IoT Integration in Industry—A Literature Review

Bhavesh Chandrayan and Ravinder Kumar

Abstract The paper attempts to enlighten the managerial perspective of the Internet collaborative framework called as Internet of Things (IoT) which interlinks the fundamental concept of cyber computing to the available advanced manufacturing methods for an agile and truly wireless communication to carry out operations in the industrial sector. The correlation between developing a wireless domain framework to facilitate smart manufacturing is outlined in the paper with a channelized concentration on the latest innovation in the same pool along with the barriers and possible evolution of Supply Chain Management (SCM) in the future which will unite the manufacturing methods with a framework developed to facilitate the processes in real time along with a greater equipment control over the existing devices. The paper showcases the findings of various research authors in the field of IoT, and it propagates to the fundamentals of Industry Internet of Things (IIoT) and also collaborative manufacturing. The research also highlights the nature of the evolution and the vision for the future development of the IoT services which could seamlessly control the industrial operations with fluidity and minimum latency by integrating the elements of IoT into the elements of SCM.

Keywords IoT · Supply chain management · Cyber computing · Smart manufacturing · Industry Internet of Things (IIoT) · Industry 4.0

1 Introduction

In the recent years, the global competition in the manufacturing sector has put industries in great pressure to push out the products and services with respect to the market's fluctuating demand. The need for quicker transaction processes and better product life has accentuated the need for an integrated service which can facilitate the global variations with ease and minimal time loss. With the advancement of the applications of Internet, the concept of interlinking industrial services with it came

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into light and since then, a lot of research has been done in the field to generate a framework to manage the global demands using Internet.

IoT is a wide and dense web of devices and appliances that are embedded with sensors, electronics and connectivity to the cloud computing, enabling them to transfer real-time data. The purpose of this interlinking is to evolve a mesh of information to transfer over the Internet which can control the devices and applications as per the user's control without being physically present near the device. This direct integration is proposed to optimize the time loss, improve efficiency and economic profits and to minimize physical interaction with the devices.

Utilization of this service to control and develop the manufacturing sector has been thought upon for a long time with research being done to achieve this level of agility with no loss in the productivity. This advancement has bought the Fourth Revolution in the industry closer, and hence, the name Industry 4.0. Various manufacturing equipment and processes are controlled remotely using IoT to adapt to the dynamic customer demands and for the continuous optimization of the ongoing processes with ease. All the manual configurations are expected to be automated under IIoT which is expected to benefit the industry and create a dense network of smart manufacturing processes. This proposed model where the Internet is integrated into the devices using software and sensors can actuate the desired changes in the physical world without manual intervention across the globe. This concept opens the gateway to vast applications of this integration along with critical barriers which can hinder the expected fluidity of the whole framework, the reason why researchers have been digging deep to identify the issues and target them for solutions.

To understand the cyber network connectivity and its influence on the industrial sector, multiple research articles are reviewed which will help generate a concise outlook to how successful this technology can inculcate the automation process in the industry. The research papers bring about a detailed analysis of the IoT as a part of the Industrial Revolution and helps generalize this concept with a peek into the future prospect of IIoT and automation.

The paper bifurcates the basic framework of IoT and SCM into four and eight elements, respectively, which can help educate the fundamental concept of integration of one of the pillars (i.e. IoT) of Industry 4.0 into SCM (Figs. 1 and 2).

2 Literature Review

The literature review narrows down various researches on the topic to 20 relevant and latest researches which could help assess the challenges, limitations, barriers and practices of the IoT implementation in SCM which could help channelize and construct an intricate review and conclusion to justify the aim of the research paper. The various researches incorporating all the important keywords related to the research topic are briefed below (in descending order of their publishing year).

Birkel and Hartmann [1]. The paper showcases detailed introduction to the risks and challenges associated with the integration of IoT in SCM and helps model a

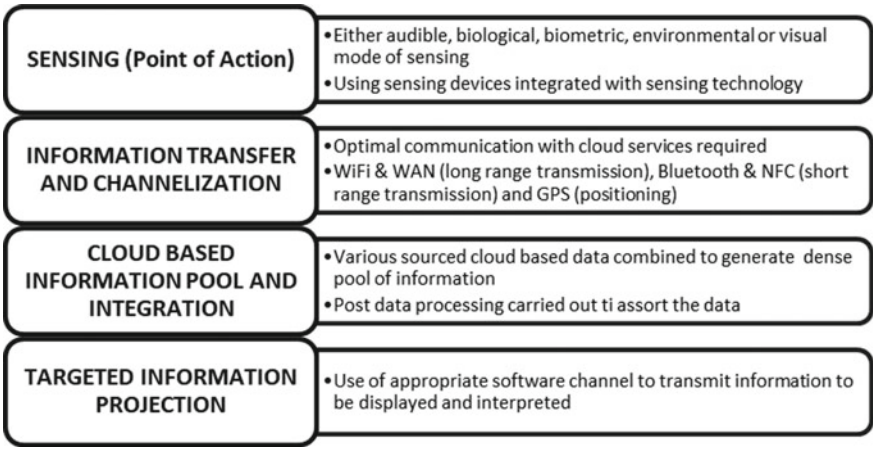

Fig. 1 Various elements of Information of Things (IoT)

holistic review framework for differentiating and understanding the literature incorporated so as to bring about the knowledge to practice and research on the deduced gaps.

