

Chapter 4

Impact of Wireless Sensor Network Technology on Service Innovation in Supply Chain Management

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ABSTRACT

Driven by the rapid development of information and communication technologies (ICT) as well as today's globally competitive environment for enterprises, service innovation has drawn considerable attention in such fields as supply chain management (SCM). Wireless sensor network (WSN) technology, which can provide a mobile, scalable, and reliable monitoring solution, has gone through rapid development in recent years. The objective of this chapter is to provide an overview about wireless sensor network technology and a discussion on how this technology can be applied to modern industries and especially bring service innovation to supply chain management. An overview of the history and potential applications of WSN is provided for the necessary background. The architecture, topology, standards, and protocols of WSN are fundamentally important and thus introduced in details. In a general sense, the impact of information technologies on supply chain management and service innovation is then briefly discussed. After that, much emphasis is placed on the possibility, procedures, and critical challenges of implementing WSN in supply chain management. In the end, two case studies are provided to illustrate the application of WSN for service innovation in both cold chain management and healthcare settings.

INTRODUCTION

Wireless sensor network (WSN), also known as Ubiquitous Sensor Networks (USN), is identified as one of the 21 most important technologies for

the 21st century by Business Week (1999) and one of 10 emerging technologies that will change the world by MIT Technology Review (2003). Basically, a WSN is a wireless network consisting of spatially distributed small autonomous devices using many scattered sensors to cooperatively monitor environmental or physical conditions such as temperature,

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vibration, pressure, location or motion, at different sites (Römer & Mattern, 2004, Haenselmann, 2006). Low-cost and smart devices with multiple microsensors deployed in large numbers over wide areas and networked through wireless links and the Internet can provide an unprecedented feasible tool for automatically monitoring, tracking, and controlling the entities of interest.

It has been well recognized that supply chain management and its service innovation are strategically vital to corporate competitiveness and profitability in today's operating environment (Burgess, 1998). Supply Chain Management (SCM) offers a firm greater insights into potential opportunities and threats that its supply chain may carry by integrating supply and demand management within and across all supply chain organizations. The successful coordination, integration and management of key business processes across the entire supply chain determine the ultimate success of all supply chain members. The main goal of service innovation in SCM is to achieve information sharing in SCM and reduction of total cost, thus improving operation efficiency and enhancing competitive advantage. It is generally true that newer IT technologies can offer better services in managing the entire supply chain. With the recent development of WSN technology, WSN has shown its great potentials in different areas such as military sensing, environment monitoring, traffic surveillance, object tracking, nuclear reactor control, fire/flood detection, etc. Therefore, it is necessary to evaluate how this state-of-art technology can be applied for service innovation to reshape supply chain management.

Development of Wireless Sensor Networks

As its name may imply, the development of wireless sensor networks is closely related to the advancements of sensing, wireless communication, and computing technologies. The research in sensor networks originated from the defense

applications in sensor networks. During the Cold War, the networks of air defense radars as well as a system of acoustic sensors on the ocean bottom called the Sound Surveillance System (SOSUS) were developed and deployed. From then on, many more sophisticated sensor networks have been developed. Note that these sensor networks generally adopt a hierarchical processing structure. In other words, information is processed at consecutive levels until it reaches the user (Chong & Kumar, 2003). Modern research on sensor networks started in 1980s with the development of Distributed Sensor Networks (DSN). The technology components for a DSN were identified in 1978, which include acoustic sensors, communication under high-level protocols, processing techniques and algorithms, and distributed software (Habermann, 1978). Later, military systems soon utilized the benefits of sensor networks to network-centric warfare (Alberts, Garska, & Stein, 1999). In network-centric warfare, the mounted sensors and weapons are controlled by separate platforms that operate independently but share information with each other over a communication network. Sensor networks can provide multiple observations, extended detection range, faster response time, and the necessary redundancy for high reliability, and thus the detection and tracking of objects can be improved. It is well recognized that the development cost can be effectively lowered if the commercial network technology and common network interfaces can be exploited.

Wireless communication networks have a long history (Callaway, 2004). In 1920s, for example, the U.S. Army Signal Corps established the War Department Radio Net, a nationwide radiotelegraphic network that was called the largest and most comprehensive radio net of its kind in the world (Raines, 1996). Later, the Transcontinental Corps (TCC), a peer-to-peer network, was built to facilitate communication among different area nets in the United States, and this has become a basis for the architecture of wireless sensor network due to its low power ad hoc design and longevity

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