Production System Effectiveness Determination under Sustainable Industrial Revolution Class

[1]Yakubu A. J., [2]Kareem B., [3]Akinnuli B. O.
[1]*Federal Polytechnic Ile-Oluji, Nigeria, Department of Civil Engineering,*
[2,3]*Federal University of Technology Akure, Nigeria. Department of Industrial and Production Engineering,*

ABSTRACT–Studies through literature reveal that many production systems were found unproductive and some fade away because they cannot sustain industrial revolution which required dynamic and optimal management available resources-based uncertainty. Hence the need for development of a model at resolving sustainable productivity challenges under revolution class. The attributes (internal and external) of industrial failure were determined using questionnaire administration and oral interview of industrial experts in five (5) selected production companies (Company A, B, C, D and E) in Nigeria.Production System Effectiveness (PSE) factors: Availability P(I), Performance P(p) and Quality P(O) were determined using Traditional Approach (APQ) in order to arrive at manageable decision-making criteria under uncertainty, risk or competition. Initial measures of PSE were based on the input internal factors (manpower, machine, material, energy, management, information / communication, money and marketing), while sustainability decisions were determined using industrial revolution standards. Paired t-test statistic was used to test the levels of significant difference on (PSE) at 5 %.The results indicated varying optimum decisions which were influenced by the standards of measurement. The mathematical model developed under Traditional Approach for PSE shows that all the companies selected for investigation were not-sustainable while company A, D and E were sustainable under Traditional Approach for WPSE. However, the differences identified had little or no effect on sustainable decision making in all companies investigated.

Keyword: Industrial Revolution, Production System, Effectiveness, Sustainability

I. INTRODUCTION

The persistence failure in production process due to inadequacy of production resources has been affecting the production system productivity. The study that identified and integrated the factors responsible for productivity failure is very rare. Productivity measurement with reference to: sustainable trend, global acceptable and industrial revolution standards were partially explored. A model is necessary to holistically consider factors that influencing both productivity and sustainable development

The standard of living of a given country can be directly related to the *per capita* energy consumption. The recent world's energy crisis is due to two reasons: the rapid population growth and the increase in the living standard of whole societies. The *per capita* energy consumption is a measure of the *per capita* income as well as a measure of the prosperity of a nation [1]. The energy improvement challenges have adversely affected the productivity of other resources in the production systems.

With increasing globalization, human capital and manpower development, machine revolution, material advancement, modern communication, advanced marketing and energy hybridization, a good sources utilization policy is required and can be accessed through qualitative education and training in sources management [2].

Human capital development is crucial and ultimate in propelling productivity. Equipment and technology are products of human minds and can only be made productive by human beings. The energy sector also contributed to the industrialization of any nations, its failure however has an advert effect on the nation economy growth [3].

From the past studies [4, 5] and [6] factors that influence sustainability of the production process were grouped into internal and external factors. Internal factors include manpower development, machine revolution, material choice and selection, management strategy, energy utilization/availability, information acquisition method, money/funding rate, and marketing strategy [7]. The external factors are related sustainability trend, global sustainability acceptable standard and industrial revolution sustainability [8].

II. METHODOLOGY

The manufacturing industry is a large industry that undertakes series of activities, which include the production of different items, machines, equipment etc. There are a range of sections in the manufacturing industry, from the managerial section down to production, maintenance and inspection departments. The manufacturing industry is ever changing. Due to the competition between corporations, industries, businesses, firms and organizations, there is always the desiring need for something new. Every industry or firm must have a competent management in place to ensure that the production process is always on the right track. In order for the manufacturing industries to compete favourably with one another, they must be innovative [9] A competitive manufacturing industry is an ingredient of sustainable development [10].

Sustainable development is a long term continuous development of society, aimed at satisfaction of humanity's need at present and in the future via rational usage and replenishment of natural resources, and preserving the earth for future generations [11]. In other palace, sustainable development means attaining a balance between environmental protection and human economic development and between the present and future needs [11]. In all cases, manufacturing (production) industries played a prominent role at achieving a sustainable development goal by 2030 [7].

