The Prospect of Industry 4.0 as a Contributor towards Economic Diversification and Growth in African Nations

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Abstract

It is widely acknowledged that the lack of economic diversification has been a stifling factor with respect to economic growth in many African nations. Complacency has been a contributor towards the lack of economic diversification in the region, as seen in oil producing nations that have depended almost entirely on the oil and gas sector whilst neglecting other sectors. The deflated oil price in recent times had devastating effects on the economies of a number of nations in Africa including Nigeria, Angola and Ghana.

Though not a dominant force in Africa, there has been an emerging boom experienced in recent times in the manufacturing sector in Africa (The Economist 2014). One can argue that Industry 4.0 (Smart Manufacturing) has the potential to contribute towards sectoral growth, which in turn can contribute towards economic diversification and development in the region. This paper investigates the prospect of smart manufacturing in African nations as a contributor towards their economic growth and diversification.

INTRODUCTION

The lack of economic diversification has been a hindering factor with regards to the economic growth of nations in Africa. A number of nations in Africa are almost completely dependent on either the agricultural or oil and gas sector. One can argue that the boom experienced in the latter, overtime led to complacency on the part of some of the governments within the region including the government of Nigeria, Angola, Egypt and Libya. The nonchalance exhibited by the governments of these nations towards developing other sectors allowed for an increase in the dependency on oil, whilst other sectors were largely ignored. The deflated oil price in recent times had a significant negative impact on the economies of many oil producing nations that depend almost entirely on oil including Nigeria, Ghana and Angola. The ramifications of the deflated oil price were quite complicated, as its impacts were felt globally and not only felt in the oil producing states (Obstfeld M., Feretti, G., and Arezki, R. 2016).

Though farming and services are still a dominant force in Africa, there is an emerging boom in the manufacturing sector in Africa. This boom remains a regional phenomenon irrespective of the emergence of new industries in the region (The Economist, 2014). Some may argue that the growth of the manufacturing industry in Africa is likely to fizzle off. However, in contrast to this pessimism, statistics show that the manufacturing sector’s contribution to GDP in Sub Saharan Africa has been consistent at 10-14% in recent years (Economist 2014). Furthermore, according to Balchin, N., et al. (2016), African manufacturing grew from $73 billion to $98 billion (in 2005 prices) in 2014, which is the equivalent of about 3.5% annual growth. In addition, manufacturing exports doubled from $50 billion in 2005 to over $100 in 2014 (in 2005 prices).

Based on the above analysis, one can argue that the need for economic diversification is paramount. This paper investigates the prospect of smart manufacturing in African nations as a contributor towards economic diversification and growth.
Smart Manufacturing (Industry 4.0)

“Smart Manufacturing is the dramatically intensified and pervasive application of networked information-based technologies throughout the manufacturing and supply chain enterprise” (Davis, J., Edgar, T., Porter, J., and Sarli, M., et al., 2012).

Industry 4.0 is NOT the fourth industrial revolution. However, it has the propensity to lead to a fourth industrial revolution. Industry 4.0 introduces the internet of things alongside a number of digital technologies including big data analytics, industrial cloud and cyber physical systems among others to allow for a significant transformation in manufacturing. Industry 4.0 introduces a decentralized model in manufacturing which allows for decentralised decision making as well as a high level of autonomy of machines and processes.

Key Constituents of Industry 4.0 comprise of:

- Internet of Things (IoT)
- Cyber Physical Systems (CPS)
- Big Data Analytics
- Industrial Communication Technology
- Industrial Cloud

**Internet of Things (IoT):** This is the implementation of the internet in manufacturing production as well as through other value chain networks. IoT allows for the remote accessibility of objects or machineries (sensed or controlled) across existing network infrastructures. Other benefits of IoT include;

- Swifter manufacturing of new products
- More dynamic reaction to product demand
- Real time optimization in manufacturing processes and supply chain networks, through linking various systems including machineries, sensors and control systems.
- Tracking of assets in factories
- Improved analytics
- Increased efficiency, accuracy and reduction in human intervention

**Cyber Physical Systems (CPS)**

This technology creates a virtual copy of a factory floor and physical processes and merges this virtual world with the real world to allow objects or machines to communicate with one another and humans in real time. CPS also allows for decentralized decision making.

