertilisation of ideas. Higher-order thinking that enables understanding, analysis, and control of one's cognitive processes, especially when engaged in learning are nurtured and are allowed to mature. Learning models must change if employees and students are appreciate the process learning to learn. Mobilisation of the brainpower or intellectual power is critical as they form key components on sustainability of institutions in terms of the Knowledge Management system.

Africa continues with repair and maintenance educational paradigm which has limited scope in the current industrial and manufacturing technological advancement. The purpose of education is not simply to prepare participants for a specific capability, but rather to give them a sense of purpose and trajectories available in various communities. It should be able to foster capabilities which should assist them in adjusting and responding to socio-economic challenges. Students must be enabled to explore who they are, who they are not and what they could be. Educational imagination is therefore about a true knowledge society capable of transforming the social life of students and subsequently that of the community into productive and fruitful citizens.

The curriculum model implies that knowledge consists of an independent body of facts that can be digested, assimilated and transmitted through a good teacher and, by means of thorough coverage of specific textbooks. Students are effectively assessed by occasional exams that may be objective tests or essays. This particular model is generally teacher-centred and the instructor is a major actor in the learning process. This was refuted by Paulo Ferrier (1970) who advocated for the liberation of the education system so that the learner would be treated as an active participant docile in the learning process not as a tabula rasa or clean slate. African TVET is very participatory in origin and execution.

Industrial Engineering and Operations Management Systems cannot be realised if most textbooks used in Africa are foreign-centric, aimed at perpetuating foreign-centric superiority and triumphalism. Students from day one are disoriented by being totally disconnected from that which is relevant and appropriate to them. Teacher and student are hostages to texts.

### **2.3.1 The Role of Technical Vocational Education and Training in National Development**

Are generally viewed as crucial cogs for rapid socio-economic growth, and essentially to increase the productivity and providing people with the skills, competencies and knowledge they need to participate fully in the socio-economic transformation.

- Have capacity to domesticate and institutionalise skills development programmes, advance vocationalisation, Tvetisation and Cbetisation of education through pracademic processes and procedures thereby orient graduates toward Industrial Engineering and Operations Management Systems.
- Ensure nurturisation, nourishment and maturation of attitudes, perceptions, skills, knowledge and competencies necessary for the execution of duties in the modern day working environment
- Design and implement training needs for specific groups
- Design and put into operations training programmes that influence culture change
- Production of comprehensive training modules informed by research outputs
- Are considered skills, knowledge and competency factories and supermarkets.
- Liaise, link, coordinate, collaborate and create synergies with industry to jointly problem solve industries and community challenges.

## **3. Research Methodology**

The previous section contextualises the identification of factors contributing to the successful implementation of Industrial Engineering and Operations Management Systems in Africa through indigeously grounded TVET

Knowledge Management Systems. The researcher hereby provide the research design process encapsulating the measurement, the phases followed in the data collection and the methods of data analysis. For the purpose of gathering comprehensive data set, the research study was approached as an analysis of implementation of Industrial Engineering and Operations Management Systems of TVET Knowledge Management Systems in Africa with special reference to Zimbabwe.

### 3.1 Research Approach

This research pursued a quantitative-qualitative approach planted in the ontology of constructivist and interpretivist philosophy in which reality within this perspective is subjective and influenced by the context of the situation, namely the individual's experience and perceptions, the social settings and the interaction between the individual and the researchers (Schwandt, 1994 in Ponterotto, 2005). Manen (2002) argued that the approach represents an attitude or disposition of sensitivity and openness. It is a matter of openness to everyday experienced meanings as opposed to theoretical ones.

### Sampling and Target Population

#### Purposive Sampling

Purposive sampling method was used to select the participants. The purposive sampling technique also called judgment sampling is the deliberate choice of an informant due to the qualities the informant possesses. It is a non-random or non-probability technique that does not need underlying theories or a set number of informants.