In line with the sustainable development goal, production industries required a good transportation system (by land, water or air) which comprised automobiles, marines and aeronautics. Transportation industries have played a good role in sustainable development in the areas of safe transportation of raw materials and finished goods to/from the production industries [12] Good transportation system has enabled wastes elimination, and prompt availability of raw materials and other production resources as and when required for production activities, thereby improving resources utilization, procurement management and sustainability [13, 14, 15].

Developing countries need accelerated growth and the manufacturing industry provides the bulk of this transition to developed economies. This means a bulk of investment is necessary to develop infrastructure for the industries to thrive, reach their sustainable capacities and attain accelerated Gross Domestic Product (GDP). On this basis, strategic planning geared towards promoting adequate investment in the manufacturing industry is necessary [16].

The global demand for effective utilization of both humans and machinery is increasing due to wastage incurred during product manufacturing. Excessive waste generation has made entrepreneurs find it difficult to breakeven. The development of dynamic error-proof Overall Equipment Effectiveness (OEE) model for optimizing the operations of a complex production system is targeted at minimizing/eradicating generated wastes/losses [7].

The global mantra in the past four decades has culminated in the desire to achieve sustainability and sustainable development. This mantra has stemmed from concerns for the future, in terms of resource endowment, human health and the environment. Nigeria has yet to meet this goal as there are several challenges to sustainable industrial development [17].

2.1 Industrial Revolution

Technical advances also change the way humans produce things. The step into production technology, which was completely different from the past, is also called the industrial revolution. The new production technologies fundamentally changed the working conditions and lifestyles of people. What were the industrial revolutions and where do we find ourselves now? "From the First Industrial Revolution to Industry 4.0"[18].

Industry 0.0 to 0.9 dating back to around fifteen century, the Industrial Revolution was the transition to new manufacturing process using stone called stone-age. It was in terms of manufacturing a smaller number of various goods and creating local standard of living for some people. Stone are used in absence of the idea of manufacturing with machine. The first Industrial Revolution (Industry 1.0)began in the 18th century through the use of steam power and mechanization of production. What before produced threads on simple spinning wheels, the mechanized version achieved eight times the volume in the same time. Steam power was already known. The use of it for industrial purposes was the greatest breakthrough for increasing human productivity. Instead of weaving looms powered by muscle, steam-engines could be used for power. Developments such as the steamship or (some 100 years later) the steam-powered locomotive brought about further massive changes because humans and goods could move great distances in fewer hours[18]. Fuel sources like steam and coal made machine use more feasible, and the idea of manufacturing with machines quickly spread. Machines allowed faster and easier production, and they made all kinds of new innovations and technologies possible as well.

Second Industrial Revolution (Industry 2.0)began in the 19th century through the discovery of electricity and assembly line production. Henry Ford (1863-1947) took the idea of mass production from a slaughterhouse in Chicago: The pigs hung from conveyor belts and each butcher performed only a part of the task of butchering the animal. Henry Ford carried over these principles into automobile production and drastically altered it in the process. While before one station assembled an entire automobile, now the vehicles were produced in partial steps on the conveyor belt - significantly faster and at lower cost. The first Industrial Revolution represented the period between the 1760s and around 1840. This is where the second industrial revolution picked up. Historians sometimes refer to this as “The Technological Revolution” occurring mainly in Britain, Germany and America [19].

During this time, new technological systems were introduced, most notably superior electrical technology which allowed for even greater production and more sophisticated machines.

Indeed, the third Industrial Revolution (Industry 3.0) began in the ’70s in the 20th century through partial automation using memory-programmable controls and computers. Since the introduction of these technologies, we are now able to automate an entire production process - without human assistance. Known examples of this are robots that perform programmed sequences without human intervention.It began with the first computer era. These early computers were often very simple, unwieldy and incredibly large relative to the computing power they were able to provide, but they laid the groundwork for a world today that one is hard-pressed to imagine without computer technology. Around 1970 the Third Industrial Revolution involved the use of electronics and IT (Information Technology) to further automation in production. Manufacturing and automation advanced considerably thanks to Internet access, connectivity and renewable energy. Industry 3.0 introduced more automated systems onto the assembly line to perform human tasks, i.e. using Programmable Logic Controllers (PLC). Although automated systems were in place, they still relied on human input and intervention [18].

