Sustainable Supply Chain Management: Impact of Practice on Manufacturing and Industry Development

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Abstract-
Green supply chain, cleaner production, and re-engineering practices are nascent sustainable initiatives, combined with the integration of new and developing technologies to revolutionalize industry operations in the near future. The understanding and full application of these techniques are yet to be fully grasped, especially as it pertains to different organizations culture’ operational structure and business goals. The diversity in Cyber-physical systems (CPS), autonomous vehicles, robotics, additive technologies, and alternative energy systems, in the manufacturing sector, have received extensive research over the last decade, with the promise to replace humans in future supply chain. The present paper is an exploratory assessment that evaluates sustainable technology initiatives in alignment with Sustainable Supply Chain Management (SSCM). Our inferences are based on viable implementation strategy, impacts, challenges, and the scope of applicability for increased productivity in the near future. In conclusion, we share on how the promulgation and proper management of new and developing industrial technologies are essential to maximize time, minimize cost, and improve the value of employee commitment, and customer contentment.

Keywords: Industry, Technology, Sustainability, Supply chain management

1. Introduction
It is promising as technological advancement would continue to improve into the future, the question is asked, to what extent do the tendencies support sustainability and how securely the existing technologies or the decision to adopt new ones, improve product delivery, material handling and organize storage without causing harm in the immediate environment. As such, maximize profits while meeting societal satisfaction. The pursuit of growth and development; innovations, technological integration successes, and coupled with standardization frameworks have become mechanisms for increasing productivity in today’s industry [1]. (i.e., The Social Responsibility and Accountability Standards; ISO 26000, SA 8000 respectively and the Environmental, Quality, Energy, and Risk Management Standards; ISO 14001, ISO 9001, ISO 5001, ISO 31000, without failing to mention the Business Community Standard; ISO 22301, respectively). Supply chain management combines events which bring logistics and manufacturing/service operation to a coordinated bearing where resources are transformed and utilized to meet specific demands. Literature has presented sustainable supply chain management as in Ref. [2]–[4]. Sustainable development as regards to economic, environmental and social security cannot be disjointed if the clamor for climate protection and social well-being were to be emphasized as much [5].
The body of the present paper continues with literature and highlights of sustainable supply chain concepts and impact of emerging technological initiatives, applicable in different industrial sectors, and the envisaged benefits or the barriers, as per when to be implemented. In subsequent chapters, the paper details more about the argument that quantum leap technologies are quintessential for time and cost savings.

2. Literature: Emerging Industrial Technological Initiatives

The fast-growing trend of Information Communication Technology (ICT) integration in industries has increased tremendously and facilitates logistics and production operations. In order to drive a sustainable supply chain management, factors embedded in the logistics processes (to manage information, items, cash, and abstraction while considering the mechanism of how, where and when) must interplay with the supply chain management in itself. Real-time process control has found beneficial use in manufacturing across many industries for performance optimization and minimizes unscheduled downtime with improved quality. Process control, also, is done using the information flows and mostly through ICT. The economic practice of enterprises and the implementation of logistics goals is feasible, primarily through management strategies, where the use latest innovations to acquire, and process, or transmits information; through the application of technological changes [6]. Researchers [3], [7] support the pivotal role of information systems about enterprise resource planning and electronic data interfacing within a business supply chain network to increase productivity. Fischer (2017), proposes an approach in line with efficient equipment which is network-controlled and via sensor technology to drive the logistics process for urban transport systems.

Radio Frequency Identifier (RFID) systems, barcodes, and usage of other electronic tags are pivotal for product tracking in real-time which forms part of the consideration for strategic managerial approach, and advantageous for determining specific product location at any given time in the supply chain. RFID tags on the manufacturing component provide easy retrieval and are essential for future supply chain according to Qi et al., (2016). Ma et al., (2015) has investigated the potential of RFID technology to track and trace items in a large scale distribution network. The idea behind traceability is to provide productive monitoring and withdrawal of product in case of any abnormality timeously and only for the contaminated lot so that a single anomaly would not affect a whole lot of products.

Digital evolution through the development of the Internet of things (IoT) ideology is rapidly transforming global perspective on trade, manufacturing, process and service operations. Investigations concerning the integration of CPS in manufacturing for sustainability performances have also received insight by the Trentesaux and Prabhu, (2014), specifically for factory production-line energy conservation. There is assurance that the CPS will gain benevolence in the future, in areas of smart manufacturing and proffer dexterity in operations and sustainability in the supply chain process [10].