Table 1. Quantitative Sample and justification

Organization	Respondents	Sample size	Justification for the selection
8 Polytechnics and one private college	Principals, vice principals, Heads of departments and Divisions	42	Management, custodians and implementers of the curricula and had a reasonable chance of providing relevant information
8 Polytechnics and one private college	Polytechnics lecturers (academic)	46	Practitioners responsible for translation of the syllabi and day to day interaction with learners
8 Polytechnics and one private college	Learners (students)	46	Had been in the institution for at least two years, would have an appreciation of the knowledge related information
8 polytechnics	Experts	30	Responsible for coordinating and guiding the drafting of curriculum documents
Head office	Directors and Deputy directors	6	Policy coordinating of polytechnics programmes at head office
Curriculum Research and Development unit	Curriculum experts	13	Responsible for curriculum policy formulation and provide expert guidance in polytechnics
<b>Total</b>		<b>183</b>	

#### 3.1.2 Data Collection in Quantitative Approach

Both quantitative and qualitative data collection methods were employed. Structured survey questionnaires were for data collection from all selected categories in the sampled institutions. Quantitative questionnaires were sent out to all identified participants. The strength of the mixed methods of data collection adopted in this study anchored in the fact that the quantitative and the qualitative survey questionnaires are contrasting measuring instruments, they tend to complement each other's weaknesses.

#### Design and development of data collection instruments

The design and development of the data collection instruments were done after a thorough and comprehensive literature review. The literature review led to the identification of the elements (research constructs, sub constructs and items) that constitute research variables. The data instruments were designed and developed to provide adequate information on the research questions and the overall research objectives of the study. The following discussion explains how the instruments were designed and developed under the respective headings. The interviews were conducted because the researcher realised the added advantage of gaining an in-depth comprehension of the underlying

issues inherent in **Industrial Engineering and Operations Management Knowledge** efforts in the research entities. The quantitative questionnaire survey was designed with a purpose of substantiating the findings from the qualitative questionnaire survey a number of aspects the researcher wants to be sure of addressing (Hancock, 2002).

### 3.1.2 Data Analysis

#### Quantitative data analysis

Data collected using the structured questionnaires were analysed using descriptive statistics methods. Inferential statistics in the form of the Chi-square test and frequency diagrams were conducted on the research data. Babbie *et al.* (2006) referred to descriptive statistics as a method of presenting data in a manageable form. Quantitative data analysis involves aspects such as the frequencies of variables, differences between variables, a statistical test designed to estimate the significance of the results and the probability that they did not occur by chance.

Quantitative data analysis with the application of statistical software consists of the following stages Saunders, M., Lewis, P. & Thornhill, A. (2012).

- Preparing and checking the data and inputting of data into computer.
- Selecting the most appropriate tables and diagrams to use according to research objectives.
- Selecting the most appropriate statistics to describe data sets.
- Selecting the most appropriate statistics to examine relationships and trends in gathered data.

The research data collected through survey questionnaires were computed using the Statistical Package for Social Sciences (SPSS) software.

### 3.1.3 Qualitative data analysis

Data collected through the interviews were analysed using the qualitative methods of data analysis. The process of organising and thinking about data was fundamental to understanding what the data does and does not contain. The data analysis commenced with the organisation of the gathered data, which involved creating an inventory of the researcher's findings and establishing how the data was completed. The data was arranged and grouped according to theoretical themes: Theme B: Knowledge and Knowledge Management, Theme C: Policy issues, Theme D: Knowledge Generation and Theme E: Knowledge Management Strategies.

## 4. Research Results and Interpretation

This section presents the analysis and interpretation of the research data for the TVET institutions in Africa with particular reference to Zimbabwe. The analysis follows the triangulation approach where data collected through the survey questionnaires is supported through the use of interviews and literature review.

### 4.1 Demographic Characteristics of the Quantitative Respondents

Emanating from the quantitative research data demographical characteristics of the respondents in terms of age, gender, religion, academic qualifications, marital status, experience and grade as presented in the below.

Table 2. Classification of the respondents

Category of respondents		Respondents	Valid %
Valid	Experts	35	20%
	Academics	53	31%
	Students	50	29%
	Management	35	20%
	Total	173	100%

Table 3 provides a good basis for validating the research results as this will give credence to the authenticity of the research. Cross validation is possible taking cognisance of the cross-section of the respondents.