The fourth Industrial Revolution (Industry 4.0) is characterized by the application of information and communication technologies to industry and is also known as "Industry 4.0". It builds on the developments of the Third Industrial Revolution. Production systems that already have computer technology are expanded by a network connection and have a digital twin on the Internet so to speak. These allow communication with other facilities and the output of information about themselves. This is the next step in production automation. The networking of all systems leads to "cyber-physical production systems" and therefore smart factories, in which production systems, components and people communicate via a network and production is nearly autonomous. The Fourth industrial Revolution is the era of smart machines, storage systems and production facilities that can autonomously exchange information, trigger actions and control each other without human intervention.

This exchange of information is made possible with the Industrial Internet of things (IIoT) as we know it today. Key elements of Industry 4.0 include:

(a) Cyber-physical system — a mechanical device that is run by computer-based algorithms.

(b) The Internet of things (IoT) — interconnected networks of machine devices and vehicles embedded with computerized sensing, scanning and monitoring capabilities.

(c) Cloud computing — offsite network hosting and data backup.

(d) Cognitive computing — technological

platforms that employ artificial intelligence.
"Industry 4.0 starts to move towards Industry 5.0 when you begin to allow customers to customize what they want
In short, Industry 4.0 is a game-changer, across industrial settings. The digitalization of manufacturing will change the way that goods are made and distributed, and how products are serviced and refined. On that basis, it can truly lay claim to represent the beginning of the fourth industrial revolution.[18].

2.2 Emergence 5th Industry revolution (Industry 5.0)

Less than a decade has passed since talk of Industry 4.0 first surfaced in manufacturing circles, yet visionaries are already forecasting the next revolution — Industry 5.0. If the current revolution emphasizes the transformation of factories into IoT-enabled smart facilities that utilize cognitive computing and interconnect via cloud servers, Industry 5.0 is set to focus on the return of human hands and minds into the industrial framework.
Industry 5.0 is the revolution in which man and machine reconcile and find ways to work together to improve the means and efficiency of production. Funny enough, the fifth revolution could already be underway among the companies that are just now adopting the principles of Industry 4.0. Even when manufacturers start using advanced technologies, they are not instantly firing vast swaths of their workforce and becoming entirely computerized. The cost of a new product can be determined with the help of costing software for manufacturing industry. It automates the costing processes and accelerates the time to market on new products.
In addition to these pieces, Industry 5.0 integrates human creativity and robotic precision, working toward a unique solution that will be the demand of the next decade. Together, Industry 4.0 and 5.0 have created a roadmap that industries must follow in order to ensure sustainable and effective performance.[18].

2.3 Industrial Sustainability Measure

The effectiveness of operational level and management (EM) practices and their long-term impacts on material inventory was assessed using data from U.S. industrial facilities [20]. Demand-side mitigation solutions such as changing peoples' consumption behaviors can substantially help limit climate change. In manufacturing realm, promoting and directing consumption behavior of customers is good factor of encouraging sustainable industrial development [21].

Sustainability measures are being re-designed to provide a measurement of sustainability within the link of accountability [22]. Measuring and evaluating the performance of production process sustainability is still not a common practice in companies [23].

2.4 Production System Effectiveness (PSE)

PSE depends on availability rate, performance efficiency and quality rate. Therefore, PSE increases with increase of these three elements. Increase in availability rate reduces buffer inventories needed to protect downstream production from breakdowns and increases effective capacity. Increase in the rate of quality products means that there is less scrap and rework, reduces costs, and yields a higher rate of quality [24]. PSE is a complete performance measurement indicator. The industrial revolution in which production system effectiveness / productivity were been measured are enumerated in Table 2.1. In this study the choice of sustainable PSE was based on the three standards, this was rare in the past studies. [25].