Lean manufacturing which in recent times have gained popularity as one of the most conservative approaches to manage waste within the production factory [11] will contribute significantly to the reduction of solid waste of more than 1.3 billion tonnes annually [12]. Additive technologies are also taking over the future of Manufacturing production operations [13], [14] through 3-D Printing, by utilizing a variety of sustainable material to develop components and new parts [15]. From the energy perspective, the manufacturing sector uses
33% of world energy produced and contributes up to 38% of CO₂ to the global carbon emission footprint [4]. The above submissions are not good reports in any case, as such require modern technological development that allows the combination of alternative materials, renewable energy sources, smart and energy sufficient equipment or infrastructures.

3. Methodology
A case study investigation was carried out on three medium sized ceramic manufacturing company, one of which is selected from Nigeria, South Africa, and Uganda. The reason was to investigate the impact of sustainability practices to facilitate the organization's effectiveness and promote production operations. Data collection strategy was through simultaneously observing and taking notes to gain a clear perception of the company’s activities. Open and closed-ended questions where designed and framed such that the structure of the themes provides feedback on current organizational performance. Also, the resolve on expectation for further improvement motivated the expert consultation section (Professionals in sustainable engineering and innovation: four professors and thirteen academic doctors participated). A total of ten persons from each firm provided viable information’s during the questionnaire exercise, making a total of 47 people that participated in the entire process. Correlation between the insights from the data supplied by the organizations was conducted to establish connections to understand the influence of sustainable activities, while emphasizing technologically enabled processes, thus identified and discussed.

4. What is learned and discussion
4.1 Operational Excellence and Sustainability Consideration in the Manufacturing Industries
The fusion of ICT and new mechanical systems are breaking barriers in the transport supply chain; solving traffic delays and promoting emission control in the sector. The development of automobiles which operates on alternative energy sources and autonomously driven vehicles is a revolution waiting to take the world by surprise. Also, production will become more effective and carried out more efficiently, and in a sustainable manner. While storage, monitoring, delivery services, and customer order oriented services will be coordinated within the click of a button. Delivery of the right product, at the right time, place and of the right amount will also become a great concern. Hence, in an approach primarily known as the Efficient Consumer Response (ECR), the most efficient and reliable technology is required. The use of most robust technologies; drones, robots or in other cases cloud computing to coordinate businesses shall change the playing field for manufacturers, as well, product delivery and lead business competitiveness in the future. Not to mention the role of mobile telephone and other handy electronic devices which will become pivotal consideration for future business facilitation.

It is worthy of note that managerial professionalism, to say the list, require training and retraining to align an enterprise to the corporate goal of meeting sustainable targets, however, the main focus of this paper aims to deconstruct the complexity in the over conceived idea of ICT development and technological improvement, as it contributes to that regard. Subsequently and up to the concluding section, the paper showcases the argument concerning efficient and robust ICT consideration for SSCM in the future with emphasis on Industrial-IoT enabling practice for increased productivity.
4.2 Industrial Technology Development and Challenges

Technology no doubt can play a generalized role in the supply chain structure (supply, manufacturing, and distribution), shown in figure 1. The sustainability proposal continues to change the requirement for business organizations and increases their dependence on innovative and enabling technology to thrive (figure 2). The search for fast portable and comparatively cheap information solution that will drive future industries is not farfetched. The integration of information technology innovation in the SCM process is breaking grounds on design optimization of materials and operation flow, as tracking and monitoring become more efficient and reliable [16]. It is arguable that the future of manufacturing will adopt the closed-loop business model and will require robust information technology systems [17]. Big data management schemes, cloud computing, RFID application, machine automation, and intelligent control systems to consolidate the industry 4.0 concept and embedded therein, the IIoT initiatives to attain a sustainable industrially developed statue. Further understanding and possible utilization of the IIoT will usher the ground-breaking application of radar sensors and proximity cameras for monitoring purposes, to self-report and safeguard against accidents. The ‘3D-Printing’ manufacturing processes will become even more flexible and time efficient, available commercially for demonstration and deployment.