Table 2. Gender distribution of respondents

Distribution	Gender	Valid%	
	Male	119	69%
	Female	54	31%
	Total	173	100%

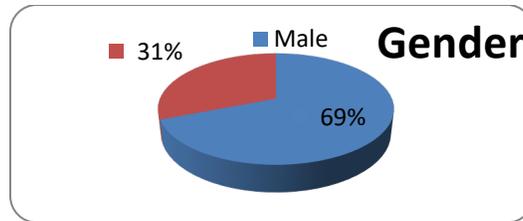


Figure 1. Gender

As highlighted in the Table 2 and Figure 1 respectively, it is observed that both gender categories are represented with a 31% of 173 of the quantitative respondents being females and 69% of 173 being males respectively. This makes the research data representative as both genders' views are considered as part of the research study.

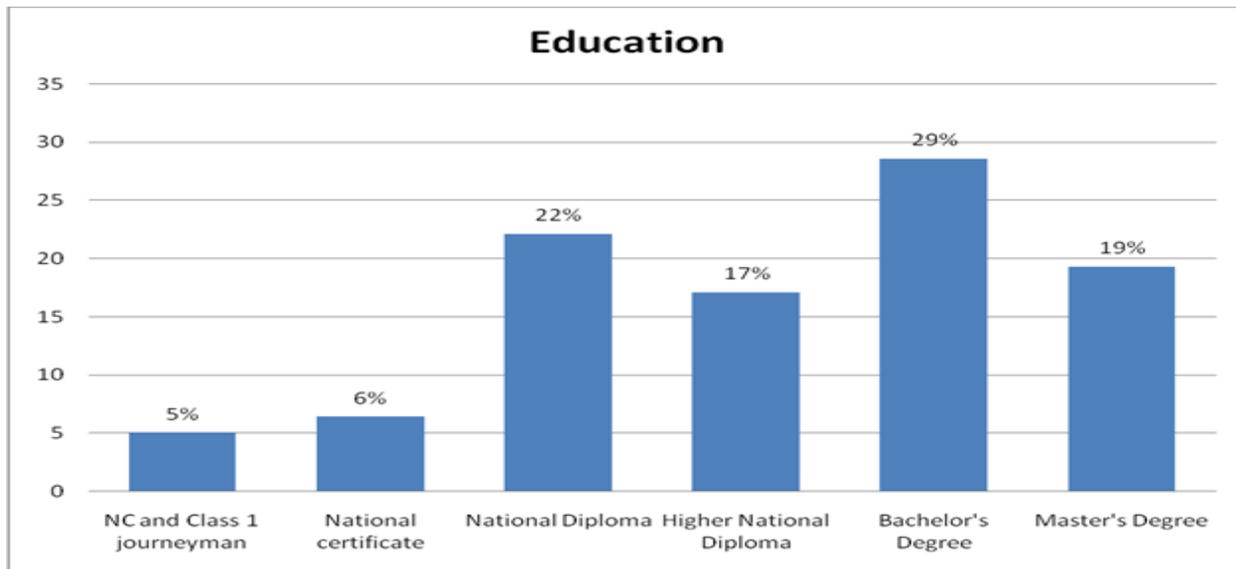


Figure 2. Distribution of respondents per academic qualification

Figure 2. it is noted that the educational background of TVET knowledge workers ranges from the national certificate and a class 1 journeyman to masters degrees. In addition, it is further noted that 52% of 173 of the quantitative respondents do not have first degrees despite the fast pacing and changing trends in knowledge and technology on the global arena. 29% of 173 of the quantitative respondents hold Bachelor's and 19% of 173 of the Master's degrees respectively. This may impact negatively on the application of TVET Knowledge Management System in terms of research and innovation.

#### 4.1.2 Presentation and Analysis of Research Results

Emanating from the data survey questionnaires, the research results are presented in the form of Tables, documentary analysis and test cases noted in literature review. In order to maintain confidentiality and research ethical considerations, the usage of actual names is avoided but merely African TVET institution or private institution or polytechnics. Respondents were asked to indicate perceptions, beliefs and attitudes they experience in their respective institutions in terms of the application of TVET Knowledge Management. On the same questionnaire, the respondents were also asked to indicate their preferred definition of industrial engineering and operations management and TVET Knowledge Management.

