모바일 서비스를 이용한 Wireless Supply Web 모델링

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Wireless supply web modeling using mobile service

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요 약

모바일 서비스는 공급사슬의 모든 단계와 연관되어 있는데, 특히 재고 주문관리, 주문 충족, 구매, 물류와 모니터링 분야와 밀접히 관련시켜 볼 수 있다. 기본적으로 모바일 서비스의 핵심은 참가자들 간에 정보의 공유로서 이를 통해서 공급사슬의 지각과 반응의 효율을 높일 수 있다. 모바일 서비스의 장점은 편재성 (ubiquity), 속도, 추적, 위치확인, 개인화와 안전성에 있다. 공급사슬의 3가지 중요한 요소는 속도, 변화 및 가시성을 들 수 있는데, 모바일 서비스는 이 세가지 분야를 충족시킬 수 있다. 본 연구의 목적은 모바일 서비스를 이용해서 wireless 공급 웹을 모델링 하고자 한다. 재고관리, 원격 진단, 현장 작업자와의 통신, 추적과 모니터링을 포함한 고객요구 충족, 재고의 가시성, 실시간 shop floor data collection, 자산 추적 및 창고관리분야에 적용가능한 고객중심의 공급 웹을 모델링하고 RFID를 이용해서 창고관리 문제에 대한 프로토타입을 제시하고자 한다.

1. Introduction

Traditionally, supply chains created value through efficiency and low price. Today, supply chains have to create value through their flexibility, in which wireless or mobile technology makes it possible. Their design must accommodate a customer's changing mind after the order is placed so the company retains the control of the manufacturing and fulfillment process. Mobile technology is making every step of the supply chain more efficient and saving companies'money. The advent of more sophisticated information and demand flows has led to the creation of a variety of new supply designs, such as build-to-order, configure-to-order, and fulfill-to-order. Recently the use of Internet and enterprise data has increased supply chain velocity through fast and accurate collection and manipulation of enterprise data while maximizing service level (Kalakota, 2000). Lee and Whang (2001) proposed e-fullfillment concepts by making more use of the information flows than physical flows and capitalizing on current physical pipelines and infrastructures as much as possible for the last mile of delivery. The core concept is tied to five strategies: logistics postponement, dematerialization, resource

exchange, leveraged shipments, and the clicks-and-mortar model.

The supply chain model is classified into four categories; deterministic models, stochastic models, hybrid models, and IT-driven models (Min and Zhou, 2002). Deterministic models assume that all the model parameters are known and fixed with certainty, whereas stochastic models consider the uncertain and random parameters. Hybrid models contain the properties from both deterministic and stochastic models. As Shapiro observed, IT technology was the major driving force for supply chain innovations and the subsequent re-engineering of the business process (Shapiro, 2001). This enables IT-driven model as an important category. The mobile service-based SCM corresponds to the fourth category.

The applications of wireless technology range from B2C (Business to Consumer), B2B (Business to Business), and B2W/E (Business to Worker/Employee). In the B2C areas, portal servicesin Yahoo and eBay, electronic commerce in Amazon, Internet banking in Cashfree, mCommerce, and messaging service are major applications. E-Marketplace and SCM are important areas for the B2B. In the B2W/E, email, intranet, operational application, file service and sales force automation are major applications. With the use of wireless devices and mobile business solutions, the supply chain is transformed from a reactive, digitally enabled, linear process to a proactive supply web that acts much like a nervous system (Shankar and O'Driscoll, 2002).

Delivering mobility isn't just about wireless devices and networks. It's really about connecting people -- connecting them with one other, with their work, their homes and their play -- and supporting their experience regardless of which technology is used (Violante, 2001). In order to improve customer support by quick response, offering multi-media support, highly personalization and one-to-one customer support, an integrated call/web center referred as contact center is proposed (Pensa, 2001). This can respond more promptly for the customers equipped with the mobile devices.

The purpose of this paper is to propose an overall framework utilizing mobile service in SCM. In the areas of inventory management, remote diagnostics, communications with field workers, order fulfillment including tracking and monitoring, stock visibility, real-time shop floor data collection, asset tracking and warehousing, customer-centric mobile supply web is proposed and implemented for the wireless warehousing and replenishment system.

2. Mobile service technology for SCM

Mobile service technology provides communication without any physical connection in space, which supports the basic infrastructure for mobile service. Important technology building blocks for SCM are mobile device, browser, wireless network infrastructure, location technology, wireless enablement, security and transaction engines.

- Mobile device

Mobile devices available for SCM are digital/cellular/mobile phone, PDA (Personal Digital Assistant), two way Pagers and Palmtops or Laptops. These devices are sometimes SMS (Short Message Service) and WAP (Wireless Application Protocol) enabled. As all these devices are changing pretty fast, they will continue to push different types of functionality out of the devices.