**Big Data Analytics**

This allows for the early detection of defects or production failure, thus enabling its prevention. Furthermore, big data analytics contributes towards machine learning which in turn makes autonomous decision making a possibility. Predictive maintenance can be achieved by the implementation of big data analytics. Ultimately, the power of big data analytics can be harnessed to achieve significant increase in productivity, improvement in quality of products as well as allow for substantial cost and time savings.

**Industrial Communication Technology**

Industrial communication technology allows communication between machines, humans and objects within a factory floor. It also makes it possible for data to be remotely disseminated and received from remote location(s).

**Industrial Cloud Technology**

The implementation of Industry 4.0 leads to the generation of large amount of data. These data would need to be stored and made available for utilisation in real time. Industrial cloud technology allows this to be possible.

**LITERATURE REVIEW**

**Smart Manufacturing (SM) Defined by Automation Giants**

The author explored the definition of Industry 4.0 by two automation giants “Bosch” and “Siemens”, which has been briefly explained below.

**Bosch’s Definition of SM**

Seven key features where established by Bosch Rethroth GB (2016) based on their pilot projects. These features include;

**People as key Players**

This feature enhances the level of individualisation of work environment as people are supported by digital assistant functions and smart workplace design. This feature includes a system that can recognise workers and produces work environments that are designed specifically to each individual worker.

**Distributed Intelligence**

Tasks can be carried out independently in accordance to specific commands made possible by decentralised intelligence automation alongside software. This intelligence allows for flexible facilities that can automatically adapt to changing market and manufacturing conditions.

**Fast integration and Flexible Configuration**

The plug and produce feature enables people, processes, machines and the flow of products to be networked collectively. Multiple processes including configuration/reconfiguration, commissioning and integration are simplified by software tools.
Open Standards
This allows for the exchange of information in the value creation network.

Virtual Real-Time Representation
There are a real-time virtual representation of machine, objects and processes within Bosch’s smart factory. These virtual representations are directly linked to the physical components and objects, providing data for real time processes enhancement.

Digital Life Cycle Management
Processes from development, production to recycling are managed to bring about cost and time savings, allowing for products to be made available to the market quicker.

Secure Value Creation Network
This is a protection feature that protects people from machinery related hazards. This feature also offers protection to the production facility including protection from cyber-attacks and faults from surrounding environment.

Siemens Definition of SM (Siemens 2017)
Siemens’ Digital Enterprise Suite offers a complete package that integrates and digitalizes an entire value chain including production planning, production engineering, production execution and services
All key facets in the manufacturing process have been integrated into Siemens’ Digital Enterprise Suite” including Manufacturing Operations Management (MOM), Product Lifecycle Management (PLM) and Totally Integrated Automation (TIA).

Industrial Software and Automation Portfolio
Siemens’ software and automation portfolio comprise of the “Cyber Physical Systems (CPS)”, which is a technology that allows for decentralized decision making. There is also the digital twin, a facet of CPS that creates a copy of a factory floor and real life processes in a virtual world, making it possible for objects or machines to communicate with one another and humans in real time.

Industrial Communication Technology
Siemens’ industrial communication technology does more than aid communication between machines, humans and objects within a factory floor. It also allows for data to be remotely disseminated and received from remote location(s).

Industrial Cloud and Big Data Analytics
Complex processes in Industry 4.0 means that numerous data are generated. Most of these data would have to be stored, processed and utilized in real time. Industrial cloud and big data analytics makes this a possibility.

Industrial Security
Siemens’ industrial security is very vital as increased networking makes data more susceptible to cyber-attacks.

In summary both Bosch and Siemens have within their smart factories the key Industry 4.0 technologies including, big data analytics, CPS, IoT, industrial cloud and industrial communication technology. These technologies are essential to the functionality of a smart factory as they enable other elements of Industry 4.0 to function including autonomous robots, predictive maintenance, and digital performance manager, among others.

Global Industry 4.0 Statistics
Industry 4.0 has gone beyond being a future trend and is gradually becoming a reality worldwide. Many organisations are gradually starting to integrate Industry 4.0 technologies in their operations. An amalgamation of IoT, cloud computing, big data analytics, 3D printing, advanced automation, sensors and more are now increasingly being implemented to bring about significant transformation in organisations around the world. Organisations around the world are already beginning to benefit from advance level of digitalisation and integration (PWC 2016).