Table 3. Respondents' views on Africa TVET Industrial Engineering and Operations Management

TVET education	Respondents	Valid Percent
Yes	166	96%
No	7	4%
Total	173	100%

Table 3. above 96% of 173 of the quantitative respondents demonstrated a positive belief in African TVET Industrial Engineering and Operations Management System. Only 4% of 173 of the quantitative respondents gave negative answers. The significant responds in favour of African TVET Industrial Engineering and Operations Management System is a demonstration that Africa must use its on initiative to development Africanised systems.

Table 4. Respondents' views on Africa TVET Industrial Engineering and Operations Management System perceptions

Industrial Engineering and Operations Management System	Respondents	%
Yes	30	76%
No	10	24%
Total	40	100%

From Table above 76% of 40 the qualitative respondents had a positive view on TVET Industrial Engineering and Operations Management System. The positive views would make implementation of TVET Industrial Engineering and Operations Management System possible as respondents would be generally aware of the requirements for setting up or developing such a system.

One out of 40 of the qualitative respondents noted that,

“The optimization of explicit knowledge is the full utilisation of information and data together with people, skills, ideas and motivations. Industrial Engineering and Operations Management System is an audit or collection of processes that govern the creation, dissemination and utilisation of knowledge”.

Respondents demonstrated that there is a general understanding and appreciation of knowledge and TVET Industrial Engineering and Operations Management System. Appreciation of Industrial Engineering and Operations Management System can be leveraged to enhance and transform the application of Industrial Engineering and Operations Management System in Africa.

#### TVET Industrial Engineering and Operations Management System Perceptions on availability of ICT facilities

Table 5. Availability of ICT facilities

Availability of ICT facilities	Respondents	%
Yes	39	97%
No	1	3%
Total	40	100%

Table 5. above shows that availability of ICT facilities stood at 97% of 40 of the qualitative respondents. This implies that comparably TVET institutions do not largely lag behind developed countries in terms of ICT. The 97% of 40 of the qualitative respondents confirmed that ICT facilities make it possible for the application of TVET Industrial Engineering and Operations Management System. 3% of 40 of the qualitative respondents had a negative perception about ICT facilities.

Table 6. Respondents' views on practical Application of Industrial Engineering and Research Knowledge

Research Knowledge	Respondents	Valid Percent
Yes	26	15%
No	147	85%
Total	173	100%

From 6. Table above respondents considered the importance of industrial engineering and research knowledge as a vehicle through which new skills and knowledge could be acquired. A total of 147 of 173 of quantitative respondents agreed that practical application of Industrial Engineering and Research Knowledge is vital and critical to the development of tacit knowledge acquisition require for Industrial Engineering and Research Knowledge. The overall score of 85% of 173 of the quantitative respondents supported Industrial Engineering and Operations Management System is quite significant. Such a huge affirmation points to the importance of practical research in enhancing the acquisition of tacit knowledge for Industrial Engineering and Operations Management System.

Table 7. Knowledge Generation for Industrial Engineering And Operations Management

Knowledge Generation	Respondents	%
Yes	25	63%
No	15	37%
Total	40	100%

From Table 7. above, on knowledge generation for industrial engineering and operations management, 63% of 40 of the qualitative respondents indicated limited sponsorship for knowledge generation. 37% of 40 of the qualitative respondents concurred that sponsorship is available for knowledge generation. Lack of sponsorship limits the exposure of knowledge workers to corridors of knowledge generation. Socialisation and Publications create platforms where peer reviews benchmark one's work locally, regionally and internationally.

Table 8. Respondents' views on Industrial Engineering and Operations Management TVET policy alignment in Africa

Policy Alignment	Respondents	Valid Percent
Yes	97	56%
No	76	44%
Total	173	100%

Table 8. above indicates that respondents were not quite clear on the policies aligned to the aspirations of knowledge workers to be able to participate in Industrial Engineering and Operations Management System. A total of 56% of 173 of the quantitative respondents are in agreement that the policies are properly aligned while 44% of 173 of the quantitative respondents expressed contrary views. Such level of inconsistency in terms of not knowing how policies should be applied has a negative impact on the overall knowledge generation for Industrial Engineering and Operations Management.

