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Effect of Investment in Fourth Industrial Revolution (4IR) Technologies on Cost of Production and Sales Revenue of Manufacturing Industries in Tanzania

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Abstract

The study assessed effect of investment in 4IR technologies on production costs and sales revenue of manufacturing industries in Tanzania. Specifically, the study set out to establish causality of investment in 4IR technologies on manufacturing industries' costs of production and sales revenue. To achieve the research objectives, the study used a quantitative descriptive design to generate the required data. Moreover, the study used structured questionnaires for cross-sectional survey, administered with 225 production managers of manufacturing industries in Tanzania. It used probability sampling in the form of cluster sampling. Additionally, the study used the Least Square method to analyze the objectives of the study. The study found a statistically significant causal effect between investment in 4IR technology, manufacturing firms cost of production and sales revenue whereby, when manufacturing firms increase investment in 4IR technologies by 1 unit, the production cost of such firms rose by 1.08 units while the corresponding sales revenue rose by 5.96 units hence the benefits of technological investment outweigh the cost. Implicitly, the emergence of 4IR does not occasion a decline in production due to increase in costs of manufacturing firms in developing countries endowed with resources like Tanzania, but rather complements and accelerates growth. This study calls on the Tanzania Government to review and improve its Sustainable Industrial Development Policy of 2020 and the Integrated Industrial Development Strategy of 2025 to promote and support not only resource-based industries, but also technological based industries, to speed up industrialization within the country. The government should also improve its investment policies and align them with technological changes brought by 4IR, to attract more foreign direct investments, importation, adoption and imitation of 4IR technologies from developed countries that lead to enhanced productivity and revenue generation in Tanzania manufacturing sector. Despite the fact that government and institutions in Tanzania are not fully prepared and equipped in terms of technology supportive infrastructures, policies, strategies and technology governance quality, manufacturing firms should keep investing in industry 4.0 technologies since the benefits obtained outweigh the cost.

Keywords: 4th Industrial Revolution, Cost of Production, Sales Revenue

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1. Introduction

The Tanzanian economy is characterized by poor infrastructure, low level of digital literacy and technological backwardness, labor intensive, low level of technical education, as pointed out by the Tanzania's industrial integrated development strategy of 2025. The economy is largely informal and still depends on agriculture. These characteristics will no more attract investment and productivity because 4IR poses a challenge to the economic growth catch-up theory since it revises the rules of manufacturing, (Lee et al 2019). The growth strategy which was based on the low- cost labor and cheap raw material becomes irrelevant as innovation makes the cost of automation drops and smart productivity boost production.

Tanzania as many others Sub-Saharan African countries, is not well prepared to embrace 4IR thus its impacts expected to hit hard (Millington,2017). Due to high level of automation and technology, developed countries productivity level increase at low cost while developing countries productivity expected to decline due to high production costs (resulted from heavy technology investment costs). As a result of open market system, protectionism will not be sufficient to protect few local industries against inflow of cheap goods from developed countries. Few available industries will crumple, unemployment level will increase, developing countries become completely open market for foreign goods, and exportation of finished goods subsides as well as foreign direct investments.

1.1 Objectives of the Study

Specifically, the study will set out to achieve the following:

- To establish causality of investment in 4IR technologies on manufacturing industries' costs of production.
- To determine causality of investment in 4IR technologies on manufacturing industries' sales revenue

2. Review of related literature

2.1 Empirical Evidence

The world has lived four industrial revolutions, the first used stem engines for mechanical production, the second used electricity and division of labor to create mass production, the third introduced information technology and automated production processes, currently the world has reached the fourth industrial revolution (4IR). According to Schwab (2017), 4IR is digital transformation that widely affects work life across the world. Frey and Osborne (2023) suggested that technological and economic changes over the past few centuries represent three major industrial revolutions, first, mechanical production in the late 18th century, second, usage of electricity for mass industrial production in late 19th century, third, personal computers and internet in the 1960s. Recent changes in the world of work are normally termed as the fourth industrial revolution or Industry 4.0 which is featured by key technologies such as artificial intelligence, genetic engineering, cloud computing, biotechnology, 3-D printing, nano-technology, internet of things among others. Bangens (2014) called 4IR as the second machine era. The suggested, the key difference from previous industrial revolutions, current technology is

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not aimed at replacing physical labor and support human being in doing their work but rather at replacing intellectual work and human workers altogether.

