To Examine the Impacts of IoT on Pharmaceutical Supply Chain Management in Zambia

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Abstract. Climate change ranks highly among the challenges faced by humanity in the world today and negatively emasculate efforts for communities to attain sustainable development. All the countries are introducing new legislation practices that help to minimize environmental degradation and resulting climate change. Business are being compelled to adapt innovative supply chain practices, methods and processes that minimises the impact on the environment, reduces human susceptibility from the effects of climate change and environmental degradation. In line with this thyme of environmentally friendly business processes, this paper looks at how logistics and supply chain management for pharmaceutical products to the public health sector by XYZ Limited (XYZ) in Zambia have been enhanced after the implementation of the Warehouse Management System (WMS).

1 Introduction

The main area of critical focus within the current industries is Logistics and supply chain management. More recently, there has been change to the principles underpinning the effective flow of materials and information to meet the requirements of customers that proves that logistics and supply chain management are not new ideas [1]. Actual processes within the logistics may include transportation, appropriate storage, inventory management to the point of final consumption [2].Supply chain management can be considered as a wider concept of logistics. In a business environment logistics is defined as the area of supply chain that plans, implements, and controls the flow and storage of goods and services including related information. Supply chain management (SCM) involves the planning and management of the all supply chain processes from procurement (sourcing) of inputs through production (operations) and conveyance (physical distribution) of specific outputs to end customers [3]. SCM also include information flow in both directions from the end customer and throughout the supply chain (SC) networks. When Information Communication Technologies (ICTs) are introduced in SC networks there is swift sharing of information which give an accurate visualization of market trends [4]. In this paper researchers examines the enhancement of logistics and supply chain management with the integration of internet of things (IoT) and implementation of the Warehouse Management System (WMS) within the public health sector for pharmaceutical products. Researcher has also examined how collaboration and coordination of supply chain (SC) players can improve performance along the SC in order to provide superior goods and services that fulfill customer specific demand and assure profitability of the SC with IoT connectivity applications that has provided platforms for interface that ensure there is effective information transfer and reliable feedback has been received among interlinked SC for XYZ.

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2 Literature Review

The research methodology used to prepare this article is bibliographical and comparative. Initially, information was collected, sorted and analysed from reliable bibliographic sources, and the data were then compared, ranked, and concluding remarks were made. Several publications have been analysed in international scientific journals or key-word conferences and books such as "XYZ Zambia", "WMS Zambia", "industry 4.0", "IoT impacts", "supply chain", "logistics" and many others.

2.1 Industry 4.0 and Big Data

In today's modern, companies have to grow up in a more and more competitive and highly changing environment. It is due to this dynamic world, firms are not only forced to cope with their operational concerns but also to keep an eye in what is happening around the world, what their competitors are doing and how they are doing it, what the costumers feel and what they are expecting to receive or how to improve the suppliers relationship making it stronger and more reliable. All these relationships are translated into data, from several different resources and forms, so enterprises must be ready to take in and integrate them so as to find out useful knowledge.

As defined by many studies, the industry 4.0 or the fourth industrial revolution is the combination of the existing information and communication technologies together towards the production of products and services. From identifying the raw material till the resultant product reaching the end customer - the whole procedure can be done more efficiently by implementing and integrating the technologies defined under industry 4.0

[5]. This technology enables for a paperless business deals by networking between the companies and individuals interested in it. Most of the industry 4.0 and that of its interconnection focuses towards the key functions such as procurement, logistics and transport, warehousing and order fulfilment. As suggested by earlier research study that Industry 4.0 involves an overview on ways that production floor is currently operating.