#### Leadership practices

- i. Policy alignment necessary for effective Industrial Engineering and Operations Management Implementation Of TVET In Africa
- ii.

Table 9. Policy issues (qualitative)

Availability Policies	Respondents	%
Yes	11	27%
No	29	73%
Total	40	100%

From Table 9. above, 73% of 40 of the qualitative respondents indicated that there was no policy on the application of TVET Industrial Engineering And Operations Management. 27% of 40 of the qualitative respondents indicated that there was a policy position in place. TVET Knowledge Management Systems primarily houses sophisticated information, locates knowledge resources, improves collaboration, networking, sharing, research and knowledge mobilisation. It captures as well as uses knowledge for the betterment of society.

Table 10. Distribution of respondents' views on philosophy of TVET Education for industrial engineering and operations management in Africa

Philosophy of education	Respondents	Valid Percent
Pedagogy	7	4%
Andragogy	10	6%
TVET	100	58%
CBET	42	24%
TVET and CBET	14	8%
Total	173	100%

From Table 10. above it is noted that 58% of the quantitative respondents were positive of the philosophy applied in TVET education system with the rest giving various ratings, 24% CBET, 6% andragogy, 4% pedagogy and 8% TVET

respectively. The fact that respondents gave varied answers is an indication that the philosophy of TVET Industrial Engineering and Operations Management education is not visible and readily known to the practitioners yet it is supposed to be the cardinal template upon which day-to-day operations are based. Some 6% of 40 of the qualitative respondents from the qualitative questionnaire gave competence based (CBET) paradigms and 31% professed ignorance. A total of 63% of 40 of the qualitative respondents gave different answers like research and development, technology driven paradigms or not sure. One of 40 of the qualitative respondents said, “But the main tool, being used is the internet although from our side there is not much data inputting or uploading but more of downloading”.

Demonstration ignorance on the aspects of paradigms or philosophies applying to African TVET education system limits the capability and horizon of understanding of TVET practitioners. This creates challenges when it comes to the application for industrial engineering and operations management because knowledge workers will have limited knowledge in terms of the philosophy upon which knowledge is nurtured. It is apparent from the above research data that TVET educational philosophy is not readily known by TVET experts who are supposed to superintend and implement knowledge-oriented platforms and initiatives for the betterment of society.

Table 11. Respondents’ views on knowledge sharing and networking platforms

<b>Knowledge sharing and networking</b>		<b>Respondents</b>	<b>Valid Percent</b>
Valid	Yes	86	50.0%
	No	86	50.0%
	Total	172	100.0%

Based on Table 11. it is apparent that the general responses are balanced at 50% of 172 of the quantitative respondents. While these results are consistent with other findings presented earlier in this chapter, it is surprising to note that knowledge sharing and networking platforms get such a mediocre score taking cognisance that polytechnics are learning institutions where sharing and networking are considered vital. The 172 is as a result of one respondent who did not complete the question related to knowledge sharing and networking.

#### 4.1.3 Model For Knowledge Centric Implementation Process

Emanating from the research study findings highlighted in this chapter, the researchers propose a model that could be applied by academics and other knowledge practitioners to comprehend and improve on TVET Industrial Engineering and Operations Management implementation in Africa. The demarcations of the model are established through empirical cases of mature knowledge-centric and knowledge-oriented institutions explored like Timbuktu in Mali which was a garrison of TVET Knowledge predating colonisation and the great Zimbabwe monument and the Pyramids of Egypt. From literature reviewed that integrative approach with focus on E-facilities, E-learning and those that take cognisance of the social factors have a high degree of accomplishment of TVET knowledge-centric organisations outcomes.

#### 4.1.4 Model Formulation

The suggested model for TVET industrial engineering and operations management knowledge centric implementation process in the research institutions. As established in this research study and also supported by Knowledge Management literature, the model is anchored in the findings that TVET Knowledge Management can be approached tacitly. The model recognises that knowledge creation, acquisition, harvesting, harnessing, transfer, sharing and dissemination are the main Industrial Engineering and Operations Management Processes. In this research study, the four social variable factors (Organisational Structure, Culture, Human Resources, technology and Leadership) are considered critical in creating an Industrial Engineering and Operations Management Knowledge-Oriented environment to enhance productivity. The conversion processes comes through socialisation, internalisation, externalisation and combination, Nonaka (1994) which are the platforms for tacit and explicit knowledge. Sponsorship to workshops, conferences and symposium are key ingredients widening the scope of collaboration, knowledge sharing and above all building a solid foundation for TVET Industrial Engineering and Operational Management Systems superstructure.

