CLOUD COMPUTING AND IOT APPLICATION: CURRENT STATUSES AND PROSPECT FOR INDUSTRIAL DEVELOPMENT

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ABSTRACT

The dawn of the fourth industrial revolution motivates the unveiling of new business models and technological selections, to enable enterprises to operate efficiently. The vision of digitization and intelligent or smart technique to organize future industrial operations is a compelling issue to address. Deployment of the Internet of Things (IoT) concepts relies on the robustness of innovative functionalities available to drive industrial processes. i.e., improvement in industrial operational performance is not far-fetched from the urgency to gain an understanding of IoT architecture and protocols for applicability. The present study is an exploratory research into the most recent cloud computing services and IoT technologies to proffer knowledge on their potentials and analyze their applications from an industrial perspective to promote sustainable operations. This article covers the general requirement for the success of a digitization trend in the industrial sector and considers state-of-the-art technological intervention towards cloud computing advancement to promote IoT services. Industrial systems enabled with IoT should improve operations and transform businesses in the future. Industries today should convert IoT data into valuable information to aid the increase of sustainable and conservative practices, this would enable the provision of better solutions leading to organizational effectiveness. This present study is a contribution to the body of literature on the subject matter.

Keywords: Cloud computing, Internet of things, Manufacturing SMEs, Techno-innovation

1. INTRODUCTION

The pursuit of growth tendencies and development through innovations, technological integration successes, and standardization, which are a part of sustainable frameworks have become mechanisms for increasing productivity in today's industry (Peter & Mbohwa, 2019). World-wide focus on technological advancements and the industry 4.0 paradigm holds lots of potentials through Information Communication Technology (ICT), steered by the Internet of Things (IoT) to transform industrial operations. IoT applications generate tremendous traffic. Since IoT traffic is due to the communication between objects, the reliability of transmission becomes critical, especially in situations when the wireless sensor network (WSN) is unstable, compared with the wired network. IoT technology is applied in many domains which include environmental monitoring, transportation, automotive vehicles, industry, medical technology, healthcare, smart home, and smart city (Augustin, Friedman, & Teixeira, 2011). Cloud computing, therefore, is an advanced technology for allowing well-situated, on-demand accessing from anyplace to a shared pool of computing system that has server, storage, application and network links (Buyya, 2013).

Radio Frequency Identification (RFID) systems, barcodes, and usage of other electronic tags are pivotal for product tracking in real-time, this forms a part of the consideration for strategic managerial approach and is advantageous for sustainable supply chain activities. The gradual shift from production-centered service delivery to the service-oriented manufacturing disposition was brought about by the intervention and development of the concept of Cloud computing (Li et al., 2010). This technology allows data to be accessed conveniently and at low cost, thereby creating the platform for collaboration and organizational effectiveness (Kalapatapu & Sarkar, 2017). Researchers have aligned cloud computing capabilities with sustainability (Wu, Greer, Rosen, & Schaefer, 2013; Xu, 2012), and operational effectiveness for large and small manufacturing enterprises. The cloud manufacturing concept has in recent times received much clearer contribution and is defined as "the concept of sharing manufacturing capabilities and resources on a cloud platform, by making intelligent decisions to provide the most profitable, conservative, and robust manufacturing route available" (Fisher et al., 2018). Its capabilities have been explored in case research (Yang, Shi, & Zhang, 2014). Also, an efficient cloud manufacturing system regarding management applications has been investigated (Ferreira et al., 2014). Energy conservation protocols relating to cloud manufacturing services orientation based on resource scheduling has also gained insight by authors (Cheng et al., 2013).

The aim of this article is to investigate the interlink between cloud computing performance and the internet of things. The authors proffer an understanding of cloud computing performance and IoT enabled technologies in the built environment and industrial manufacturing space through an exploratory survey of the concepts and comparative assessment of the technologies via the use of literature on emerging trends. This study puts into consideration digitization trends, challenges, prospects, and the advancement of cloud computing to promote IoT services, industrial development, and manufacturing SMEs and their perspective. After careful consideration based on exploratory literature this study is arranged using the framework itemized as follows: A succinct discussion of theories within the study framework, a review of the basic concepts that cover the described methodology (section three). Juxtapositions on the understanding of the subject matter are presented in section four, and conclusive deductions in section five.