Despite the fact that, 4IR holds great optimism of becoming a driving force for industrial, social and economic growth, it is anticipated to pose a major threat and lead to changes in the patterns of production, employment and consumption, thus set broader socio-economic drivers of change in both developed and developing economies. These changes brought by 4IR maynecessitate proactive adaptation by individuals, governments and corporations around the world (Runde, 2016). According to the World Economic Forum (2016) many economies in the Sab-Saharan Africa have deepened their fear of the consequences of the 4IR. Inability to catch-up with the rise in production cost and production decline due to expensive technological transformation requirements, skills disruption, job dislocations and mass unemployment may undermine economic transformation and sustained growth. Most effects of the 4IR depend on how individuals, governments and corporations will react and accommodate technological transformation.

Regretfully, the preposition that, industry 4.0 adversely affect manufacturing value added in country's not prepared to embrace it has been supported by Ngepah et al (2024). Empirical evidence from their study "the impact of industry 4.0 on South Africa manufacturing sector" suggested a significant and negative correlation between the variables. The findings from the study suggested that, South Africa is characterized by deficiency of ICT capacities, inadequate secure data, unsubstantial medium and high-tech investment, inadequate knowledge capacity, absence of regulated system. Therefore, the study recommended, to deal with the negative and significant relationship between industry 4.0 and manufacturing value added, the government and policy makers must concentrate on building up the adaptability of both public and private institution, investing significant on fourth industrial revolution technologies and promoting technical education. According to this study, currently there is no notable manufacturing industries value addition in South Africa as a result of emergence of industry 4.0 rather the cost of manufacturing keeps on rising and revenue declining until government intervention through building of supportive infrastructure development and promotion of technical education for skills matching.

Kajewole et al (2024) in their work titled "Does industry 4.0 and environmental quality asymmetrically affect South Africa's manufacturing sector? Afresh insight from non-linear autoregressive distributed lag model". In their analysis they revealed a positive but insignificant relationship between industry 4.0 technologies and manufacturing long term value addition. To fully reap benefits of investment in the Fourth Industrial Revolution, it is recommended governments and institutions to prepare and equip in terms of technology supportive infrastructures and enhances technology governance quality.

Tanzania as many other Sub-Saharan African countries is characterized by inadequate investment in technical education, low innovation level, un-preparedness of government and institutions to embrace Fourth Industrial Revolution in terms of Policy, Strategies, ICT

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infrastructures and Technology Governance Quality. Most large manufacturing firms in Tanzania have adopted, imitated and imported industry 4.0 technologies from developed countries but little attention has been given to analyze the effects of such technologies on manufacturing industries value addition (sales revenue and production cost). This study aims to provide insight on how investment on 4IR technologies made by manufacturing industries in Tanzania affect their cost of production and sales revenue and offer appropriate recommendations.

2.2 Guiding Theory

This study is guided by the Catch-up Theory. The Catch-up Theory. According to Lee et al (2019), the core mechanism of the catch-up theory is the different sources of technological improvements among developed and developing economies. The technological progress of developed economies is primarily based on trial and error, or innovation. The costly and risky innovation results in moderate long-term growth. However, the developing economies can achieve technological progress through technology adoption and imitation, which costs much less than research and development (R&D), as there is a large technological gap between developing and developed economies. Therefore, in the early stage of catch-up, the technological growth rate of developing economies is much higher than that of developed economies. Only when the technology gap between latecomer economies and advanced economies narrows, the technology growth rate begins to slow down. The income growth rate is thus brought down.