Knowledge practitioners should be able to select the most appropriate set of TVET (figure 3) (Industrial Engineering and Operations Management elements to support the innovation and creativity processes in organisations. The framework builds on the theoretical foundations underlying TVET Industrial Engineering and Operations Management to identify key processes enabling innovation and creativity in building Industrial Engineering and Operational Management Systems in Africa. The model demonstrates that the main goal TVET is come up with

Industrial Engineering and Operations Management Systems to improve efficiency and effectiveness within an organisation or society through cross-pollination and cross-fertilisation of ideas and sharing.

The model represents a departure from established Industrial Engineering and Operational Management Systems frameworks in that, it is very pioneering because it recognises knowledge, wisdom, consensus, consultation in the management process and creating a fully-fledged tacit/explicit regenerative symbiotic relationship. Additionally, the model takes cognisance of both heritage based knowledge and exotic knowledge sources including ICTs and knowledge oriented factors necessary for knowledge improvement, creation, sharing and networking. This is also a new development in the field of Industrial Engineering and Operational Management Systems.

The researcher contend that the model needs to be improved with further empirical investigations in various institutions in Africa as well as being rigorously tested to validate for operational applicability. However, the researchers pioneered some of the elements and witnessed positive results in areas like infrastructure development and management of students financial and enrolment systems.