1.1. Cloud Computing

Cloud computing (CC) is a significant and emerging terminology in the information technology world and current global disposition towards digitization, and this finds application in various sectors which includes the manufacturing industry. CC is the fastest emerging area in the digital economy and is a computing concept that involves a network of computers connected over the internet. Lately, CC has been a critical idea in the IT domain; it is perceived as the vital territory of venture in the information systems environment (Henzel & Herzwurm, 2018). CC has steadily transitioned its application and has changed how firms' service, and manage client. This led to CC speedily being accepted as a concept and a house-hold name within various industrial sectors. CC has been a creative innovation that has extraordinarily modified the IT business, and its commercial operating logic. CC has empowered firms by diminishing work expenses utilizing on-site hardware, information storage, and system in the data center, rather than buying extra hardware (Alani, 2016; Lele, 2019; Ren et al., 2015). CC can be construed as internet-based computing, whereby shared resources, software, and information are provided to computers and other devices on-demand. Hence, IT services are provided by massive low-cost computing units connected by IP networks.

This technology allows data to be accessed conveniently and cost-effectively, thereby creating the platform for collaboration and organizational effectiveness (Kalapatapu & Sarkar, 2017). This research is purposeful in identifying the factors which influence cloud computing adoption by manufacturing SMEs from the perspective of technology option, organizational, environmental, human, and business. Hence, since the concept is yet to enter a maturity stage, it necessitates an investigation of its contribution to knowledge, in that regard. While, manufacturing SMEs around the world are challenged to utilize innovative and effective solutions to proffer better engineering service (Peter & Mbohwa, 2019), the utilization of information systems to increase the need for business functions and processes to run efficiently and productively is timely. Moreover, the cloud computing trend is predicted by experts to continue to transition digital transformation in various businesses and industrial sectors, thus, becoming an accelerator for business strategies and manufacturing SMEs in the near future (Huang, Li, Yin, & Zhao, 2013). Integrating cloud computing in information technology strategy makes the manufacturing sectors to enhance their capabilities and ensure a high-security level of of performing industrial manufacturing operations, and restricted infrastructural investment. This receives insight in the subsequent chapters.

1.2. Internet of Things

Digital evolution through the development of the Internet of things (IoT) ideology is rapidly transforming global perspective on trade, manufacturing, process and service operations. Current trend sees monitoring of the industrial operations processes through the lens of sensors technologies, wherein a communication network allows machines to be organized and to actualize effective control during selective operations, e.g product/component manufacturing. It is thought that the adaptation of new technology should encompass utilization for; (1) Tracking and tracing (2) Automation of production line (3) Materials Management (4) Ergonomic reliance, and (5) Energy Savings, to lead effective industrial sustainable supply chain operation (Peter & Mbohwa, 2018b).

The Internet of Things attracts technologies that enable the interconnectivity of both physical and virtual systems through a holistic data sensing, processing, and application process within an IoT architecture. What is to be achieved determines the protocol for interoperability and systems service delivery. This is the primary orientation of cloud manufacturing, which also draws a similarity on the understanding of the Internet of Production (IoP) strategy (Peter & Mbohwa, 2018b). The Internet of Things can likewise be considered as a worldwide system that permits correspondence between man and man (M2M) and among things of diverse perspectives relating to everyday activities, security, energy management, to list a few shown in fig.1. IoT depicts a reality where almost everything can be associated, and impart wisely more than ever. It is the precursor to Industry 4.0 (I4.0), which envisions the era of digitization, involving three main components. First, which consists of the Internet of Things (IoT), combined with cyber-physical systems. Secondly; big data advancements and powerful analytics (data analysis and immediate solution). Thirdly; new developing infrastructure for communications and energy supply that is secure and safe to handle the heavy industrial applications and usage in an interconnected intelligent factory scenario according to (Paul Carreiro, 2015), or smart factory operations process (Gilchrist, 2016; Peter & Mbohwa, 2018a).

The IoT concept has been thought to be "related" as far as electronic gadgets are concerned, examples: Web servers, Personal computers, smartphones, laptops, tablets, and other advanced mobile phones. IoT has expanded tremendously due to constant innovations in hardware, communication networks, and software solutions (Hahm, Baccelli, Petersen, & Tsiftes, 2016). It is now possible for a large number of devices to communicate with each other through the internet and generate massive collections of data, thereby, permitting the storage and processing of massive data in the cloud servers, and used in the future (Sethi & Sarangi, 2017). i.e., For fast processing of data and the expectation to receive feedback faster, saw the introduction of fog computing technologies (mediate between IoT device and the cloud computing centers).