Table 1: Sustainable Standard of Production System Effectiveness / Productivity

Sustainable Standards/ Classes	**Effectiveness/ Productivity Range**	**Sustainability Implication**
Industrial Revolution P(R)	0 – 0.5	I1.0 (Not sustainable)
	0.51 – 0.84	I2.0 (Fairly/averagely sustainable)
	0.85 – 1.0	I3.0 – I4.0 (Sustainable)

	≥ 1.0	I5.0 (Sustainable) (Felsberger et. al., 2020; Kareem et al. 2020)

2.7 Framework for Model Development

The productivity challenges were caused by both external and internal factors, individually and collectively. The identified internal and external factors are sustainable development trend, industrial revolution, and globally sustainable/acceptable standard. The block diagram that shows the relations among the internal, external and production system effectively is given in Figure 3.1.

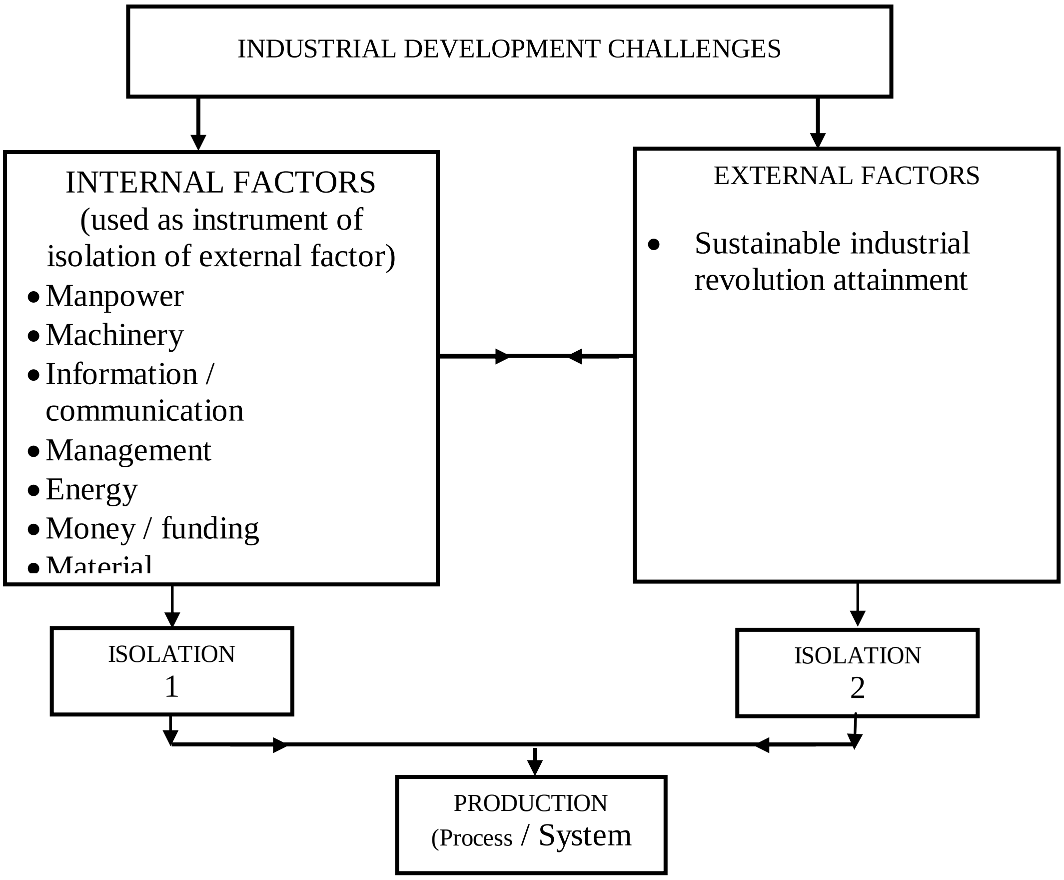

Figure 1: Block Diagram of Production (Process / System)