In its simplest form as explain by Abramovitz (1986), the catch-up hypothesis states that a country should grow more rapidly if it is initially backward in its level of economic development. This stems from the fact that a country lag in technology carries a potential for rapid growth with imitation and adoption of technology than already advanced countries. This catch-up can take place through capital-embodied technical progress. The lagging country possesses an older, less modern capital stock. The discarding of this stock and its replacement by more modern equipment is accompanied by large productivity gains, larger than those achieved by countries which possessed up-to-date equipment in the first place.

The most popular explanations for developing economies high rate of economic growth as compared to advanced economies are low labor costs, demographic dividends, low land costs, and low environment costs, among others, Lee et al (2019). However, although developed economies, such as the US, enjoyed similar elements in their early stages of development, they never experienced a high-speed growth phase. The reason is clear: latecomer economies are able to adopt and imitate technology at a lower cost.

2.3 Conceptual Framework

A conceptual frame work below explains the relationship that exists between investment in fourth industrial revolution technologies and country's Manufacturing Value Addition (MVA). Investment in industry 4.0 features used as explanatory variable while manufacturing value addition (sales revenue and production cost) used as dependent variable.

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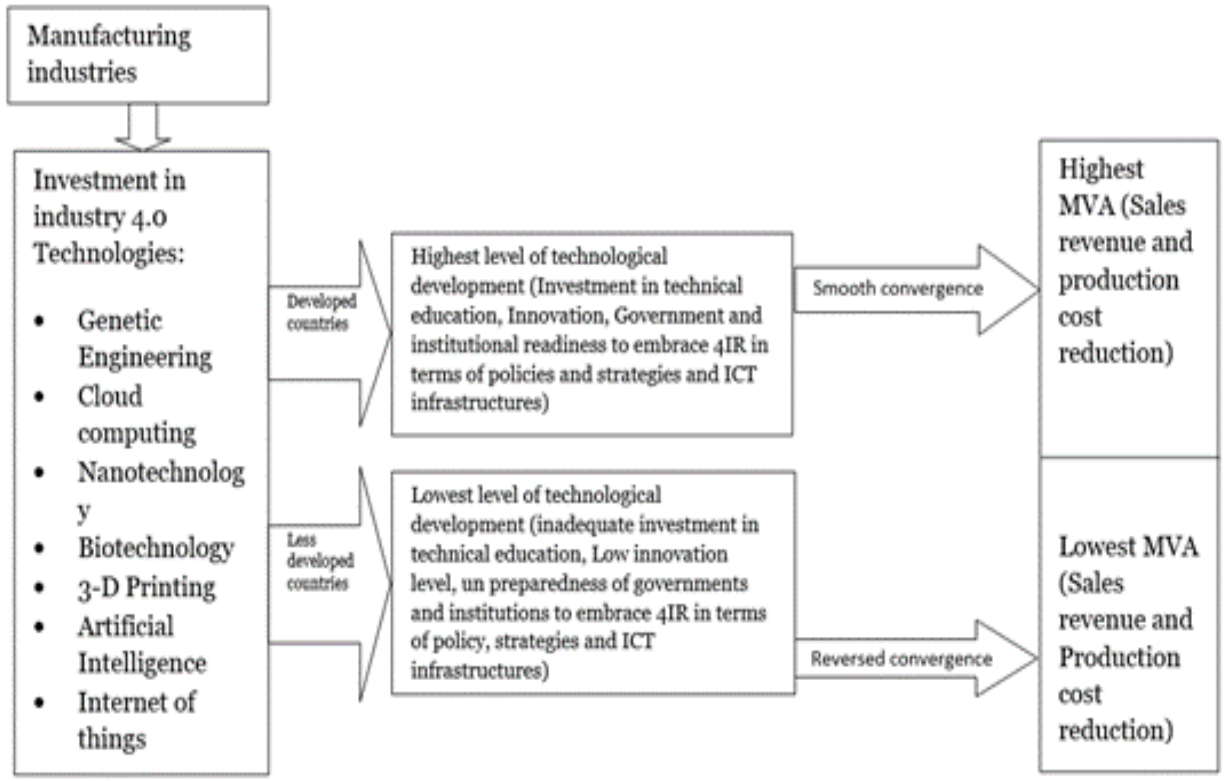