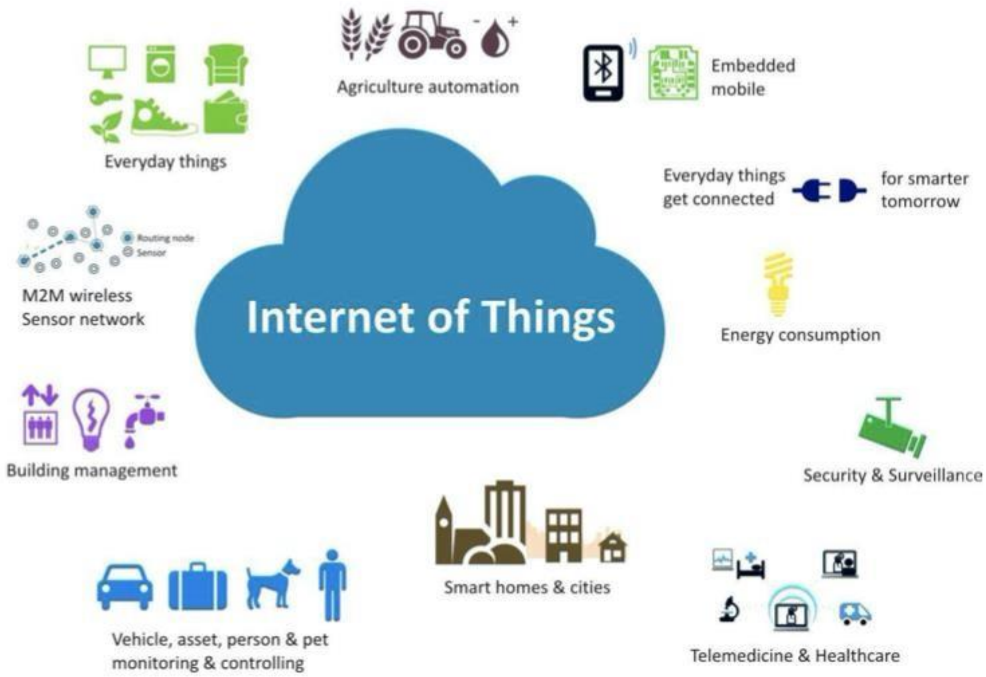

Figure 1. Internet of Things (Özer, Arslan, & Şahin, 2019)

The performance of IoT, together with fog and cloud, could be determined using many factors (Chiang & Zhang, 2016). Application layer protocols play a vital role among these factors, which has received insight from the authors (Dizdarević, Carpio, Jukan, & Masip-Bruin, 2019). The HyperText Transfer Protocol/secure (HTTP) and (HTTPS) are extensively used protocols to make communication with other servers through the internet. HTTP appropriate for computing devices with high-power, faster processing units, and reliable communication mediums. But IoT devices have been noticed to have slower processing units and actuation time. Few lightweight protocols have been created for IoT devices at the application layer level. They are; Advance Message Queuing Protocol (AMQP) and Data Distribution Services (DDS); also, there exist the Constrained Application Protocol (CoAP), Message Queuing Telemetry Transport (MQTT), and Extensible Message and Presence Protocol (XMPP). These protocols support constrained devices for message exchange (Houimli, Kahloul, & Benaoune, 2019). A single messaging protocol is not enough to provide all communication services because protocols use different communication models.

1.3 Emerging Technologies and Industrial Development

The tendency to execute sustainability practices to reflect on industrial engagement while determining growth potential has become a topic of interest to both managers and academia (Gianni, Gotzamani, & Tsiotras, 2017; Journeault, 2016; Onu & Mbohwa, 2018; Souza & Alves, 2018; Tsalis, Nikolaou, Grigoroudis, & Tsagarakis, 2015). The use of some of the most robust technologies; drones, robots, or in other cases, cloud computing to coordinate businesses is changing the playing field for manufacturers, as well, product delivery to lead business competitiveness in the near future. 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/quality will be tracked. Technology, no doubt, will transform the traditional perspective of the supply chain structure (supply, manufacturing, and distribution). Also, as the sustainability proposal continues to change the requirement for businesses, and increases their dependence on innovative and enabling technology to thrive through the planning and control, organizing, and the manufacturing or service operations processes? Big data management schemes, cloud computing, RFID application, machine automation, and intelligent control systems will be required to consolidate the application and use of internet technologies. Thus, embedded therein, the IIoT initiatives for a sustainable industry development 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, through effective cloud data management, and while ensuring safety in operations.

