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ABSTRACT

The growing awareness of the strategic value of service along with higher product performance expectations has directed many industries to adopt service-centric competitive strategies in managing their supply chains. Service innovation based on currently available advanced technologies has become critical in improving enterprises’ competitive strengths. Wireless sensor network (WSN) technology, which can provide a mobile, scalable, and reliable monitoring solution, is emerging as a tool for service innovation in supply chain management. This paper provides an overview of wireless sensor network technology and discusses how it can benefit modern industries. The fundamental theories of WSN are introduced as well as an overview of the development. The impact of information technologies on supply chain management and service innovation is then briefly discussed. Much emphasis is placed on the feasibility, procedures, and critical challenges of implementing WSN in supply chain management innovation. Current and future applications of WSN are also provided, followed by a case study demonstrating the application potentials of WSN for service innovation in the healthcare industry.

Keywords: Service Innovation, Supply Chain Management, Wireless Sensor Network (WSN), Wireless Sensor Network Technology, Wireless Sensor Technology

1. INTRODUCTION

It has been well recognized that supply chain management and its service innovation are strategically vital to corporate competitiveness and profitability in today’s more complex and dynamic operating environment (Burgess, 1998).

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Supply Chain Management (SCM) offers the 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. With supply chain management being important at
present and in the future, the maintenance of a leading and innovative service is increasingly recognized to be crucial to survival and success (IfM/IBM, 2008). 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.

Wireless sensor network (WSN), also known as Ubiquitous Sensor Network (USN), is identified as one of 10 emerging technologies that will change the world by MIT Technology Review (Van der Werff, 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, 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 as well as for data collection, processing, and information sharing.

Generally, the more advanced information and communication technologies (ICT) can offer better services in managing the entire supply chain. With the recent development of WSN technology, WSN has shown their 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.

2. WIRELESS SENSOR NETWORK TECHNOLOGY

2.1 Development of Wireless Sensor Networks

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 and have since developed many more sophisticated sensor networks. These sensor networks generally adopt a hierarchical processing structure where 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). It is well recognized that the development cost can be effectively lowered if the commercial network technology and common network interfaces can be exploited. Similarly, wireless communication networks have also seen large advances since 1920s. The foundation of the amateur packet radio communications advanced the development of the Multiple Access with Collision Avoidance (MACA) channel access protocol that employs a binary exponential random backoff mechanism (Karn, 1990). In 1990, the 802.11 Working Group was established by the Institute of Electrical and Electronics Engineers (IEEE) 802 LAN/MAN Standards Committee (LMSC). The first WLAN standard was released in 1997, which enables data rates of 1 and 2 Mb/s. The 802.11 standard specifies the carrier sense multiple access with collision avoidance (CSMA/CA) channel access method, which is a refinement of the MACA protocol (O’Hara & Petrick, 1999). In 1997, the Home RF Working Group was formed as well, followed by the formation of the Bluetooth Special Interest Group in 1998 (Haartsen, 2000). Revision 1.0 of both specifications was released in 1999, representing the development of Wireless Personal Area Networks (WPANs).

Recent advances in wireless communication and computing techniques have resulted in a significant development in wireless sensor network. Low-cost sensors based on Micro-electro-mechanical system (MEMS) and nanoscale electromechanical systems (NEMS) are appearing. Advances in IEEE 802.11a/b/g-based wireless networking and other wireless systems such as Bluetooth, ZigBee, and WiMax
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