Source: Author (2024)

Depending on technological development level of a country such as investment in technical education, innovation, preparedness of governments and institutions to embrace the fourth industrial revolution in terms of policies, strategies and ICT infrastructures; emergence of industry 4.0 may positively or negatively affect value addition (cost of production and sales revenue) of manufacturing industries. Most likely developed countries will smoothly converge and attain highest level of manufacturing value addition while less developed countries are likely to experience reversed convergence and lowest MVA.

3.0 Methodology

3.1 Research Philosophy

This study embraced ontology paradigm as a way of looking at the social reality that is composed of certain philosophical assumptions to guide and direct thinking and actions as pointed out by Mertens (2010). A research approach is usually influenced by ontological and epistemological assumptions or stances of the researcher. This study has adopted the positivism ideology. The philosophical stance adopted (positivism) aims to utilize hypotheses to test existing theories for generalization purposes.

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3.2 Research Design

This study applied quantitative descriptive design. Specifically, it deployed quantitative and statistical aspects of data organization, presentation and analysis through figures, numbers and tables. Deductive reasoning was employed by this study whereby the researcher collected data during investigation of the problem and subjected the data from investigation toanalysis before drawing inferences and logical conclusions. A survey strategy was opted for the above design.

3.3 Area of the Study

The study was carried out in Tanzania. A total of 61,110 manufacturing industries were involved in the study. The number represents the sum of manufacturing industries in Tanzania by June 2020. A sample size was then drawn from such a population, since it was unrealistic to reach every manufacturer.

3.4 Data Collection Methods

This study employed different data collection methods. Both primary and secondary data were collected. Structured questionnaires for survey were administered with production managers of manufacturing industries to collect primary data. The study also used secondary data to complement primary data. The main sources were documentary review of various official documents and reports (i.e., manufacturing industries' survey reports from the National Bureau of Statistics [NBS], the Tanzania Investment Reports from the Tanzania Investment Centre (TIC), relevant to the research problem.

3.5 Population and Sampling

The targeted population was all manufacturing industries in the country by June 2020. The targeted sampling unit were production managers of manufacturing industries. Since the study population was known with reliability and sampling frame easily determinable, the study adopted a probabilistic sampling method. Specifically, the study used the cluster sampling technique. A sample of 225 manufacturing industries was used in this study to generate the required data. This study allowed the variability results of 5% (margin error), 90% confidence interval at all times, using the Cochran Formula for sample calculation.

3.6 Pre-Testing of Questionnaire

Pre-testing was conducted in circumstances that were similar to the actual data collection and on population members in the likeness of those sampled. Pre-testing of questionnaires using a total of 26 production managers of manufacturing industries, which was almost 10% of the total sample size, preceded the actual manufacturing industries survey. Sudman (1983) suggested the use of 20-50 cases during pre-tests as sufficient for discovering major errors in a questionnaire and ensure data validity.

3.7 Data Analysis

3.7.1 Descriptive Statistics

Primary data was analyzed quantitatively. Measures of central tendencies, skewness and kurtosis of data covering the study period (2012 to 2021), were conducted using descriptive statistics.