- Browser

Wireless Internet is generally thought of wireless access to the Internet but also include the extension of enterprise applications and/or

data to mobile device. The mobile devices run in some sort of browser. The protocol, security, markup and scripting languages are different between wireline and wireless web browser, which is shown in Table 1.

• Wireless network infrastructure

Major advance in wireless infrastructure is the transition from analog to digital technology, which breaks data and voice into bitsand bytes, and transmits them across the airways. Wireless communications involves the transmission of radio waves from one source to a receiving point. Three key concepts for wireless network are wireless routing, spectrum, and transmission standards. Circuit switched and packet switched network are available in the routing. Data networks mostly used packet routing. Two major spectrums, 1.8 to 2-giga hertz and 800 to 900 spectrums, are available. These spectrums have divided radio frequencies in such a way that different technologies can run at different frequency rates, which enables different services coexist. Several standards are available to send radio signals from mobile devices to wireless networks. These are frequency division standards (FDMA: Frequency Division Multiple Access), time division standards (TDMA: Time Division Multiple Access), code division standards (CDMA: Code Division Multiple Access), and global standards (GSM: Global System for Mobile). GSM, which has been adopted in Europe, is a global standard for wireless communications that uses types of TDMA for the interface technology. GSM is 2.5 generation (2.5G) and the third generation (3G) will bring broadband IP networks. Other types of networks are satellite network, enhanced specialized mobile radio (ESMR), multi-channel multipoint distribution service (MMDS), and local multipoint distribution service (LMDS).

• Wireless enablement

Main components of wireless enabler are wireless infrastructure and wireless middleware. Wireless infrastructure has components parallel to web infrastructure. Through transcoding, wireless infrastructure can be achieved. Transcoding is automatic reformatting of any standard HTML web content to make the page small enough to send to a wireless device. Wireless middleware makesit possible to figure out how to handle multiple devices for the message to be sent out. They are XML based and use the concept of style sheets that corresponds to each device respectively. For example, while the cell phone allows 4 lines, 15 characters, more lines and more characters are available in the PDA. The web and wireless protocols and infrastructure are shown in Figure 1.

• Security and transaction engines

For the wireless security, public key infrastructure (PKI), wireless transport layer service (WTLS), WML signature, and elliptical curve cryptography (ECC) are adopted. Most wireless applications need some sort of payment capability, bill presentment capability, and transaction handling capability. These are the basic functions for m-commerce.

3. A framework for m-SCM

SCM is the process ranging from the initial raw materials to the ultimate consumption of the finished products linking across suppliers, manufacturers, distributors, and customers. It includes all information flow and coordination of the entire material flow from suppliers through conversion and delivery to customers. Through the use of wireless and mobile service in the SCM, velocity, variability, and visibility can be achieved on top of the traditional SCM. The

mobile resources related to SCM are inventory, truck fleet, sales and marketing people, field technicians, delivery status, and customer location data. These resources require many management issues such as planning, scheduling, tracking, tracing, reporting, optimizing, coordinating, and collaboration.

Mobile solutions that add to supply chain are:

- Better inventory management in warehouse, stores, and work in process through handheld wireless devices, tracking and scanning.
- Accuracy in the order fulfillment process through the seamless information flow and significant coordination process.
- Better communication through the supply chain based on wireless dispatcher in the call center enabling optimal routing, and JIT.
- Real time assettracking resulted in inventory reduction, eliminating order fulfillment variance, leakage reduction, and fewer returns.
- Remote diagnostics through remote monitoring and control.
- More responsive service management by redesigning postsale service and support functions.
- Real-time shop floor data collection resulted in the control and track of the manufacturing line.
- Reduced lead time, paper work and errors resulted in improved productivity.

A framework for mobileservice-based SCM, named as M-SCM, is proposed to obtain mobile service advantages by utilizing mobile technology. Figure 2 shows wireless information exchange in transportation operation. Warehouse, field personnel, truck fleet and transportation operation center are interconnected through wire and wireless network. In the transportation operation center, scheduling, tracking, fleet management, and dispatch operations are performed. Real time data and information are delivered among participating personnel or organizations. Figure 3 shows M-SCM strategy based on mobile service. Four criteria, time-based, asset productivity, technology, and relationship are proposed for the architecture.

M-SCM architecture of wireless monitoring and replenishment in warehouseis shown in Figure 4. In the warehouse, RFID (Radio Frequency Identification) tag is attached in each product. Information from RFID tag on each item in a warehouse goes into the sales transaction database in the terabyte capacity computer. At the sametime, suppliers can get a real-time view of store shelves. Through this process, the warehouse takes the advantages of higher visibility, on-shelf product availability, self-check out at the retail store, and vendor managed inventory. Regarding the inventory replenishment, continuous replenishment policy, optimizing model under uncertainty, and CPFR (Collaborative Planning, Forecasting and Replenishment) have been adopted in this environment.