The challenges posed by the internal/external factors hindered attainment of the maximum obtainable productivity index of unity (1). That is for the N number of internal factors, productivity continued to decrease with increase number of factors N called challenges. Therefore, traditionally, productivity or production system effectiveness (PSE) was mathematical presented as (Eqn 1) was modified as in Eqn 2, to take care of the stochastic nature of the process.

$$PSE = APQ \quad (1)$$

$$PSE = P(S) = APQ \quad (2)$$

where,

$PSE\ is\ production\ system\ effectiveness$

$A\ is\ Availability$

$P\ is\ Performance$

$Q\ is\ Quality$

$P(S)\ is\ probability\ of\ production\ system\ (effectiveness)$

Eqns 1 and 2 are similar because their outcome always less than 1 but they are different because the former is static while the latter is probabilistic, its outcome can change in space and time. This indicated the real nature of the production system. On this basis, Eqn 2, on consideration of the stated challenges was modified as Eqn 3.

$PSE = P(S) = APQ < 1$ (3)

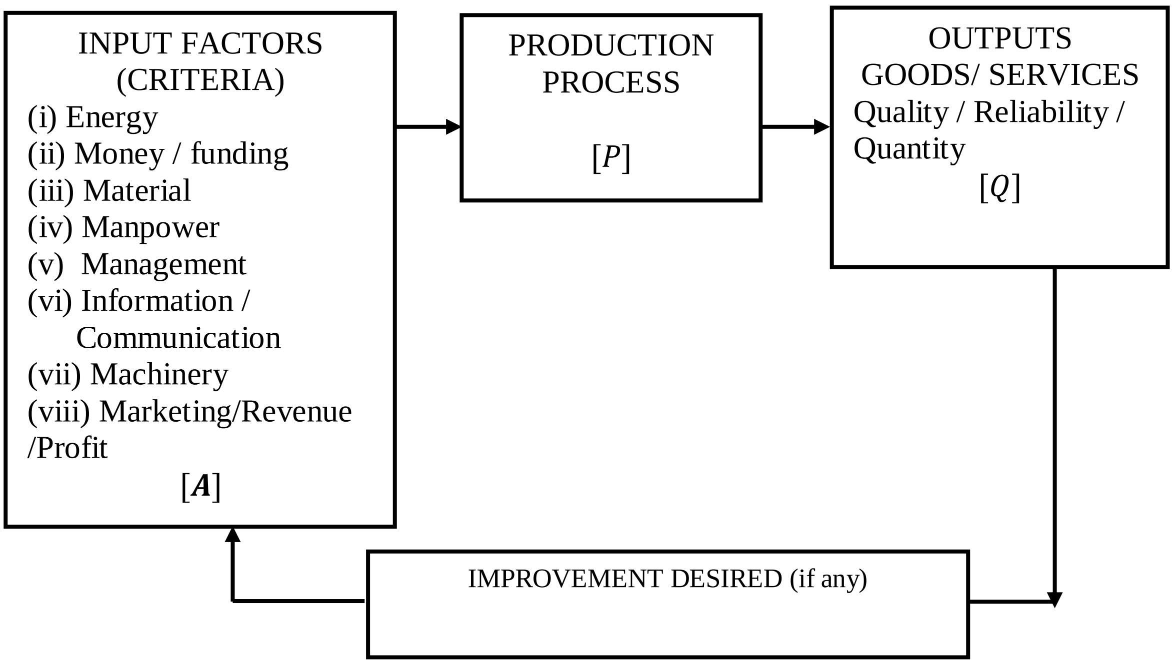

Figure 2: Block Diagram of propose Model Characteristic

The problem at hand is how to improve productivity such that external factors hindrance is mitigated. That is, industrial revolution, $P(R)$, which is termed exogenous variables are satisfied as presented in Eqns4.

$P(S) = APQ \geq P(R)$ (4)

where:

$P(R)$ *is industrial revolution*

The block diagram shown in Fig 3.2 depicted the improvement strategy developed at meeting the set standards, with the main objective of meeting the condition of productivity stated in Eqn5.