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3.7.2 Estimation Approach

The Least Square method was used to analyze the study objectives. The model helped to estimate changes in dependent variables (Cost of Production and Sales Revenue) when an independent variable change (Capital Investment in 4IR technologies). Regression analysis describes the relationship between variables by fitting a line to the data observed. Prior to regression analysis, stationarity of time series properties was tested using Augmented Dickey Fuller (ADF), to understand the behavior and patterns of the data. To assess the effect of investment in 4IR technologies by manufacturing industries on cost of production and sales revenue, the following estimation model was used:

$Yt = \beta o + \beta 1 Xt + et$ 1

$Zt = \beta o + \beta 1 Xt + et$ 2

Where;

Yt and Zt Stands for the outcome variables (Production cost and Sales Revenue) and Xt stands for Capital Investment in 4IR technologies. β0 is the constant term and β1 is the coefficient relating to the explanatory variable, and et stands for error term.

3.8 Reliability of data

Cronbach's alpha was used to test the reliability coefficient, which calculates internal consistency by examining how each test item relates to each other and to the entire test., where "_ > .9 – Excellent, _ > .8 – Good, _ > .7 – Acceptable, _ > .6 – Questionable, _ > .5 – Poor, and < .5 – Unacceptable". Cronbach's alpha reliability coefficient, given as a value between 0 and 1, was employed in this study. The scale's items may be internally consistent when Cronbach's alpha is close to 1.0.

4. Results and Discussion

4.1 Time Series Properties

Stationarity of time series data denotes that a variable's mean, variance, and auto correlation remain constant across time. During this study, all variables were stationery at lag (0). Using the ADF test at this point all the variables P-Value were less than 0.05 and the value for the ADF unit root test statistic was higher than that of 5% critical value.

Table 1: Unit Root Test

Variable	P-Value	Remarks
Capital invested in 4IR Technology	0.0000	Lag (0)
Cost of production	0.00233	Lag (0)
Sales Revenue	0.0404	Lag (0)

Source: Author (2024)

4.2 Reliability test

This study performed the reliability test on its variables. This test was conducted so as to ensure the internal consistency of the variables of study. Cronbanch's Alpha test was employed in this

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study. The test results portrayed a scale reliability coefficient greater than 0.65 which means the variables were consistent and reliable to be used for further statistical predictions.

Table 2: Reliability test

Item	Value
Average interitem covariance	.0007149
Number of items in the scale	2
Scale reliability coefficient	0.675

Source: Author (2024)

4.3 Descriptive Statistics

This study maximum and minimum values are very close to the mean of the sample; this is an indication that most observations of this study are not dispersed far from their mean. This finding has been complemented by the standard deviation approaching zero (very low dispersion). In the table below, the skewness of variables (capital invested in 4IR technologies and cost of production of manufacturing industries in Tanzania) is portrayed by values approaching zero indicating asymmetry distribution of named variables, that is normal distribution of study data. To ensure reliability and consistency of data, all variables data were transformed to logarithm.

Table 3: Descriptive Statistics

Variable	Observations	Mean	Std. Dev.	Min	Max	Pr(Skewness)	Pr(Kurtosis)
Log_tech	10	26.95366	0.0194808	26.92522	26.97458	0.6659	0.1403
Log_cpd	10	29.27204	0.1259779	29.05401	29.42062	0.4448	0.4289
Log_sales	10	28.27026	0.1266928	28.055	28.47899	0.4833	0.6963

Source**:** Author (2024)

Where;
Log_tech is Capital Invested in 4IR Technologies by manufacturing industries in Tanzania
Log_cpd is Annual Cost of Production of manufacturing industries in Tanzania
Log_sales Annual Sales Revenue of manufacturing industries in Tanzania

4.4 Regression Results

4.4.1 Investment in 4IR technologies and Cost of production

From table 4 the regression summary indicates that, the findings are statistically significant with a t-statistic of less than 0.05 at 95% confidence interval. According to these findings, when manufacturing firms increase investment in Fourth Industrial Revolution technologies by 1 unit, the production cost of such firms will increase by 1.08 units in the short-run. In the long-run manufacturing firms recover the initial capital outlay for technological investment since the benefits outweigh the costs. In Long-run the level of technological transformation preparedness,

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ICT supportive infrastructures, technical education and skills set of the country will be higher to match 4IR. These findings are very promising to manufacturers in developing countries like Tanzania that, they can access benefits of 4IR even before the government and institutions are fully prepared and equipped in terms of modern technology supportive infrastructures, policies, strategies and technology governance quality. These findings differ from suggestions provided by Kajewole et al (2024), in their analysis they recommended that, for manufacturing firms in developing countries to have value addition as a result of industry 4.0, government and institutions must be fully prepared and equipped in terms of technology supportive infrastructures, policies, strategies and technology governance quality.