Anandhi et al. [2]. The paper highlights the benefits of IoT integration SCM by using RFID tag tracking methodology to boost the real-time positioning and information pulse updates to avoid anti-counterfeiting by the application of cloud storage and Internet-based online information and data tracking architecture.

Tao et al. [3]. The paper reports the use of IIoT for smart manufacturing (SM). SM needs smart interconnection among the several attributes of manufacturing. This issue can be solved using IIoT; it compromises access hub (A-Hub), customized access module (CA-Module) and local service pool (LSP).

Yang et al. [4]. In this era of globalization, competitions are growing worldwide, and the need of customized products is increasing. To acknowledge this type of challenges, and to meet the customer demand, it requires new technologies. The paper talks to transform manufacturing sector using IoT which has an enormous potential connecting all the resources required for the production, based highly on integrated smart cyber-physical system (CPS).

Abdel-Basset et al. [5]. The literature demonstrates and suggests the construction of an intelligent and smart framework for SCM by applying IoT in the various steps of supply chain processes so as to collaborate big information data, products, process tracking, etc., which could upscale the infrastructure towards smart and efficient tradition.

Chamekh et al. [6]. The paper proposes a secured framework for information sharing and data tracking in the SCM by using Merkel tree architecture which claims to replace the peer-to-peer bases information transfer with additional security and scalable management scheme.

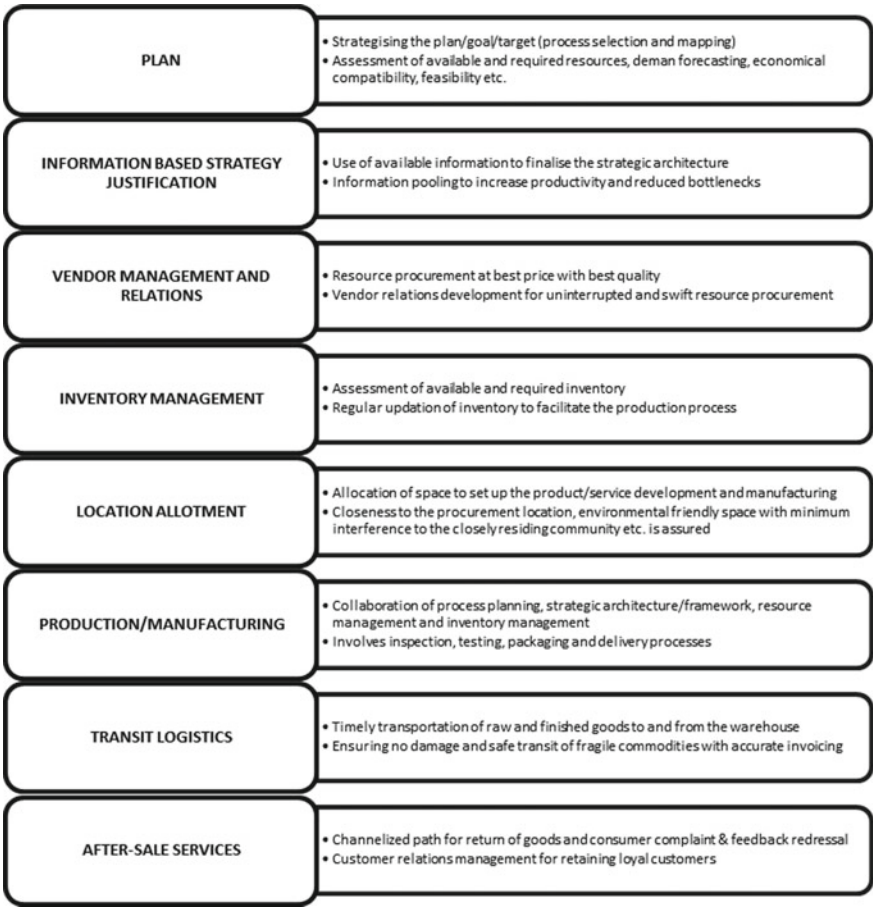

Fig. 2 Various elements of Supply Chain Management (SCM)

Wollschlaeger et al. [7]. This paper focuses on the industrial automation, with introduction of IoT, CPS and discusses the evaluation of industrial communication. And also, review is done on the effect of implementation of IoT and CPS on industrial automation with relation to Industry 4.0.