Many of the small and medium enterprises are forced to properly balance their management and the technical requirements and performances through continuously increasing the amount of data that varies in size and complexities and their overall ability towards conventional methods and tools for managing, storing and analysing data [30]. Hence, the use of traditional datasets that historically included huge amounts of structured data is now in its limited use within the industries. With the advancement and the increase use of global data, it is now required these datasets to generate in an unstructured form due to the increased demand and use of wearable technologies, internet of things (IoT) technologies and tools, online and offline transactions and that of social media platforms. Earlier research studies have suggested that there are vast amounts of data because of the use of multiple storage and recording tools adopted within the production and industrial units of many manufacturing sectors. Many companies forces to implement the advancement of technology and that of big data techniques to leverage the performance optimisation of processes, operations and to gauge the benefits through real time application model development. Earlier research studies have identified various examples and application papers that discusses the importance on using Big Data in manufacturing sectors. For example, pharmaceutical companies have used the technology to optimise manufacturing process; design companies have utilised big data analytics to design and develop next generation of future smart factories or digital factories by relying on managing information through various data sources. Similarly, automotive manufacturing companies uses big data and wider big data analytics to facilitate the use of smart grids to monitor the energy supply and usage within their production and manufacturing activities [31].

Early research studies and experts have identified that the key strategic decisions for the growth of SMEs is the adoption of technology and innovation. Big data is considered to be the key driver towards this growth by enabling to identify, model, predict and analyse the market data to facilitate the customer service function within the SMEs. It also benefits from the potential of higher proportion of productivity and performance through the capture of right amount of data and information at the right time and place. This allows the key decision makers in the company to make better strategic decisions to facilitate and sustain the future growth. The network of intelligent systems and devices that can gather and share a massive amount of data is defined as Internet of Things (IoT).The Internet of things (IoT) is one of the fastest growing subject of interrogation in research, workplace and in commerce [6]. It's the innovation that is potentially impacting not only on how businesses are conducted but it is also having an effect on the life styles of people globally. The IoT has introduced new innovations in economic, environmental, healthcare, social and political spheres [7]. What exactly is the "Internet of things" and what impact is it having on the physical supply chains in industry sectors that are using IoT? The IoT allow people to intelligently be connected to computers, mobile devices, workflow process and shared information that improve collaboration along the supply chains. The linkages are made possible with smart sensors, on/off switches and internet connectivity [8].

2.2 XYD Limited (XYZ) in Zambia

XYZ Limited (XYZ) is a semi-autonomous State- owned Enterprise that is incorporated under the Zambia Companies Act (1976). XYZ is solely responsible for the supply chain management of pharmaceutical goods to the public health sector in Zambia on behalf of Ministry of Health [9]. Commencing from 2015, substantial interventions to enhance the availability of health commodities and improve the performance of the supply chains (CSs) were gradually introduced. These new SC strategies included reforms at the central level applicable to the management of the sourcing (procurement), storage, physical distribution operations, and computerisation of commodity management within XYZ and health [10]. The purpose of XYZ in its current form and going forward is improving availability of key products in all health facilities by strengthening, order processing, pipeline monitoring, improving delivery times, monitoring and evaluation, product re-distribution in the field, minimizing stock outs, and introduction of the regional hub strategies.

In 2015, XYZ Limited (XYZ) in close collaboration with its cooperating partners (CPs) developed the XYZ Master Plan (2015) where a number of capacity improvement strategies were proposed. XYZ has been and continues to implement different supply chain initiatives to meet its mandate for sustained availability of essential medicines and medical supplies at the health facility level (last mile delivery point) [11]. These SC strategies which the researcher focuses in this paper are given below:

a) Implementation of a new Warehouse Management System (WMS) at central level;
b) Development of the Electronic Logistics Management Information Systems (eLIMS) at health facility;
c) Automation of other warehouse processes [12].

2.3 IoT enabled Warehouse Management System (WMS)

The main aim of technologies such as CPS and IoT are to solve the challenges within conventional supply chains and logistical operations to monitor and synchronise real information from physical processes

and SC entities to a cyber space [13]. Despite the common points between Logistics 4.0 and Industry 4.0, it is claimed that the former one's characteristics are based on digitalisation, automisation, networking and mobility [14]. Supply chain management of health commodities is an important part of the health systems in Zambia. Significant improvements have been undertaken by XYZ Limited to strengthen both capacities and systems at various levels of the SC service delivery value chain. Among the priority areas is strengthening of supply chain Management Information System (MIS) for pharmaceutical and other health products. In many physical supply chains it has proven to be very difficult to consistently identify and track movement of goods in real-time because of limitations on technologies that are in use. However, the era of internet of things (IoT) has bridged this gap and visibility has been enhanced along supply chains. The IoT has rendered information in the provision of goods and services among supply chain members to be easily collected, stored and shared. As a result superior collaboration and flexibility by internal functional departments and external supply chain alliances have improved [15].