These findings highly complement the work by Abramovitz (1986) who insisted that the fundamental mechanism for catch-up economic theory is differences in technological improvements between developed and developing countries. In his work, it was suggested that, technological progress of developed countries depends on costly and risky trial and errors which result to moderate but long-term growth while developing economies achieve technological progress by imitation and adoption which cost much less than research and development. Thus in early stage of catch-up, the technological growth of developing economies like Tanzania is much higher than that of developed economies as well as the income growth rate. Newman (2016) also supported this study finding, in his analysis of economies and technological transformation he suggested that, countries that lag in technology carries potential for large productivity gains and growth than already advanced countries.

Table 4: Regression Summary (Investment in 4IR technology and cost of production)

Log_cpd	Coef.	Std.Err	t	P> | t |	R-squared
Log_tech	1.086014	.0014256	761.79	0.000	.89239

Source**:** Author (2024)

Where;
Log_tec is Investment in 4IR Technologies
Log_cpd is Cost of production of Manufacturing Industries in Tanzania

4.4.2 Investment in 4IR technologies and Manufacturing Industries Sales Revenue
From table 5 the regression analysis indicates that, the findings are statistically significant with a t-statistic of less than 0.05 at 95% confidence interval. According to these findings, when manufacturing firms increase investment in Fourth Industrial Revolution technologies by 1 unit, the sales revenue of such firms increases by 5.96 units. These findings suggest that, it is highly beneficial for manufacturing firms in Tanzania to keep on acquiring modern (4IR) industrial technology since their benefits outweigh their acquisition and operational costs. Therefore, according to the findings, the sales revenue of manufacturing firms in Tanzania depend on investment in modern technology by 84.23% ceteris paribus. These results highly complement the causality result of technological investment and cost of production in table 4.

These findings highly differ from the findings of the study titled “the impact of industry 4.0 on South Africa manufacturing sector” conducted by Ngepah et al (2024) who came to conclusion

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that there is significant and negative correlation between 4IR and manufacturing industries value addition. In their analysis they suggested that investment in industry 4.0 technologies in African countries, especially those with deficiency of ICT capacities, inadequate secure data, unsubstantial medium and high-tech investment, inadequate knowledge capacity, absence of regulated system will adversely affect any value addition (including magnifying production cost and sales revenue reduction) from manufacturing firms. Current study findings suggest strong positive correlation between investment in industry 4.0 technology and manufacturing industries sales revenue whereby increase in one unit of investment modern technology lead 5.96 units increase in their sales revenue. Despite the fact that, Tanzania as a country is not fully prepared to embrace technological transformation brought by 4IR, manufacturing firms should keep on investing on such modern technology.

Table 5: Regression Summary (Investment in 4IR technology and Sales revenue)

Log_SR	Coef.	Std.Err	t	P> | t |	R-squared
Log_tech	5.968835	.912978	6.54	0.000	.88423

Where;
Log_tec is Investment in 4IR Technologies
Log_SR is Sales Revenue of Manufacturing Industries in Tanzania

5.0 Conclusion

The objective of this study was to assess effect of investment in 4IR technology on manufacturing firms cost of production and sales revenue in Tanzania for the 2012 – 2021 period. The study used primary annual data for the 2012 - 2021 period to estimate the degree of causality and capture the effects of investment in 4IR technology on manufacturing firms cost of production and sales revenue. Specifically, the study has found a statistically significant causal effect between investment in 4IR technology, manufacturing firms cost of production and sales revenue whereby, when manufacturing firms increase investment in 4IR technologies by 1 unit, the production cost of such firms rose by 1.08 units while the corresponding sales revenue rose by 5.96 units, therefore, the benefits of technological investment by manufacturing firms in Tanzania outweigh the cost. Therefore, emergence of 4IR does not necessarily cause manufacturing firms production decline due to increase in production costs in developing countries like Tanzania endowed with resources but rather complements and accelerate growth. Benefits of investment in 4IR technologies outweigh the cost.