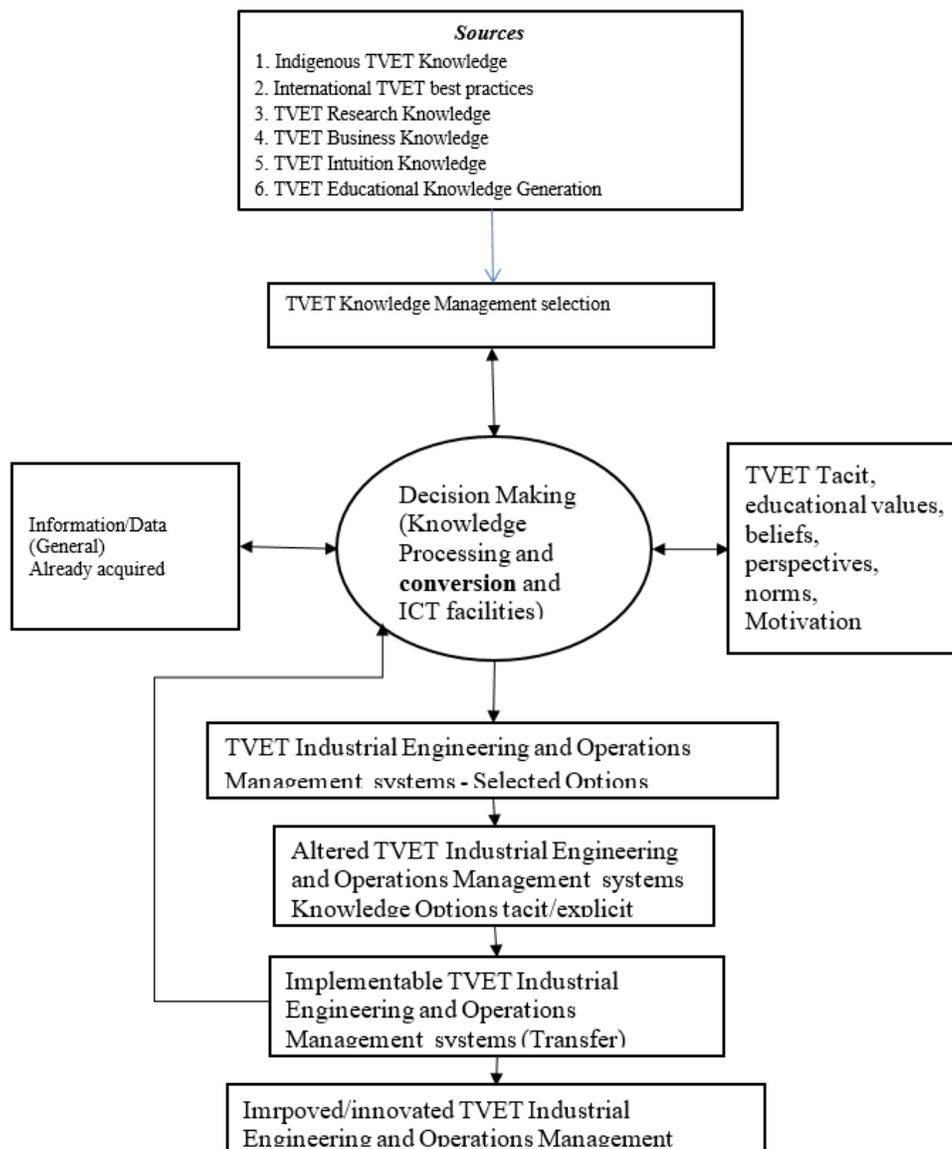


Figure 3. TVET Industrial Engineering and Operations Management Model developed from the Research Study

## 5. Findings, Recommendations, Wayforward and Conclusion

### 5.1 Empirical findings

- Africa education ecosystem is rooted in foreign centric discourse. These alienate and disorient learners from the local context and push them to what to be identified with that which is foreign.
- TVET knowledge acquisition is characterised by low conversion, under-utilisation and mis-utilisation, limited collaborations and networking.
- Generally TVET knowledge workers' qualifications are not commensurate with current global trends and the dichotomy of Industrial Engineering And Operational Management Systems.
- TVET Knowledge Management system is hampered by lack of Afro-centric policy.
- ICT plays a determining factor as key enabler and facilitator to the acquisition, sharing, networking and generation of Industrial Engineering and Operational Management Systems.

#### 5.1.1 Recommendations

Emanating from the implication of the research study as explored above, the researcher makes the following recommendations for effective and efficient Industrial Engineering and Operations Management In Africa.

- TVET Knowledge Management practices and initiatives should be reasserted and repurposed to anchor national development in terms Industrial Engineering and Operational Management Systems.
- Develop clear policies and philosophies that repurpose and support the implementation of national Industrial Engineering and Operational Management Systems in Technical Vocational Education and Training (TVET) embedded in indigenous knowledge systems.
- Understand and emphasise practical approaches and solutions to create indigenous TVET Industrial Engineering and Operational Management Systems as a competitive edge.

#### 5.1.2 Wayforward

- 5.1.3 This study opens opportunities for future research due to the complexity and limited resources of the researcher that ultimately affected the landscape of the research area to mainly polytechnics in Zimbabwe. Further appropriate research to validate the model used can be explored to determine if there is an optimal interrelationship of Knowledge Management processes and performances.

#### 5.1.4 Conclusion

This research study has managed to demonstrate that African governments through their education institutions need to rediscover, reposition, repurpose and reassert the philosophy of indigenous Technical Vocational Education and Training for national reskilling, industrial engineering and operational management. Adequate budget provisions, public policy orientation, and resources mobilization to improve efficiency, good corporate governance and effectiveness of public educational institutions should be put in place. African governments must domesticate, institutionalise, commoditise, and embody decolonization curriculum strategies that promote and enhance heritage based TVET philosophy. Thinking philosophies need to be recoded, reengineered and reconfigured to enable mindset repositioning to enhance development of Industrial Engineering and Operations Management System.