2. Review of Concepts

2.1 Cloud Computing Services

The cloud is a parallel and distributed computing system consisting of a collection of interconnected and often virtualized computers, which are dynamically provisioned and presented to its users as a single computing resource based on pre-agreed service levels between the Cloud Service Providers (CSPs) and the Cloud users (Buyya, Broberg, & Goscinski, 2011). CSPs have very large data centers with the infrastructure capable of high-performance computing. Beyond these, applications and services are also offered to users on-demand and in a flexible manner. This means that the resources being utilized by users have the ability to "grow" or "shrink" to meet changing demand (Hamdaqa & Tahvildari, 2012). The cloud services are classified within different models offered to clients, namely; private, public, community, and hybrid (Mell & Grance, 2011). The three cloud services categories are as follows.

Infrastructure as a Service (IaaS): is the most prevalent and developed market segments of cloud that deliver customized infrastructure on demand,

Platform as a Service (PaaS): that provides platform and environment to the developers who build cloud services and applications on the web, storing information in the cloud to permit cloud user interface.

Software as a Service (SaaS): that provides its own application running on a cloud infrastructure. The cloud user needs not to control or manage the cloud infrastructure, including storage, operating system, services, network, and application. It also reduces the need for computers, server, and storage and manage and run all application. In cloud computing, data are growing exponentially, but the security of data is still questionable. Due to the transfer of data to the cloud data center, the security problem occurs and data owner loss their control on data. Security and privacy for cloud data is a significant aspect of cloud computing that is still not solved — these cloud security.

The purpose of cloud computing is to quickly access essential resources as an inexpensive way, at any time, place, and in a significantly safe manner. However, the threat of data protection and lose is imminent. The process of cloud storage consists of four layers

- New storage layer: store data on cloud data center
- Management layer: ensures privacy and security of cloud storage
- Application interface layer: provide cloud application service platform
- Cloud access layer: allows access to the cloud user

In a bid to provide efficient and reliable services on the cloud, the CSPs must evolve, which has brought about newer concepts. High-Performance Computing (HPC) can be defined as an aggregation of interconnected computing workstations (parallel), working together to solve complex problems (Bungartz, 2013; Li et al., 2010). It is essentially a cluster of high-end computers linked by high-speed networks and collectively working on a specific set of problems. Though similar, HPC and Cloud Computing are different concepts. A comprehensive comparison of both technologies was made in Goscinski et al., (2017), with some of the key differences being that Cloud relies on virtualization, supports on-demand utility-like computing and elasticity, all of which are not required for HPC and might even have adverse side-effects on HPC. Besides, HPC applications need individual requirements such as scalability, performance, and flexibility in handling workloads, which the Cloud provides (Hamdaqa & Tahvildari, 2012).

2.2 Cloud Services and IoT Application Protocols from the Industry Perspective

The current section accesses cloud service application and IoT mechanism and the energy implication and evolution. Amidst the different technologies for communication and interaction, most of which are internet linked. A brief overview of a few of the IoT implementation technologies is presented in this section. First, and of the most popular is the **Bluetooth**. This is a wireless technology that is known with capabilities for transmitting information across a short distance of private domains or networks. Recent development has led the actualization of the Bluetooth Low Energy BLTE performing at a higher efficiency due to lower energy consideration and time, which also translates to lesser cost and aligns it as an appropriate application of the internet of things. The **Wi-Fi and Low Power Wi-Fi** component. This technology is popularly known for data transfer rates in high-speed privately or in a public domain/network. The development of low power Wi-Fi has resulted in an inconsistency in data transfer without the challenge of power lose during data transfer or idling time. Also featured is the **Worldwide Interoperability for Microwave Access (WiMAX)**, with **WiMAX 2**, is the latest development in the technology sphere, with very high speed, substantial data transfer capability.

The remarkable assets of software, hardware may be necessary for transferring the protocol data of WSN for the relevant standards like TCP/IP. The answers solutions might add overhead to the transmission of data, the efficiency of reduction. Like the protocols of WSN should be made for protecting IPv6; presently, the layers of software bridging different performances of 6LoWPAN should allow the connection of inter-device. The analogy is illustrated in fig. 2, showing the protocol and standardization initiatives in IoT.