$P(S) = APQ = 1$ (5)

The modelling outcomes are summarized in Table 3.1. First, the initial (availability, A, performance, P, and Quality, Q) productivity measures were modified by productivity of the internal factors that affect production system effectiveness. Next, Production System Effectiveness $PSE/P(S)$ was determined under normal conditions. Then, further decision analysis under the influence of external factor. Finally, sustainability decision (sustainable or unsustainable) was made using industrial revolution class, $P(R)$.

Table 2: Summary of the Mathematical Model Development

S/n	Parameter	Traditional / Convectional (Old Model)	Definition of symbols
1	Initial condition of production process	$Availability\ A = \frac{Operation\ time}{Loading\ time}$	$A = Availability$
		$PerformanceP = \frac{Net\ Processing\ time}{Operating\ time}$	$P = Performance$
		$QualityQ = \frac{Processed\ amount - defect\ amount}{Processed\ amount}$	$Q = processed\ amount$
2	Sustainability evaluation		$P(R), Industrial\ Revolution\ \geq 0.85, 1.0$

2.8 Model Validation and Performance Test

Data were collected to test the efficacy of the model. Model was tested using first round of data collected (70 % of the data) while the second round of the data (30 %) was used for validation. Paired T-test statistics was used to test if there existed a significant difference of PSE (μ_2) and for a given production system (company).

Hypothesis:

$H_O: \mu_1 = \mu_2$

$H_1: \mu_1 \neq \mu_2$

Decision rule: reject H_0 if $P_{calculated} < p - value$.

Inference:

Since $P_{cal} < p - value$ there is enough evidence to reject.

2.9 Collection of Data

Relevant data were collected using questionnaire and oral interview conducted in five (5) selected companies, labeled A, B, C, D and E.. The data were collected on production process, working hours, downtime, product rejection, etc. these data were used for estimating relevant parameters as contained in the developed model. Estimated parameters include: Availability Rate, Production Process Performance, Quality rate, Production System Effectiveness (PSE), and decisions on production system process sustainability were made based on $P(R)$criteria established from the literature. The summaries and nature of the data collected from Company A was given in Tables 3.2

Table 3: Data collection on Availability, Performance, and Qualityof Company A

Company A												
Process line Product: Cement processing line/Eight (8) hours shift												
Input Factor	**Availability P(I) /hour = A**		**Performance P(p) /hour = P**				**Quality P(O)/quantities (kg) = Q**					
	Plants Time/(Set-up / h	**Loading Time= (Process + loading + off-loading) time /h**	**Process Time /h**	**Operating time (Cycle time)/h**			**Processed Amount/kg**	**Defect loses amount/kg**				
				Idling losses/h	**minor stoppage /h**	**Reduced speed /h**		**Rework losses**	**Defect losses**	**Start-up loses**	**Scrapped loses**	
Manpower	8	8	8	1	2	0.5	1,200	25	10	5	2	
Machinery	6	8	7	1	2	1	1,000	50	22	12	3	
Info./comm	8	8	8	0.5	1	1	950	15	5	5	1	
Management	6	8	7	0.5	0	1	700	20	14	5	2	
Energy	7	8	6	0.5	0	3	1500	22	12	5	4	
Money/fund	8	8	7	0.5	0	1	2000	50	15	7	5	
Material	8	8	7	1	0.5	0.5	1150	12	20	20	7	
Marketing	8	8	8	0.5	1	0.5	1100	11	20	18	2	
$PSE = APQ$	**0.9210**			**0.8806**			**0.9890**					
	$(0.9210 \times 0.8806 \times 0.9890) = \mathbf{0.8021}$											

III. RESULTS AND DISCUSSION

Summary of the Production System Effectiveness (PSE) results under traditional (APQ) and modified approach (MBA) are presented in Table 4.1. It can be revealed that traditional approach under equal weights has not produced sustainable outcomes in all companies investigated, while companies A, D and E had sustainable performance under weighted arrangement. The application of the modified Bayesian approach indicated a tremendous improvement due to integration of new production process information. In this case, production system effectiveness was sustainable in all companies in both normal and weighted scenarios.