In order to be operated properly, wireless supply chain should have additional important functions. They are mobility in warehousing, inventory, transportation and logistics; transaction/workflow enabler required for e-procurement; increased visibility and presence by mobile devices, tags, RFID, auto-ID, and sensors; immediacy because mobile device is ubiquitous and can access to information or transactions at the same instant when it needed; minimization of product return and improved customer satisfaction through CRM; optimal reverse logistics. Reverse logistics manages the movement of goods back through

the supply chain from the customer to the point of origin in an efficient way. Because of the policy from product warranty and satisfaction guarantee, product return is increasing, thus the reverse logistics is also a big issue in mobile supply chain areas.

4. Conclusions

Mobile services are fast emerging as means of improving SCM. Thus, mobile solutions can be applied to all stages in the supply chain: order and inventory management, manufacturing, logistics, and customer support. Some companies use bar code and wireless scanners to streamline their inventory management. Others use the technology in manufacturing areas for information sharing and real-time monitoring. In logistics, mobile solutions are employed to optimally place, pick, pack, and deliver, resulting in faster service and enhancing customer satisfaction.

Mobile service technology is reviewed how they can be used in the SCM. A framework for mobile service-based SCM is proposed which can improve visibility, efficiency and product availability. A scheme utilizing RFID in the warehousing is proposed as a real-life example. Incorporating mobility into the existing supply chain framework is an on-going process, not a one-time event. As e-business emerges, the linkage between mobile framework and e-business application is more required.

In the past, mobile solutions were mainly used in warehousing and transportation operations. Now, the mobile service is going to be integrated with the existing legacy system and internal ERP system. Especially, there is much interest in supply chain visibility and security issues. Visibility should provide means to track and monitor every supply chain event across any delivery point or logistics routing.

Acknowledgements:

This research was supported by Brain Busan 21 (BB21) program from the Busan Metropolitan City, Korea.

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Table 1. Web and Wireless browser

	Web browser	Wireless browser
Protocol	HTTP	WAP (Wireless Application Protocol)
Security	SSL (Secure Socket Layer)	WTLS (Wireless Transport Layer Service)
Markup	HTML	WML (Wireless Mark-up Language) HDML (Handheld Deice Mark-up Language)
Scripting	Java script	WML script