Interet Protocol Suite (TCP/IP) **IP Smart Objects Protocol Suite**

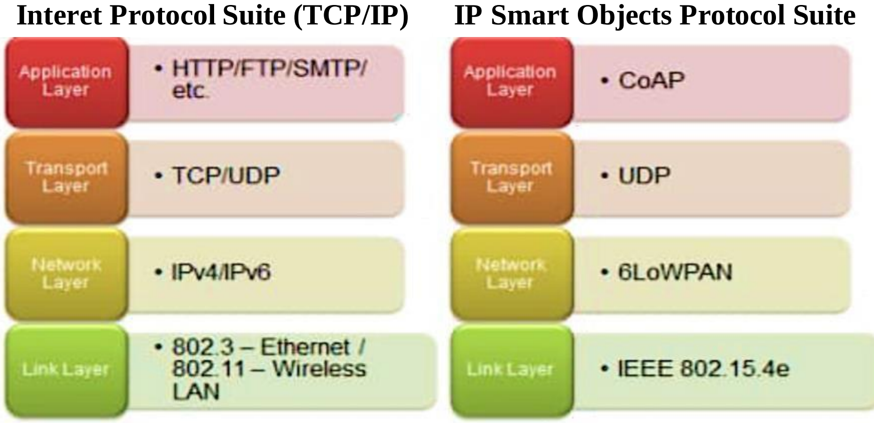

Figure 2. TCP/IP Stack and IP Smart Object Protocol Stack (Sutaria & Govindachari, 2013)

Long Term Evolution (LTE) and **LTE-Advanced** are also high speeds of information data transfer technology with the 'advanced' being three times faster and considered a promising technology for IOP. **Zigbee** and **Z-Wave** are wireless network technology that uses low power digital radio frequency in the reliable transfer operation. **Lowpan** or **6LoWPAN** refers to a Low-Power Wireless Personal Area Networks and is the revolution in wireless network environs. It is a low cost, energy requirement, and small-sized device capability to transmit information wirelessly. The technology uses a standard IPv6 protocol that is able to be transmitted across the networks of IEEE 802.15.4, compared to ZigBee/Z-Wire and stands out as an appropriate IoT application protocol.

Smart tag technologies like the **Radio-frequency Identification (**RFID**)** refers to simple systems that use radio waves to transmit information about the identity of a thing (Ashton, 2009). These tags are more advanced types of barcodes since they consist of both reading and writing capabilities. The data stored on RFID tags can be changed, updated, or even locked. This technology has succeeded in proving its capability and efficiency as an affordable tool for improving performance and reducing the time and cost of manpower and resources in many cases. In a general scenario, when the manufacture parts arrive in processing step, by the tag reader, an event such as reading the RFID number and storage, gives the required information. **Near Field Communication** (NFC) is a new communication capability that can be used to securely connect two devices that are at a short distance from each other. It is considered as one of the most useful RFID subsets. Essentially, both objects are operationalized by special hardware. NFC is the latest version of RFID, such that its communication ranges up to 4 inches. Thus, it makes the technology very useful for identification and clocking of parts or to control motion systems. Development of NFC technology may perhaps allow users to send or exchange information by touching or approximating one device or perspective to another, in the near future.

3. METHODOLOGY

The present article has conducted an exploratory investigation based on the subjective research approach, reviewing concepts, ideologies, and information that pertains to "Cloud computing and IoT application: current statuses and prospect for future industrial development." Ryan et al. (2007); have iterated subjective research system. "There are no autonomous factors or representatives engaged with a subjective report on the grounds that a subjective procedure isn't of a trial nature." More emphasis has been given, also, stating with regards to theoretical research, that it is critical to audit past research on related topics (Harris, 2012). This particular research adopts the comprehensive qualitative strategy, exploring a dependent variable (Sustainable Industrial development) and its effect on the independent variable (Cloud computing and IoT application). The research focus is on the inferences to the communication levels and data security, with a deduction to techniques, applicability, and interoperability of software and devices to meet future industrial development and manufacturing SME dispensation. The comparative research between the two entities, identifying their similarities and differences, enabled the authors to reveal the central aspect of the subject matter, which has been rarely researched. Thus, draw inference on the interrelationship between cloud computing/service, and IoT technology with Sustainable Industrial development.

4. FINDINGS AND DISCUSSIONS

4.1 Security Perspectives and Techniques for Securing Cloud Data

Cloud data encryption may not be the far-reaching solution for cloud security at the moment. However, it can be achieved by applying existing security techniques like; authentication and identity, encryption, integrity checking, access control, secure detection, and data masking. The under-listed are brief explanations of the security techniques that are applicable to cloud data.