Until 2015, MACS inventory management system was the software technology in use for managing inventory at the centralized warehousing located in Lusaka (capital city of Zambia). MACS system was not providing the platform required for the minimum inventory management needs. MACS had increasing become inadequate to handle the growth of inventory volumes and the need for monitoring, reporting and Information Technology (IT) support had become increasingly complicated. MACS did not allow for real-time reporting while operations are ongoing [16]. Prior to 2016 the finance package SAGE ACCPAC Enterprise Resource Planning (ERP) was independent of MACS and did not provided an interface platform for the two to communicate to each other. Order processing was done manually and largely inefficient [17]. To remedy these shortcomings in MACS, XYZ procured a new customized WarehouseExpert™ Management System (WMS) which is essentially an ERP integrating SAGE 300 and WarehouseExpert™ to replace MACS.

Warehouse management generally may be defined as the efficient and effective control of inventory (storage) and physical distribution (outbound logistics) to satisfy the changing customer needs and wants. Internal warehouse value chain processes ordinarily encompass control and optimal utilization of storage space and material movement [18]. The new WMS provided interface platforms that allow for standard seamless integration of all XYZ internal functional departments and external health facilities. Modules include inventory management, finance, procurement and the Human Resource (HR). All these functional departments are seamlessly integrated and easily communicate to each other by intranet connectivity [19].

2.4 Impact of IoT enabled WMS within XYZ

After years of exponential growth in inventory density, XYZ faced serious capacity challenges to maintain the quality of logistics services to nationwide and geographically wide located public health facilities. Therefore, the deployment of WMS with integrated IoT technology could not have come at any better time. In a high volume pharmaceutical warehouse such as XYZ, operational efficiency and optimal labor productivity are key ingredients in the management of customer demand in order to provide superior value to the final customer. Improvement areas include optimizing the warehouse space utilization, faster inventory turnaround, order processing, picking/packing, stock movement tracking and reporting [20]. All these are now possible within the new WMS at XYZ leading to online transactions departing from the previous manual and largely paper based transactions. WMS has augmented SC reliability (perfect order), agility, flexibility, cost reduction and enhanced responsiveness [21] .IoT has been a game changer within WMS which is a strategic component of pharmaceutical supply chain because it introduces efficiencies in the movement, control, storage of medicines and other medical products. Implementation of IoT integrated WMS at XYZ, has recorded improvement in many processes that include online order processing, receipting, storage and picking and tracking products both within the organization and along external supply chains.

Table 1. Impacts of IoT enabled WMS within XYZ [19], [22], [23] [24], [25].

No	Sector	Impact
01	Real time stock transfer	Districts and Provincial (supervisory) level are remotely connected to health facilities and perform real-time stock visibility and make timely decision on excess drugs, expiries or stock-outs. They are also able to give instructions on stock transfers from a facility that has excess stock to another facility where stock out is Imminent.
02	Master Data	The master data enable users to perform warehouse business transactions, whilst still allowing the supervisor level users flexibility to adapt to specific requirements. It contains stock keeping units (SKUs) attributes, storage locations, packaging information for medicines, suppliers and end customer data.
03	Improved Inbound & Outbound Logistics	WMS is able to manage receipts of all stock supplied to the warehouse on a valid purchase order and direct put away of the received stock in specific storage locations or control areas. This instruction is transferred through connected computers to each responsible section to take physical actions. WMS is able to consolidate consignments for different customers who are on