Table 4.2 shows the summary of the Production System Effectiveness, PSE; and the corresponding decision outcomes (sustainable, fairly sustainable or unsustainable) for companies A, B, C, D and E, under competitive production environment with reference to sustainable trend, global acceptable and industrial revolution standard factors (Table 4.2).

Table 4: Normal Production System Effectiveness (PSE)

Company	Conventional/ Traditional Approach (APQ) (normal PSE, and weighed WPSE	Industrial revolution standards	Sustainability Revolution class
	$PSE = APQ$	≥0.85, 1.0	
A	0.8016	I2.0	Fairly sustainable
B	0.4849	I2.0	Not sustainable
C	0.3430	I1.0	Not sustainable
D	0.6970	I2.0	Fairly sustainable
E	0.7128	I2.0	Fairly sustainable

IV. CONCLUSION

A model that capable of resolving sustainable productivity challenges of production industries was established in this study. The model was tested using data obtained from five Nigerian Companies. Production System Effectiveness (PSE) factors: Availability (A), Performance (P) and Quality (Q) were determined using Traditional Approach (APQ) in order to arrive at manageable decision making criteria under normal and/or competitive production environment. The results obtained from the model revealed that varying system sustainability decision making was due to standard of measure. There was significant difference on PSE in many industrial revolution cases tested, but these differences had little or no effect on optimum decision making in all companies investigated.

The mathematical model developed under Traditional Approach for PSE shows that all the companies selected for investigation were not-sustainable while company A, D and E were sustainable under Traditional Approach for WPSE. However, the differences identified had little or no effect on sustainable decision making in all companies investigated.

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REFERENCES

[1] A. F. Adenikinju,"African Imperatives in the New World Order: Country Case Study of the Manufacturing Sector in Nigeria, in O.E. Ogunkola A. and Bankole (eds.), *Nigeria's Imperatives in the New World Trade Order*. Nairobi". African Economic *Research Consortium and Ibadan: Trade Policy Research and Training Programme. 2005.*

[2] World Bank, "Investment Climate Survey Data"*Washington, DC: World Bank, 2006.*

[3] O. Agbu, "The Iron and Steel Industry and Nigeria's Industrialization: Exploring cooperation with Japan". *Institute of developing economics, Japan external trade organization, 2007.*

[4] NPC, "Nigeria Vision 20:2020*: Economic Transformation Blueprint. National Planning Commission, Abuja, 2009.*

[5] International Institute for Sustainable Development [IISD],"Business Strategy for Sustainable Development"*Leadership and Accountability for the 90s, in conjunction with Deloitte &Touche and the World Business Council for Sustainable Development, 1992*

[6] A. J. Yakubu, B. Kareem, and B. O. Akinnuli, Computer Aided System for Crankshafts Failure Rate of Automobile Based on Distance' Travel and Age *Open Access Library Journal, Volume 5, Pp1-14, 2018.*

[7] B. Kareem, B. S. Alabi, T. I. Ogedengbe, B. O. Akinnuli, O. A. Aderoba, and M. O. Idris, "Development of OEE Error-Proof (OEE-EP) Model For Production Process Improvement".*The Journal of Engineering Research (TJER), Vol. 17, No. 2, Pp59-74. 2020.*

[8] A. Ramaisa, and K. P. Ataul, "The Role of Artificial and Non-artificial Intelligence in the New Product Success with Moderating Role of New Product Innovation" *A Case of Manufacturing Companies in China. Pp1-14, 2021.*

[9] O. S. Fayomi,I. G. Akande, R. T. Processo, and O. S. Ongbali, "Sustainable need in Manufacturing Industry in Nigeria toward Quality, Policy and Planning". Cite as: AIP Conference Proceedings 2123, 020072 (2019); https://doi.org/10.1063/1.5116999

[10] B. Dal,P. Tugwelland R. Greatbanks,"Overall equipment effectiveness as a measure of operational improvement"*International Journal of Operations & Production Management*, vol. 20, no. 12, pp. 1488–1520, 2000.