- **Validation of OTP**

This strategy is mostly adopted by banks and helps to provide authentication through a One Time Password (OTP) method, which is generated at random and used to verify the cloud user. In other cases, it could be used as a system two 2-factor authenticator or as Multiple Authentication Factor.

- **Integrity Checking**

The integrity of cloud data is a guarantee that cloud data can only be changed or accessed by an authorized user. In simple terms, it is a cloud-based data verification process which ensures that the data is unmodified, or corrected. The basic techniques of data integrity-check, are the; Provable Data Procession (PDP) that ensure the integrity of cloud data on a remote server, and the Proof of Retrievability (POR) which obtains and verify evidently that cloud data has been stored by the user or that the server has not been changed from a security perspective.

- **Access Control**

Access control means, the protection of data from modification or unauthorized disclosure/access of data in the cloud by and unauthorized user. The data owner can execute some restrictive permission to access their data, outsource the data to the cloud, and exercise access control of their data in the cloud.

- **Secure Deletion**

Deletion uses different techniques: Clearing, in the technique where data is deleted from a ‘cloud bank' before it is accessed by users to avoid its reuse. Moreover, protection is provided for accepting the data even before being deleted. While Sanitization is a technique where protection for accepting previous data before deletion is not provided. This type of data is regularly circulated for a lower level of classification.

- **Encryption**

Cloud security provides data encryption service to encrypt cloud data before transfer from local storage to cloud storage, and it is impossible to understand from any system, database, or file to decrypt the data without a decryption key. An encrypted data is only possible to access by an authorized user with the decryption key. So the separation of encrypted data from the encryption key is highly necessary for cloud data security.

- **Data Masking**

Data masking is a process of securing and hiding cloud data from attackers and theft by changing the information without distorting its through nature. General terms used interchangeably for data masking are; data de-recognition, data cleansing, etcetera, which has led to the confusing of the idea. Regardless, Data masking could either be algorithmic for self, or of a public data set. There are different techniques used to mask cloud data; Static Data Masking (SDM), used by most organizations to protect a third-party interaction, thus necessitates the duplication of the database to secure information. While the Dynamic Data Masking (DDM) provide access based on the role of an individual or user in a corporation.

- **Intrusion Detection System**

Intrusion Detection System (IDS) is a software application protocol or device which monitors operation while debugging illegal or suspicious activities that may permit hacking activities or data theft. There exist two types of IDS: The Network-Based Intrusion Detection System (NIDS) which is embedded in devices or computer connected segment of a corporations' network to monitor network traffic and keep and ensure secured operation, and the Host-Based Intrusion Detection System (HIDS), which is a specific system or server-based monitoring/protection system.

4.2 Application Layer Protocols for IoT Communication

The current section of this article expounds on the IoT application layer protocols, which were introduced previously in the introductory section (internet of things). Hence, it describes the communication model, Quality of Service (QoS), security features, and transport protocols. CoAP runs on User Datagram Protocol (UDP), while HTTP, MQTT, AMQP, XMPP, and HTTP run on Transmission Control Protocol (TCP) at the transport layer level. As we know, MQTT, DDS, and AMQP follow the publish/subscribe communication model. CoAP and HTTP follows request/response communication model. The security technique for securing the cloud is demonstrated, as shown in 3 below.

- **HTTP**

HyperText Transfer Protocol (HTTP) is a client/server model intended for web applications by following a request/response model, where a client sends a request to the server; the server process the request and sends a response to the client. The server can then handle any number of client requests at any given time. TCP is being used as a transport protocol by utilizing the TCP three-way handshake protocol to establish communication between client and server. HTTP data is either in text format or the parsing JavaScript Object Notation (JSON) format. The creation of the HTTPS protocol further provides secure communication.

- **C*o*AP**

Constrained Application Protocol (CoAP) was invented to support constrained devices - IoT devices (Shelby, Hartke, & Bormann, 2014). It follows the request/response model as HTTP by using UDP at the transport layer level to provide quality services faster. CoAP has two layers; The first layer which exchanges information between client and server by using the above methods with the help of UDP. However, UDP does not provide reliable communications. While the second layer is one that is used to provide secure data transfers by resending the ‘lost packets.' To ensure reliable packet transfer, it uses four different types of messages they are CON (Confirmable), NON (non-confirmable), RST (reset), ACK (Acknowledgement). The CON message guarantee message transfers. If the receiver demands acknowledgment, it is done with the help of the ACK message. If message transfer has not done successfully, NONmessage will be returned. CoAP follows Datagram Transport Layer Security DTLS (Rescorla & Modadugu, 2012) to provide secure communications.