Lade et al. [8]. This article is the case study executed at one of the Bosch's large-scale manufacturing facilities to analyse the manufacturing and IoT. This paper reports the view on the future development of the IoT.

Chen [9]. Introduction of IoT was first carried out by Kelvin Ashton in 1999 to manage supply chain at Oil of Olay. This paper highlights the IoT devices and their application with limitation along with the assessment of the successful potential of the technology in future with respect to privacy and security.

Ben-Daya et al. [10]. The paper presents a bibliometric analysis while exploring the impacts and enablers for IoT in the processes of SCM to determine the limiting

factors or barriers which hinder the narrowing of research gap while suggesting solutions to future scope of study.

Haddud et al. [11]. The paper describes and aims to identify all possible challenges and limitations of the implication of IoT in SCM in an organization along with the literature-based benefits by conducting an online survey among academic sector researchers. The paper provides knowledge regarding the barriers to the implementation and significantly ranks them to assess the priority and criticality.

Caputo et al. [12]. This paper presents the theoretical discussion and analysis of IoT with its element from managerial point of view and trying to develop the dynamic conceptual framework, integrating the concept from the innovation and management, for manufacturing industries. This developed framework is applied in the case of additive manufacturing.

Bi et al. [13]. Important application of IoT is WSNs technology, a modelling and simulation approach for complete design process of WSN. Next generation manufacturing can be well supported by IoT infrastructure. It provides sophisticated channel to share data among manufacturing resources at anytime, anywhere.

Lu and Cecil [14]. This paper highlights the combined framework which gives a foundation for advance manufacturing domains and CPS. The architectural design of this framework is based on cloud computing and on focus of fairly recent initiatives in Europe, the USA and many other countries.

Bi et al. [15] Manufacturing enterprises operation and design require several different levels of decision making, and hence, the IT infrastructure for data acquisition and sharing has an impact on the performance of the enterprise in a broader sense. The paper objectifies at finding out the impact and correlation of the evolving IoT on the enterprises aiming towards modern manufacturing methods.

Tao et al. [16]. In pursuit of accomplishment of intelligent perception and various manufacturing resources, the investigation of IoT technologies in CMFG is being showcased in the paper.

Butala et al. [17]. This paper discusses a case study for the application of the IoT into the manufacturing sector. The paper outlines the IoT, its role in manufacturing and new possibilities which it will access for distributed manufacturing systems—i.e. employment of localized resources for the development of product and production via manufacturing systems.

Dutton [18]. The Internet is playing a significant role for social and economic development in the UK and worldwide. This paper provides a new vision for IoT, which will help to connect number of objects—'things' like sensors, monitors and RFID devices—to the Internet, and also it has social and economic implication which need to short-out.

Houyou et al. [19]. The paper elaborates the probable potential effect of the IoT methodologies and architecture infrastructure on the automation of the factory. Facilitation of reconfiguration in the proposed way serves as an enabler for flexible and agile manufacturing, similar to Lemgo Model Factory in this case. The delineation resulting in a reverse engineering approach facilitates the IoT focussed architecture in terms of working and component involved.

Liu et al. [20]. After Web 2.0, cloud computing and IoT are the new revolutions that are popular among the industrialists. The incubation of cloud manufacturing under the presence of cloud computing and IoT proves to be a paradigm shift in the manufacturing sector. Utilization and sharing of manufacturing resources are made flexible and effective with the use of cloud manufacturing as the latest mythology to organize activities associated to manufacturing.

3 Conclusion and Future Prospects

The paper collaborates the detailed explanations and scientific researchers from various authors to limelight the uses of IoT in the manufacturing sector, keeping in mind the limitations and ways to tackle the limitations. The penetration of Internet in the manufacturing and service sector has facilitated a smooth flow of work with seamless synchronization with the concerned devices and machines leading to a dense intricate network of devices interconnected and ready to be used in a click. The availability of wireless connectivity promotes this cloud-based technology to survive and develops into a productive tool to control electronic devices and with time and proper management can be used to configure the whole plant using a single smart screen.

It was clearly concluded that this cloud service can be put to maximum benefit if the mechanized devices can be automated to interlink them. The automation is the probable cause of slow development as machines require complex and delicate sensors to achieve wireless information transfer, and if this challenge can be tackled and implemented, the utilization of IoT can be optimized with ease.