[11] S. Vinceta, "An Impact and Challenges of Sustainable Development in Global Era. *Journal of Economics and Development Studies"*2(2), 2014.

[12] B. Kareem, and A. J. Yakubu, "Modelling Failure Rate of Automobile Crankshafts based on Distance Travelled and Age".*International Journal of Advance Industrial Engineering*, Pp210-217, 2017.

[13] S. Shahbazi,M. Salloum, M. Kurdve, and M. Wiktorsson, "Material Efficiency Measurement: Empirical Investigation of Manufacturing Industry". *Procedia Manuf., vol. 8, no. October 2016, pp. 112–120, 2017.*

[14] K. Silaipillayarputhur, "Process Safety Management in Manufacturing Industries a Review". *No. 5, January, 2018.*

[15] N. J. Virbahuand M. Devesh, "Blockchain for Supply Chain and Manufacturing Industries and Future It Holds" !,*Int. J. Eng*. Res., vol. V7, no. 09, 2018.

[16] V. Micicand N. Jankovic, "Investment in the manufacturing industry of Serbia". *Bankarstvo*, vol. 46, no. 4, pp. 52–73, 2017.

[17] S. M. Abiodun, F. A. Elizabeth,D. O. Inioluwa, O. O. Grace, N. A. Kehinde, O. O. Ibikunle, T. F. Olutope, W. M. Oladotun and K. A. John-Felix, "Greening Nigeria's Economy for Industrial and Environmental Sustainability" Polyurethane production as a test case. *Article in Natural Resources Forum*,

2019.

[18] Eurostat Press Office [EPO], (2021): Industrial Production, *eurostat-pressoffice.europa.eu*, 2021.

[19] A. Felsberger, F. Qaiser, A. Choudhary, and G. Reiner, G. "The impact of Industry 4.0 on the reconciliation of dynamic capabilities" Evidence from the *European manufacturing industries. Production. Plan. Control, 2020.*

[20] Z. Xingxing, and Y. Cong, Sustainable Production and Consumption, an Empirical Examination of the Effectiveness and Sustainability of Operational-level Environmental Management Practices in U.S. industry. *Journal Science direct. Volume 33, Issue 11-12, Pp 1-14, 2022.*

[21] M. Johann, Majer, A. Heike, Henscher, K. DeniseFischerand F. Daniel, "The Effects of Visual Sustainability Labels on Consumer Perception and Behavior: A systematic review of the empirical literature. *Journal of Cleaner Production, https://doi.org/10.1016/j.spc.2022.06.012, Pp 1-10. 2022.*

[22] A. Jill, D. Federica, G. Andrea,A. Sonia, L. T. Ilaria and S. Lorena,"Exploring the Effectiveness of Sustainability Measurement" Which ESG Metrics Will Survive COVID‐19? *Journal of Business Ethics*.https://doi.org/10.1007/s10551-022-05183-1 August 2022. Pp 1-18, 2022.

[23] I. Marina,C. Baumer, S. Weslynne, L. Ashton and M. S. Campos1, "Measuring the Adoption of Circular Economy in Manufacturing Companies: The Proposal of the Overall Circularity Effectiveness (OCE) Index"*Journal of Springer Nature Switzerland AG 2022. https://doi.org/10.1007/s43615-022-00188-4, Pp1-24, 2022.*

[24] B. O. Akinnuli, A. J. Yakubu and A. A. Adeyemi "Computer Aided System for Uni-functional Job Shop Machine Selection Based on Production Cost and Technology Advancement'. *Advances in Research* 5(3: Pp1-12, 2015.

[25] Z. Feifeng,W. Zhaojie,E. .Zhangand L. Ming .(2021): "K-adaptability in robust container vessel sequencing problem with week".*International Journal of Production Research https://doi.org/10.1080/00207543.2021.1902014, 2021.*