Figure 1: Simplified Supply Chain Structure; RFID Integrated Enablers [18]

The present study presents SSCM strategy from three perspectives; planning & control, organizing, and operations processes as shown in figure 2, which considers nascent technological throughput and sustainability implementation practices to ensure optimum coordination between the tiers of the supply chain (supply, manufacturing, and distribution as in fig1.), with the decision process from upstream to the downstream (consumer). I.e., industrial operations upgrade through modern technological inclusion is a decision-process concern that ensures all the players in all perspectives, exercise same socioeconomic commitment to execute planned activities in a supply chain framework. It is pertinent therefore that the process of organizing must incorporate the latest, and most useful technique to achieve maximum output which supports aggressive marketing to roll-out sustainable business operations (cost-effective, protect against environmental degradation and promotes employee behavior to work more diligently in the pursuit to meet customer satisfaction). All the factors expected to drive the SSCM is mostly required to be embedded within the organizing process to ensure optimum sustainability measures and also, to successfully achieve execution of specific operations along the tiers.
Figure 2. Sustainable Supply Chain Strategic Decision Implementation Process [19]

The purported organizing process in figure 2., will depend largely on information control to implement decision making. Information management and inventory control can become simple, fast and more accurate, through nascent innovation and development in technology. ‘Autobots,’ and ‘software-bots’ will find their way into companies and entrepreneurial disposition (technology-based). Organizational decisions to integrate information technology into the supply chain and through the use of cyber-physical systems will effectively contribute to sustainability in the supply chain processes; increase cost savings on resources, lower long-term operational cost, toxic consumption, and unnecessary waste. The specific outcomes of initiating sustainable factors into supply chain management, also, will breed technological competitiveness among companies that will directly or indirectly create room for more innovation and new opportunities’ research & development, and job creation. Regardless, despite the benefits and tremendous potentials of developing technologies, there are also challenges that pose hindrances to their adoption. Flexibility and ‘operational preference’ as a consideration have been cited as challenge to implement most of the emerging techniques [20].

Integration of modern technological advances in the manufacturing sector or small, medium and large enterprise to meet sustainable development is suggested from the software-hardware standpoint. While suppliers are faced with the challenges of constantly changing consumer preference, uncertainty in the cost of adopting new work environment and the cumbersome process involved in developing a new collaborative model for the sustainable supply chain process or the long-term benefit of starting now, far outweighs the loss. Different scenarios within the industrial manufacturing structure which accommodates advanced, and technical initiatives ranging from RFID, drones, and camera sensor technologies to mention a few, do exist and in other cases, are evolving. Technological advances when clearly understood, and effectively implemented can contribute adversely to; 1) foster integrated business and promote overall industrial throughput. 2) manage operational risks, and reduces operational cost while meeting customers satisfaction. 3) facilitate management and workers interrelationships due to constant monitoring and utilization of viable information to incline productivity.
Changing old protocols to adopt new ones and operational scale or sizing, and activity execution time are factors to be considered. The quantity of service and the durability of the technology in question to operate effectively are also a limitation, and again, the assurance of optimum control. For example; the chances that an autonomous control system will reliably run at high speed while handling products or delivering services without necessarily undergoing failure? Lack of information and the deficit in know-how to manage technology and technology transfer on a local and international scale presents more challenges concerning the use of new techniques in the supply chain management process to achieve its full benefits. In other cases also, chief executive officers and operating officers may dwell on the uncertainties based on the issues of return on investment, over the high execution cost to embracing a new concept for optimum business operation. The imagination of shorting down the old to commission a-new, with no guarantee of the maximum time for adjustment to the non-familiar practice always poses a concern to business managers. Despite a mountain of uncertainties and challenges, the gains supersede the odds, as innovation looks beyond pragmatism and evolution in technology will only get better and lead to dynamism.

5. Conclusion
The rapidly increasing digital dive to conduct business using artificial intelligence seeks more innovation and require robust decision-model that will facilitate successful implementation. As digitalization progresses, energy-intensive companies; manufacturing and power sectors must metamorphose their supply chain and integrate new ideas that will increase productivity through a re-evaluation of their current operational models and strategies, and also adopt new path in technological assistance. Hence, allow companies to compete favorably in all facet of their business operation. Successful implementation of innovative technological ideology will create the avenue for an unbroken value chain. Although, the scope of this research does not cover applicability of technological advancement in the general industrial sense that aligns sustainability in their supply chain based on the business type, or sizes of the sector (small, medium, and large scale). The paper establishes the need to transcend a new and advanced method of operations, especially, noticeable that current inclination to achieve general growth (environmental, social and economic consideration) in businesses through SSCM approach becomes the new trend [21]. We conclude that selection/consideration of new technologies in a sustainable supply chain scenario must encompass utilization for; (1) Tracking and tracing (2) coordinating and monitoring the automation of production line (3 ) Materials Management (4) Ergonomic reliance, and (5) Energy Savings, especially in energy-intensive and complex value chain companies, during ceramic ware manufacturing.

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