The literature review also clarifies the difference in the theoretical conclusion of the various researches which identity the integration as a beneficial step for the organization yet the failed practical outlook which is due to various barriers affecting the overall management style of the supply chain. Each element or pillar of Industry 4.0 can be integrated to the supply chain with positive outcome provided the constricting factors or boundary conditions of the organizational management style is not conflicted, which would be a fair solution to maximize the technological advantage of the overhauling. Due to the dynamic organizational goals and prospects, variety of hindrances in the implementation causes the slow growth and limited benefits for this type of management automation.

The future research can be focused on deeper integration of this technology with artificial intelligence collaboration to fully automate the manufacturing sector with minimum human interaction which could boost the production rate and highly minimize the human error and factory waste. IIoT can influence the CPS to achieve remote device access over the globe which can remove the human proximity constraints by providing the resources to operate the device over the Internet. A strategic architecture is proposed which can simplify the elemental integration of IoT in the SCM to bring it closer to an ideal model for various industries (Fig. 3).

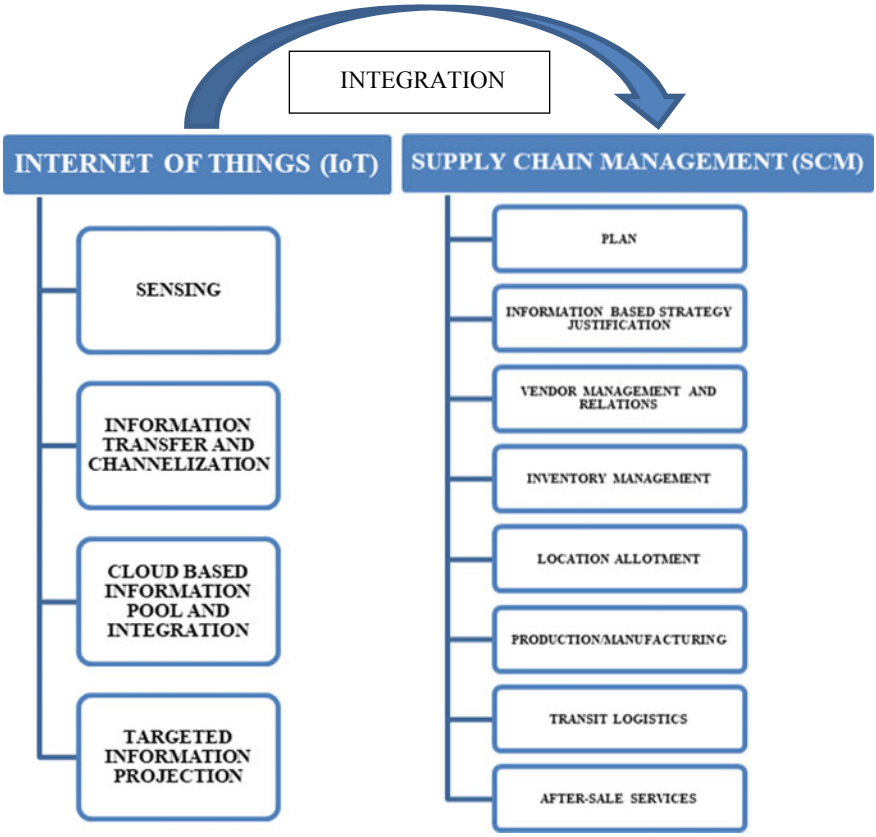

Fig. 3 IoT integration architecture for enhanced supply chain management

The effective integration of IoT in SCM can ensure the primary requirement of a successful manufacturing domain, i.e. ensuring the balance between demand and supply with agility and dynamic response to consumer's feedback and requirements. A step by step integration can help eliminate the elements of distress, and hence, boost the SCM in the long run. The framework suggests deeper study regarding the integration of individual elements of IoT and SCM to improve efficiency of SCM which could facilitate the transformation of Industry 3.0 to 4.0.

4 Research Gap

After compiling the literature review of various research papers, conference proceedings and published articles, it is clear to conclude that the implementation of IoT in the SCM has a noticeable differentiation in terms of real scenario practical demonstration of the proposed benefits to that of the theorized and study-based outcomes.

The three main factors of these barriers are domain based on technology, finances and politics, in terms of their area of hindrance and need more case studies to find solutions to them. The lack of case studies leaves this research topic with great scope of investigation and solution to the proposed issues with the implementation.

Developing nations find a great deal of issues with this implementation due to lack of technology, connectivity, cloud access, economic instability and inability to invest in a robust management which could aid the implementation and reap the benefits, rather an old traditional practice is more often noticed due to the lack of knowledge of the proposed architecture discussed in this paper, and hence, the research gap in terms of chronological advances in practice and automation is not recorded or presented. This calls for all research scholars to include their researches on this pillar of Industry 4.0 which can revolutionize the industrial sector globally.

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