- **MQTT**

Message Queuing Telemetry Transport (MQTT) was earlier designed by IBM and adopted by the Organization for the Advancement of Structured Information Standards (OASIS) (Andrew Banks, Ed Briggs, Ken Borgendale, 2017) for IoT. It is a lightweight protocol for supporting constrained devices. It follows a publish/subscribe communication model and has three important parties, i.e., publisher, subscriber, and a broker. Publisher keeps the information on the broker which is collected from sensors or other devices with specified means of identification. In advance situations, an MQTT-SN protocol is intended for ‘sensor networks,' which may then be facilitated by the UDP.

- **DDS**

Data Distribution Service (DDS) is a publish/subscribe model introduced by Object Management Group (OMG), which allows direct communication between peer to peer instead of broker involvement. DDS has main entities Data Reader and a Data Writer (Pardo-castellote, Farabaugh, & Warren, 2005), and offers dynamic discovery, scalability, and interoperability. An example of dynamic development is such that it allows subscribers to find out what the publishers' present. The protocol has been identified to support TCP.

- **AMQP**

Advanced Message Queuing Protocol (AMQP) is an interoperable protocol introduced by 'OASIS' (Andrew Banks, Ed Briggs, Ken Borgendale, 2017), which follows the publish/subscribe communication model. Because of its interoperability feature, it supports a wide range of heterogeneous applications. Its capabilities are numerous, among which are;

I) Exchange: It routes messages to respective queues that are received from publishers.
II) Message queue: It keeps the message in the queue until received by the clients.
III) Binding: It describes the state between the message queue and the change in case of any.

The TCP protocol is being used by AMQP to provide reliable communication. For security, it uses Transport Layer Security (TLS) for encryption, while for authentication, it utilizes the Simple Authentication and Security Layer (SASL).

- **XMPP**

Extensible Messaging and Presence Protocol (XMPP) is an instant message exchange protocol defined by (Saint-Andre, 2011). It is an extensible mark-up language and text-based protocol. XMPP follows the client/server communication model, and newer versions support the publish/subscribe model. It also uses TCP to provide reliable message exchanges, with TLS as an inbuilt protocol for security.

4.3 Nascent Industrial Technology Development and Challenges

The quality of service and the durability of the technologies 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, the chief executive 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, without sufficient knowledge of the maximum time for adjustment to an entirely new practice, always poses a concern to business managers. Regardless of the 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.

The usage, therefore, of clouds in engineering and the built environment is tenable to reduce operational and maintenance costs with regards to data management and analytics through the streamline of activities and the use of IoT enabled devices. CC is one of the most innovative and rapidly developing technologies which can play an important role in all industries (Chatzithanasis & Michalakelis, 2018). The technology is multiversatile in application, as a result, practitioners from cross-cutting fields around the world are adopting its use, based on its capabilities and how it fashions to support their operational activities. Moreover, embracing innovations like Cloud Computing may assist numerous firms to operate proficiently and profitably as acclaimed by Rohani and Hussin, (2015). Areas that are pivotal for cloud computing advancement is shown in fig.3., in which, the list is not exhausted. As part of a sustainable operations strategy to transform product designs, energy concerns, and environmental protection resolution through techno-innovation assistance, is hugely dependent on governmental policies, standardization, and financial models designed for the rapid techno-transformative business proliferation and execution, and forms the basis for decision-making and future industrial operations excellence.