According to a survey carried out by PWC in 2016 involving over 2000 companies from 9 major industrial sectors and 26 countries across the world, by implementing smart manufacturing initiatives organisations are anticipating a 3.6% p.a. reduction in operational costs as well as an annual increase in efficiency of 4.1%. Chart 2 and 3 below demonstrates cost reduction in percentage per annum until 2020 and cost reduction in US$bn p.a. until 2020 respectively. Some of the aforementioned cost savings statistics are possible in cases where organisations have in place integrated planning and scheduling, as this approach combines data from within the enterprise (e.g. data from sensors and data from Enterprise Resource Planning Systems) with data from horizontal value chain partners including data pertaining to inventory levels and changes in the demands of customers (PWC 2016).
Chart 2 (PWC 2016)

Cost reduction in % p.a. until 2020

Chart 3 (PWC 2016)

One can argue that efficiency gains of the magnitude forecasted can create a whole new competitive landscape, leaving companies that fail to invest early in vulnerable positions with respect to competing in today’s digital climate. Therefore, it is imperative that organisations have strategies put in place early enough towards improving their level of digitalisation.

Findings based on data from participants in PWC’s 2016 survey show that organisations anticipate an addition 2.9% p.a. until 2020 in digital revenue. This statistic is attributed to strategies employed by companies towards augmenting their existing portfolio as well as introducing new products with digital features. Digital services enabled by data analytics are deemed to be vital contributors towards generating significant revenue. Furthermore, companies are looking to harness real time data in manufacturing personalised products and customised solutions. This would contribute significantly to the manufacturer margins in comparison to mass manufactured products. Product customisation can also help to build stronger relationships with customers.

86% of participants in PWC’s survey are anticipating gains with respect to lower costs and added revenue by 2020. Furthermore, at least 33% of participants across every sector expect to achieve gains in the form of efficiency, cost savings and additional revenue of over 20%.

Analysing the Level of Digitalisation Growth by Country and Region

The nations further ahead with respect to digitalising their internal operations as well as digitalising partnering across their horizontal value chain are Germany and Japan (PWC, 2016). Furthermore, digital transformation within the aforementioned nations are viewed mainly with respect to gains in quality assurance, operational efficiency and cost reduction. These gains are attainable through significant investment in digital technologies as well as employee training.

PWC’s survey findings established that in the US companies are looking to invest more in developing disruptive business models, as they intend to digitalise their products and service portfolio. The primary focus for organisations in the US is on digital revenue growth.

Additional findings by PWC (2016) established that China’s industrial companies are anticipating significant cost reduction and increase in digital revenues by 2020. Furthermore, companies in China are quite flexible and are willing to embrace digital technologies. One can argue that china would gain the most when they automate and digitise labour intensive manufacturing processes.

Demonstrated below are the anticipated growths in digitalisation by 2020 based on regions according to PWC (2016). The region Americas is expecting the most growth in digitalisation at 42% by 2020 followed by the combined regions Europe, Middle East and Africa, expecting a 41% growth in digitalisation by 2020. At 31%, Asia Pacific is the region with the least anticipated growth in digitalisation by 2020.

Anticipated Growth in Digitalisation by 2020 in Americas (PWC 2016)
Anticipated Return on Investment for Industry 4.0 Projects

Investing in Industry 4.0 technologies can be quite expensive. Therefore, it is important that return on investment on Industry 4.0 projects is assessed. Findings according to PWC, (2016) on anticipated return on investment of participating organisations across every sector are;

- Majority of the participants (55%) anticipate a return on investment for their Industry 4.0 projects within 2 years.
- 37% of participants expect a return on investment for their industry 4.0 project within 2 to 5 years.
- Only 8% of participants are of the notion that a return on investment for their industry 4.0 project would take over 5 years.
The figure below demonstrates the above statistics.

Anticipated Return on Investment (PWC 2016)

These statistics are quite encouraging, as it shows that the majority of participating organisations believe that they would start to see a return on their Industry 4.0 projects investment in as early as 2 years. On the other hand, as little as 8% of participants are of the notion that it would take over 5 years for them to see a return on their Industry 4.0 projects investment.