		the same delivery route thereby ensuring efficiencies for full load deliveries. One feature of the WMS that has enhanced the physical distribution (logistics) of pharmaceutical products to the final distribution points is the handheld mobile device that provides real time updating of delivered products by the truck driver to the central warehouse.
04	Inventory management	The accurateness of inventory information presents a twofold strategic eminence for the enterprise: a) provides knowledge management that allow setting up of storage locations and optimisation of warehouse space utilization. b) enables the enterprise to align resources with demands patterns in a manner that optimises both customer satisfaction and enterprise profits.
05	Improved finance module	Unlike the period before 2016, the finance module is linked to the inventory module and real-time financial reports can be generated that match the inventory holding values at any period of time.
06	HR module	The HR module allow for implementation of the performance management systems (PMS) to rewards deserving warehouse staff or plan training needs by simply printing tallied work accomplishments by individual staff. This is achieved in conjunction with automatic identification (auto-ID) and data capture technologies that are able to recognize objects, collect relevant information, and feed the data directly into the WMS.
07	Cold Chain monitoring system	All warehouses are fitted with chiller rooms for storage of cold chain medical supplies whose temperature range is set at 4-8ºC. The system has Global System for Mobile communications (GSM) and sends messages to selected Staff's mobile phones when temperatures fall out of range. IoT enabled WMS system permits managers to login and find out who is on duty and give instruction for collective measures to be taken even when they are away from the duty station.

The above sections have demonstrated that IoT can enable supply chains to be connected, information shared and obtain market intelligence concerning customer demand, orders, delivery status, and inventory levels within the organization. IoT provide connectivity platforms for real-time information that organizations use to coordinate inter-functional activities and planning. Supply chain partners who are well connected and share information in real-time have high visibility of physical logistics, make flexible tactical decisions that synergizes resources and enhances the competitive advantage of supply chains. Increased visibility include planning information for demand forecasting (upstream customer needs) and delivery scheduling (downstream order fulfillment).The advantage of IoT enabled WMS in XYZ are as given below in table 2.

Table 2. Advantages of IoT in supply chain [26] [27] [28] [30].

Advantages	Description
Real time visibility	IoT connectivity enables real time visibility across the entire supply chain that helps to improve the supply chain management.
Integration	Building the integration of digital and non-digital supply chains with IoT so that a unified and whole view of inventory across the firm can be achieved.
Shared information	IoT allows easier information sharing on sales forecast and production data.
Automated execution	Seamless human-machine interactions can be enabled with IoT.
Maximum efficiency	Seamless human-machine interactions can be enabled with IoT that results in increased operational efficiency.
Organisational flexibility	Plug-and play capabilities with IoT enabled systems makes the system and operations more flexible
Enhanced responsiveness	Better information and sophisticated analytics with IoT can help accelerate responses to competitors' moves, technology shifts, and changing demand.
Proactive prevention	IoT helps decision support systems driven by predictive analytics for real time data that helps to strengthen adaptability and reliability of the system.
Last mile postponement	Swiftly repurposing organisational assets with real time data with IoT enabled systems assists on ensuring the supplies are aligned with evolving demands.

3. Conclusion

The objective of this paper was to assess the emerging subject of Internet of things (IoT) and to discuss its impacts on logistics and supply chain management. Researcher has considered a mini case study that was limited to XYZ Limited of Zambia which has shown that IoT applications introduces various innovations and improved performance efficiencies in the supply chains and creates value for organizations and customers.

The implementation of the WMS with IoT applications at XYZ Limited has automated the business workflows and has eliminated the tedious time consuming manual and paper based processes. The real-time visibility on inventory movement has improved forecasting, quantification and better logistics decisions resulting in the reduction of capital tied up in inventory. Since all operations are real-time system driven they provide high levels of productivity and accuracy in all functions allowing for statistical reporting/auditing on operator and system performance. WMS has improved storage space utilization and time for inbound sock put-away and out bound order picking by allocating racking space near the loading dock for fast moving products. IoT has introduced innovative application that is sustainable to the environment and prevents future effects of climate change. For instance, this has been evidenced by the reduction in paper transactions by XYZ after implementation of WMS.

The Internet of Things (IoT), also called the Internet of Everything or the Industrial Internet, is a new technology paradigm envisioned as a global network of machines and devices capable of interacting with each other. The IoT is recognized as one of the most important areas of future technology and is gaining vast attention from a wide range of industries. The future objective from this research study is to examine and develop a detailed guide on how enterprises and manufacturing companies are evolving to adapt the needs of data re-generation and their business practices for the next generation of technologies in the market. This could further be supported by a methodology that provides the companies on their current landscape and projections and that of their future plans towards the advancement and adoption of technologies in workplace. The research shall also expand upon the use of case study based approach to examine specific companies and industries within Zambia and wider African continent to provide the research communities with a more detailed analysis for this concept.

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