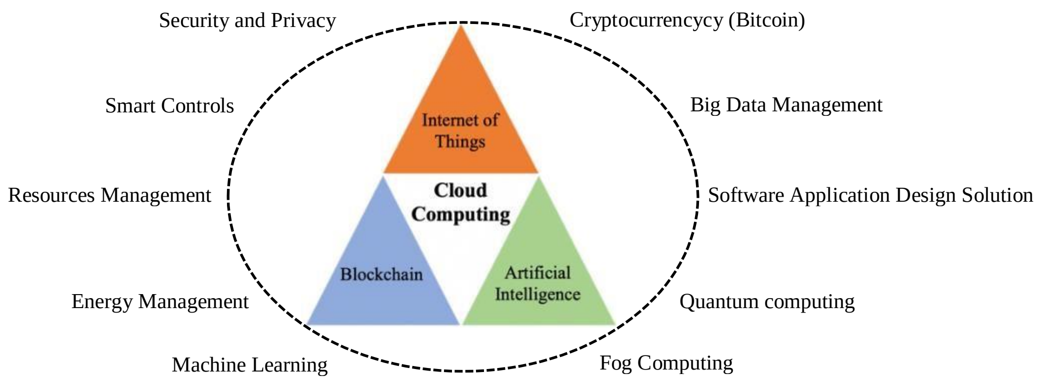

Figure 3. A Near Future Techno-innovation Solution

There is assurance that IoT and CPS capabilities will gain benevolence in the future, in areas of smart manufacturing and proffer dexterity in operations and sustainability in the supply chain process (Lee, Bagheri, & Kao, 2015). More so, the interrelationship between IP- enabled components to communicate through hardware, driven by IoT, could become expensive over time. However, the cloud system offers to coordinate and manage all things, and at any distance in-time through the application and use of dedicated portals and built-in apps (Simmhan, Kumbhare, Cao, & Prasanna, 2011). Also, the recent day pace of high-speed networks has enabled easy monitoring and remote control of things. The features of IoT capabilities are characterized to transition industrial operations through its diversity in devices, technologies, and protocol adaptability. Although the concerns regarding availability, scalability, reliability, security, interoperability, and efficiency draw intention, the integration of cloud computing systems and services provide a solution to some of the listed challenges.
(Dash, Mohapatra, & Pattnaik, 2010)

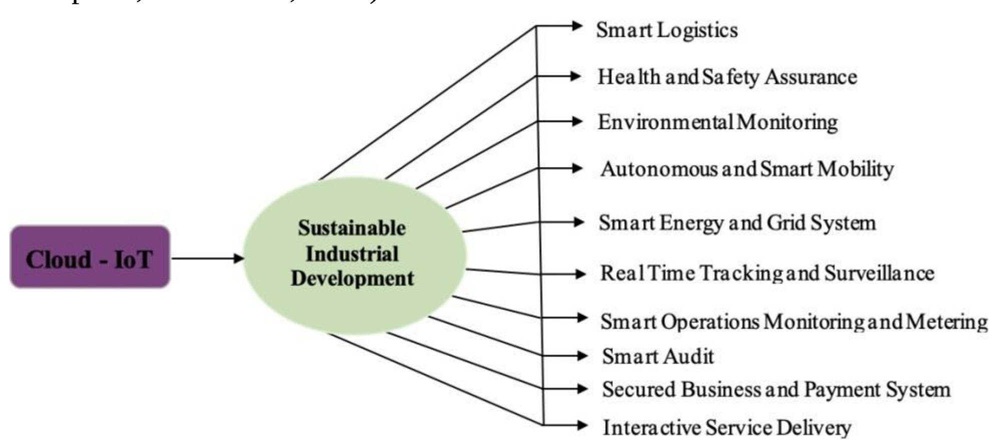

Figure 4. Sustainable Industrial Development is driven by Cloud-IoT Application

Although the concept of cloud computing and IoT had evolved independently, the synergy between the two is a combined force that cannot be overemphasized due to the mutual benefits to support industrialization and sustainable operation/activities. Hence, the integration of cloud and IoT exigencies will, as envisaged from past literature, now features a list of areas that can lead to a transformative sustainable development in the near future, and within industries, especially in the manufacturing and service sector (fig. 4). Cloud computing access can offer unlimited support and technological solutions to the implementation of IoT services and applications. Whereas, the Cloud systems and computing protocol can benefit from IoT services by extending its capabilities to deal with real-world things in a more distributed and heterogeneous manner, and for delivering engineering solutions in a large number of real-life scenarios within the general industry.

5. CONCLUSION

The consideration for IoT communication protocol and cloud security architecture to contribute to the learning of digitization and industrial assimilation has been researched. This is to promote productiveness in the general industrial operations, covering finance, manufacturing, supply chain and inventory management, health care and safety, and the broad structure of service delivery, to mention a few. The concept discussed applies to secure the cloud data for the above areas of concern, where exhaustive literature has been consulted and explained in brief. The research identifies pivotal areas of future scientific contribution for the present industrial revolution euphoria; cloud architecture in terms of process, metric performance, and validation model or methods require further researching. The present study also identifies the challenge of establishing communication among heterogeneous protocol and proffer the need for developing a solution which promotes compatibility of heterogeneous protocols like CoAP, MQTT, DDS, AMQP, and XMPP.

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