PROSPECT OF INDUSTRY 4.0 IN AFRICAN NATIONS

Africa’s large population presents a potential market for investment. Nations within the continent can make the most of both their large domestic and regional markets to bring in foreign manufacturing companies. The emergence of the middle class in African nations presents an opportunity for the domestic market and industries like the fast moving consumer goods (FMCG). This also presents an opportunity for the uptake of advanced manufacturing across various industries, which would allow for significant infrastructure upgrades. The prospect of leapfrogging and its benefits are enormous. Adopting newer trends like Industry 4.0 gives the region a chance to compete in the digital climate of today. There is also the prospect of creating new business models as well as new digital products, services and solutions in organisations within the region.

Based on the statistics presented in this paper, one can establish that Industry 4.0 has the potential to bring about significant development of the manufacturing sector in African nations. Thereby, allowing for sectoral growth which in turn can contribute to economic diversification, as African nations with ample organisations that implement Industry 4.0 can look towards the manufacturing sector as an important contributor to their GDP. Ultimately, the proper implementation of Industry 4.0 on a large scale has the potential to contribute significantly to the economic growth of the nations in Africa where it is implemented and potentially the region as a whole.

Prerequisites for the Adoption of Industry 4.0 in African nations

Government Support

Manufactures around the world have been on a constant race to implement the most novel digital technologies as a measure to attain significant gains including efficiency, cost savings and revenue generation among other gains associated with the implementation of digital technologies. It is of utmost importance that manufacturers in Africa embrace implementing digital technologies as they will face the problem of being left far behind in the race and not being able to compete if they fail to do so. Judging by the recent technological climate, one can argue that the late adoption of new technologies can prove quite detrimental to the region economically and otherwise.

It is imperative that the governments within the region pay special attention towards providing an ideal environment for organisations to quickly adopt digital technologies. Governments of many African nations would have to take a more active role in investing in the manufacturing sector as this has the potential to help drive productivity and contribute towards sectoral growth as well as economic diversification and development. Furthermore, the implementation of initiatives by the governments of African nations towards promoting Industry 4.0 can prove vital in growing the manufacturing sector. In addition, as a measure to encourage the uptake of Industry 4.0, the governments of African nations
can offer incentives of some sort to organisations that are interested in building digital enterprises.

Commitment to Investment

It is imperative that the governments of African nations as well as organisations in the region invest amply towards Industry 4.0 as its early adoption is important to allow for the ability to compete in today’s digital climate. Failure to invest can prove detrimental not just to businesses in the region but also to the economies of nations in the region and possibly the region as a whole.

The area of focus with respect to investment would mostly be in digital technologies including sensors, software and connectivity devices among others. However, investing in people is of great importance as skilled individuals would be needed in order to ensure the full potential of Industry 4.0 is achieved in the region. Organisations would have to invest in training employees as well as invest in the necessary organisational changes that would present itself as a prerequisite when implementing Industry 4.0. Change management would be necessary at this stage.

Finally, it is of great importance that the governments of nations within the region focus on educating and training their youth population in digitalisation as their training and development would prove vital.

Trust in Digital Technologies

The introduction of novel digital technologies as well as the expansion of digital ecosystems has presented itself at a great cost of digital susceptibility. This is often the case when the appropriate security measures are not put in place. Therefore, organisations must take a meticulous and proactive approach towards data security and other matters that pertain to cyber security. Ample digital security is necessary when building a digital enterprise. In essence, there has to be trust in digital technologies in order for the full potential of Industry 4.0 to be achieved in Africa.

Increase in Awareness

The level of awareness of industry 4.0 and its numerous benefits at organisational, national and regional level seem to be quite low among African manufacturers at the moment. Ample efforts need to be made to educate and support organisations within the region to achieve a level of digitalisation that can contribute towards economic growth and diversification. African manufacturers need to be aware of the ramifications of Industry 4.0, as negligence would come at a cost of being left behind in the digital race. It would pose a strong argument that the effects of being left behind in the digital race can prove detrimental to the economy of the region.