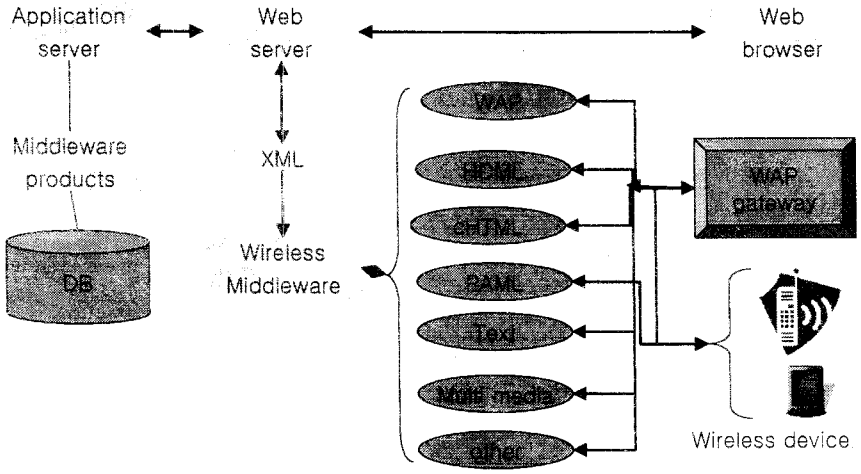

Figure 1. Web and wireless protocols

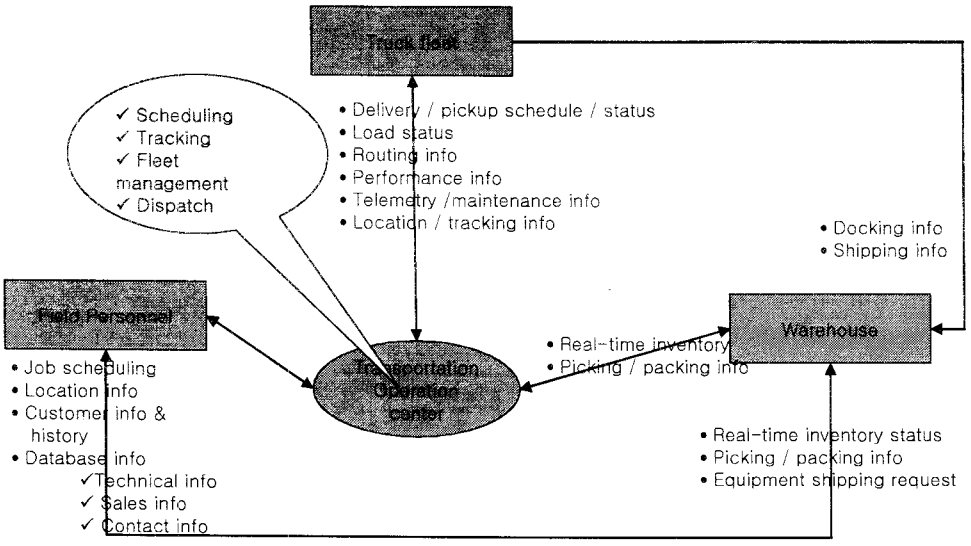

Figure 2. Wireless information exchange in transportation operation

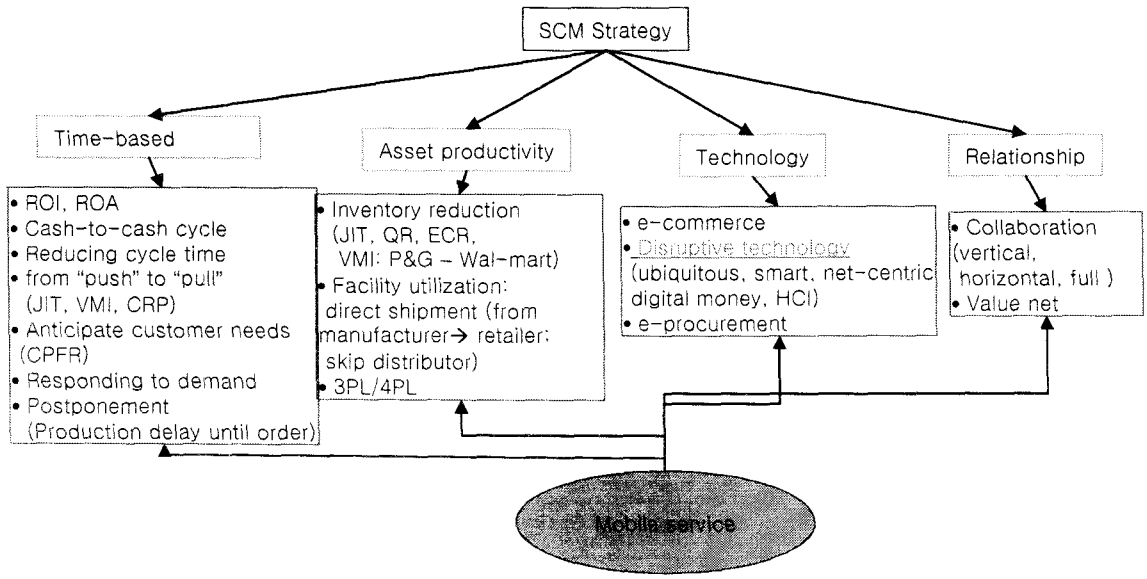

Figure 3. M-SCM strategy based on mobile technology

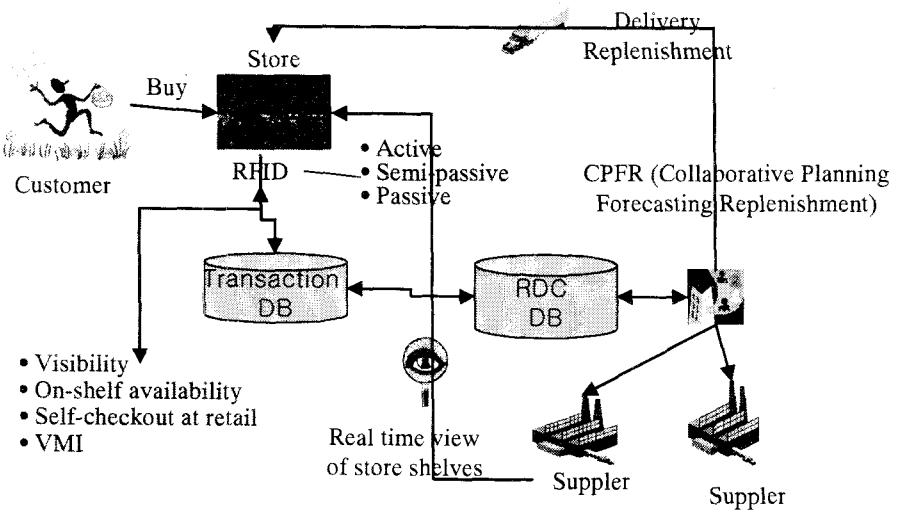

Figure 4. M-SCM architecture of wireless monitoring and replenishment in warehouse