## References

- Africa Engineering Week 14-19 September 15 [Online]. Available from: <http://www.unesco.org/new/en/unesco/events/prizes-and-celebrations/celebrations/international-weeks/unesco-africa-engineering-week-2015/> [Accessed 26 November 2020].
- African Union, Agenda 2063 – The Africa We Want (August 2014).
- Babbie, E. (2010), *The Practice of Social Research* (12<sup>th</sup> ed) Belmont, CA: Wadsworth, London Publishing.
- Bagnall, R.G. (2007). Mapping and enhancing the contribution of TVET teacher education to education for sustainable development.
- Bernard, H.R. (2002), *Research Methods in Anthropology: Qualitative and quantitative methods*. (3rd edition). California: Altamira Press.
- Chancellor, W. (1974,1989), *The Destruction of black civilisation-great issues of race from 4500 B.C to 2000 A.D*. Chicago Illinois: Third World Press 7524 South Cottage Grove Chicago, Illinois.
- Drucker, P.F. (1985), *Innovation and entrepreneurship-practice and principle*. New York: Harper Perennial.
- Dr. Magaya, D. (2018) in his article titled 'Digital Innovations: the Vision 2030 Real Deal'
- El-Ghannam, A. (2002), The determinants of social well-being, economic development, and development Index in the third world countries. Perspectives on Global Development and Technology
- Genesis1: [Online]. Available from: <https://www.biblegateway.com/passage/?search=Genesis%201&version=NIV/> [Accessed 26 November 2020]

- Gornitzka, A., & Maassen, P. (2000), 'National policies concerning the economic role of higher education'. Higher and Tertiary Education, Science and Technology Development Policy. vol.13, number 3. pp. 225-230.
- Hancock, B. (2000), An introduction to qualitative research. Nottingham: Trent Focus Group (University of Nottingham).
- Maddison, A. (2007), Contours of the World Economy 1-2030 AD. Essays in Macroeconomic History. Oxford University Press.
- Nonaka, I. (1994), 'Dynamic theory of Organisational Knowledge Creation'. *Organisation Science*. vol. 5, number 1. pp. 14-37.
- Nyerere, J. (2009), Technical And Vocational Education And Training (Tvet) Sector Mapping In Kenya: Strategy For Revitalise Technical And Vocational Education And Training (TVET) In Africa.
- Paulo, F. (1970), *A Pedagogy of the Oppressed*. New York: Herder and Herder.
- Paulo, F. (1972), *Pedagogy of the oppressed*. New York: Herder and Herder.
- Saunders, M., Lewis, P. & Thornhill, A. (2012), "Research Methods for Business Students" 6th edition, *Pearson Education Limited*.
- The legacy of Timbuktu, Africa's oldest university:[online].Available from:  
[https://www.thepatriot.co.zw/old\\_posts/the-legacy-of-timbuktu-africas-oldest-university/](https://www.thepatriot.co.zw/old_posts/the-legacy-of-timbuktu-africas-oldest-university/) [Accessed 28 November 2020].
- Louis R. Harlan, ed., The Booker T. Washington Papers, Vol. 3, (Urbana: University of Illinois Press, 1974), 583–587.

## Biography

**Dr. (Ph.D). FZwIE. PrEng. Tafadzwa Mudondo** is currently the Principal of Harare Polytechnic in Zimbabwe. Harare Polytechnic has a staff compliment of about 700 members and a students' population of about 10000. He is a holder of, Ph.D in Business Administration, specializing in Knowledge Management Systems, Executive Masters in Business Administration Degree, Bachelor of Technical Education Honours in Electrical and Electronics Engineering all from National University of Science and Technology Zimbabwe. Higher National Diploma in Computer Engineering from Xi'an Telecommunication Institute (China), Full Technological Certificate in Telecommunications Engineering, City and Guilds (UK), Class 1 Journeyperson in Aircraft Radio and Telecommunications Engineering done with the Air force of Zimbabwe. Tafadzwa Mudondo is a registered professional Principal Telecommunications and Avionics Engineer, Fellow of Zimbabwe Institution of Engineers. Tafadzwa Mudondo has 10 years working experience in the aircraft industry and 22 years' experience in managing engineering education, learning and training at a polytechnic. An author in Building Resilient and Sustainable Competitive Practices in Organisations and has many publications of Knowledge Management Systems. Tafadzwa Mudondo has a passion for Knowledge Management Systems and Learning Organisation. Member of Society for Research into Higher Education (UK), Member and Executive Board member of Zimbabwe Institution of Engineers and Executive Board member of Commonwealth Association of Polytechnics and Technical Universities in Africa (CAPA/ATUPA), member Higher Examination Council Pre-Ratification Committee-Zimbabwe and current Chair of Polytechnics and Industrial Training Colleges Association in Zimbabwe.