Change Management

The attitude of organisations as well as that of the governments of African nations does not seem to reflect that there is ample awareness of the necessity for the early implementation of advance manufacturing in organisations within the region in order to compete at a high level. It seems that the inevitability of a global shift to Industry 4.0 is yet to be embedded in the mind-set of African manufacturers and governments. Adopting and adapting to Industry 4.0 early is important as organisations that adopt and adapt the quickest would have a competitive edge. Change management would play a pivotal transitionary role in the adoption and adaptation process.

Potential Risks and Mitigating Strategies

Although the industry 4.0 forecasts are very promising, there are potential risks associated with its implementation in Africa. Therefore, it is rational that one investigates these risks and put forward mitigating strategies.

The table below pin points some potential risks and mitigating strategies with respect to the implementation of Industry 4.0 in African nations

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<tr>
<th>Potential Risks</th>
<th>Mitigating Strategy</th>
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<tr>
<td>1. Not an Avenue for Significant Job Creation</td>
<td>1. The region would have to look to developing other sectors and industries to create jobs.</td>
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<tr>
<td>The introduction of Industry 4.0 eliminates the prospect of significant job creation in manufacturing, as IT would be at the forefront of things. Therefore, Industry 4.0 is not seen as an avenue for significant job creation in the region.</td>
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<td>2. Socio Economic Impact</td>
<td>2. There will be the need to train and upskill workers within the region, so as to depend less on expatriates from other parts of the world. This would allow for more indigenous people to become skilled and grant them access to certain opportunities available to skilled individuals.</td>
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<tr>
<td>Advanced manufacturing requires educated and high level skilled workers to make it a possibility in the region. These individuals would earn significantly higher and have significantly better opportunities in comparison to the unskilled workers in the region. This would in turn contribute to the level of disparity that exists between skilled and unskilled workers in the region.</td>
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CONCLUSION

Several nations in Africa including Nigeria, Angola, Ghana, Mali, Congo and Cameroon have failed to diversify their economies, thereby stifling the growth of their economies. According to The Economist (2014), there has been in recent
times an emerging boom in the manufacturing sector in Africa. Therefore, it is logical for nations within the region to capitalise on this development to diversify and grow their economies.

Industry 4.0 has transcended beyond being a future trend, as organisations are starting to benefit from the implementation of Industry 4.0 strategies and technologies. Global statistics on Industry 4.0 are quite promising, as more organisations around the world are beginning to harness the power of digitalisation to bring about significant transformation in their businesses.

Findings by PWC (2016) states that nations that have so far made the most progress with regards to digitalisation across their internal operations and digitalisation with regards to partnering across their horizontal value chain are Germany and Japan. Meanwhile many companies in the Unites States are focusing on investing in disruptive business models as they are looking to digitise their products and service portfolio. Organisations in the United States are more focused on revenue growth. In addition, based on findings by PWC (2016), one can argue that China would stand to gain the most from implementing industry 4.0 once labour intensive manufacturing processes have been automated and digitalised. Further statistics by PWC (2016) based on regions show that Americas seem to be leading in terms of anticipated growth in digitalisation by 2020 at 42% growth, followed by a combined Europe, Middle East and Africa at 41%, while Asia pacific is anticipating 31% growth in digitalisation.

Given the promising forecasts of industry 4.0 around the world, one can strongly argue that Industry 4.0 has the prospect of contributing towards economic diversification and development in African nations. Prerequisites for the implementation of Industry 4.0 in Africa include government support, commitment to invest, trust in digital technologies, increase in awareness and change management among others. Early investment in industry 4.0 is necessary if the region wants to compete in today’s digital climate. It is necessary that the governments of nations within the region play a more active role in providing an ideal environment for organisations to quickly adopt digital technologies. Change management would be pivotal in the implementation of Industry 4.0 in organisations in Africa as it would help in the transitioning process.

Although the benefits of Industry 4.0 are promising, there are potential risks associated with its implementation in the region including the fact that it is not an avenue for significant job creation in the manufacturing sector, as Industry 4.0 requires skilled individuals. In light of this, the region would have to look towards developing other industries to create jobs. There is also the risk of the socio economic impact associated with the implementation of Industry 4.0 in Africa, as its implementation would contribute to the disparity that exist between skilled and unskilled workers in the region.

Potential Future Work

- Carry out a broad study using primary data from organisations within Africa to assess the level of digitalisation of organisations within the region.

REFERENCES


