Chapter 71
The Internet of Things (IoT): Capabilities and Applications for Smart Supply Chain

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ABSTRACT

As the Internet of Things (IoT) opens up new business opportunities, firms are trying to understand the impacts of the IoT revolution on their supply chain. Despite the tremendous interest by supply chain managers to leverage the IoT, there are still a paucity of studies that integrate the management side of supply chain with the technical side of the IoT. This chapter attempts to fill the current gap in research. This chapter discusses capabilities of the IoT-based supply chain applications. Then, it presents a conceptual framework of the IoT applications essential for smart supply chain. Finally, this chapter discusses technical and managerial challenges faced by supply chain managers in implementing the IoT.

INTRODUCTION

In today's hypercompetitive environments in which competition is among supply chain networks rather than individual firms, firms need to effectively manage increasingly extending supply chain activities. The supply chain has become the central organizing unit in today's global industries (Miles & Snow, 2007). As the Internet of Things (IoT) is opens up new business opportunities, firms are trying to understand the impacts of the IoT revolution on their supply chain. IDC (2014) predicts that the IoT base will grow at a 17.5% compound annual growth rate (CAGR), reaching 28.1 billion installed units by 2020, up from 9.1 billion in 2013 and the value of the market will reach $7.1 trillion by 2020, up from $1.9 trillion in 2013.

The IoT has significant impact on several aspects of everyday life and behavior of potential users (Bandyopadhyay & Sen, 2011). Assisted living, smart homes, e-health, and enhanced learning are a few examples of possible application scenarios in which the IoT will play a leading role in the near future (Atzori, Iera, & Morabito, 2010). The IoT will provide new opportunities for services and applications able to leverage the interconnection of physical and virtual realms (Miorandi, Sicari, De Pellegrini, &

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Chlamtac, 2012) and firms in most industries will rapidly adopt IoT-enabled applications in order to stay competitive. Many firms such as GE, Amazon, and Google are developing numerous IoT applications to capture real-time operational data and offer better services to clients. Connected cars, smart metering, and smart farming are examples of transforming traditional products and services into digital ones equipped with real-time data captured with IoT devices and sensor networks.

Recently, the IoT was recognized as a disruptive technology for supply chain. The use of the IoT for supply chain management is rapidly rising. For example, a large European cargo rail consortium, Deutsche Bahn installed a network-wide monitoring system to manage its entire rail network which comprises over 1 billion supply chain "nodes", collecting data on each segment of track, rail car, station, engine, and switch, and monitoring the condition of all of these things in real time. The collected data are fed into a control tower that aggregates them every five seconds to provide near-real-time information across the entire fleet. Deutsche Bahn has used these data to improve risk management practices such as real-time rerouting and optimization, considering all existing network traffic through nodes (Mariani, Quasney, & Raynor, 2015). Whirlpool is another example of using the IoT for internal supply chain optimization in routing work and locating misplaced inventory. Instead of using bar codes or a similar solution, Whirlpool used radio frequency identification (RFID) tags and readers across a manufacturing plant to give managers and operators real-time access to information for inbound logistics to the paint line (Mariani, Quasney, & Raynor, 2015).

The IoT helps supply chain partners monitor the process of a supply chain execution in real time and improve the efficiency and effectiveness of supply chain (Ping, Liu, Zhou, & Wang, 2011). Recent developments in the IoT have generated the capabilities of a highly visible supply chain where the location of arbitrary individual things can be determined at any point in time by all appropriate supply chain partners (Geerts & O'Leary, 2014). For example, the IoT benefits the food and agricultural product supply chain by improving the visualization and traceability of agriculture products and ensuring people's food safety (Zhou & Zhou, 2012). Industrial deployment of the IoT provides development of an ideal platform for decentralized management of warehouses and collaborative warehouse order fulfillment with RFID, ambient intelligence and multi-agent system (Reaidy, Gunasekaran, & Spalanzani 2015).

Despite the tremendous interest by supply chain managers to leverage the IoT, there are still a paucity of studies that integrate the management side of supply chain with the technical side of the IoT. This chapter attempts to fill the current gap in research. This chapter discusses capabilities of the IoT-based supply chain applications. Then, it presents a conceptual framework of the IoT applications essential for smart supply chain. Finally, this chapter discusses technical and managerial challenges faced by supply chain managers in implementing the IoT.

CAPABILITIES OF IOT-BASED SUPPY CHAIN APPLICATIONS

Based on the technology trends and literature review, this section discusses three capabilities of IoT-based supply chain applications: (1) monitoring and control, (2) information sharing and collaboration, and (3) big data and IoT data analytics.

Monitoring and Control

According to the Digital Agenda for Europe (European Union, 2015), monitoring and control refers to the control of any system, device or network through automated procedures managed by a control unit

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