6.0 Recommendations

This study calls on the Tanzania Government to review and improve its Sustainable Industrial Development Policy of 2020 and the Integrated Industrial Development Strategy of 2025 to promote and support not only resource-based industries, but also technological based industries, to speed up industrialization within the country. The government should also improve its investment policies and align them with technological changes brought by 4IR, to attract more foreign direct investments, importation, adoption and imitation of 4IR technologies from developed countries that lead to enhanced productivity and revenue generation in the

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manufacturing sector. Despite the fact that government and institutions in Tanzania are not fully prepared and equipped in terms of technology supportive infrastructures, policies, strategies and technology governance quality, manufacturing firms should keep investing in industry 4.0 technologies since benefits obtained outweigh the cost.

References

Abramovitz, M.(1986). "Catching up, Forging Ahead, and Falling Behind", Journal of Economics History, Vol. 46, No. 2, June, pp 385-406

Bangens L. 2014, 'Cluster of Competence: Forming Successful Alliances between University and Industry in East Africa, *in Innovation Systems and Innovative Clusters in Africa, Proceeding of The Regional Conference, 18-20 February, eds*.

David, Oluwaseu, Kajewole., Nicholas, Ngepah., Shaaba,Saba. (2024). 'Does industry 4.0 and environmental quality asymmetrically affect South Africa's manufacturing sector? Afresh insight from nonlinear autoregressive distributed lag (NARDL) model'. *Discover sustainability*, 5(1) doi: 10.1007/s43621-024-00335-x

Frey, C. B. and Osborne, M. 2017. "The Future of Employment: How Susceptible Are Jobs to Computerization" *Technological Forecasting and Social Change* 114:254-280.

Lee,S., B.S.Kim.Y. Kim, W. Kim, and W. Ahn. 2019. "The Framework of Factors Affecting Technology Transfer for Suppliers and Buyers of Technology in Korea."*Technology Analysis & Strategic Management* 30 (2). 172-185.

Mertens. D.M. 2010. *Research and evaluation in education and psychology: Integrating diversity with quantitative and mixed methods* (3rd Ed.) Thousand Oaks, CA: Sage

Millington. K.A.2017. *How Changes in Technology and Automation will affect the Labor Market in Africa.* Helpdesk report on Knowledge, evidence and learning for development.

Ministry of Industry and Trade.1996. *Sustainable Industries Development Policy- SIDP* (1996-2020). Dar Es Salaam, Tanzania: United Republic of Tanzania Printer.

Newman, C. 2016. *Manufacturing Transformation: Comparative Studies of Industrial Development in Africa and Emerging Asia.* London Press. London.

Nicholas, Ngepah., Shaaba,Saba., David,Oluwaseu,Kajewole. (2024). 'The impact of industry 4.0 on South Africa's manufacturing sector'. *Journal of open innovation*, doi: 10.1016/j.joitmc.2024.100226

Runde, D. 2016. "Is America ready for the 'Fourth Industrial Revolution'?" Foreign Policy. https://foreignpolicy.com/2016/04/04.

Schwab, K, 2017: The Fourth Industrial Revolution. New York: Random House USA Inc.

Sudman, 1983. "Survey Research and Technological Change" *in Sociological Methods & Research*,vol, 12(2), Pages 217-230.November.

World Economic Forum Africa. 2016. https://www.weforum.org/events/world-economic-forum-on-Africa-2016