

snapMan: A 2D-barcode based eSupply Chain Process Integration using Mobile Devices

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Abstract

With the recent development of the mobile technology and the rapid adoption of mobile devices, mobile phones have become pervasive computing units that can be easily integrated into many business processes. In this paper, we focus on the development of an electronics supply chain process integration which allows many processes in supply chain to communicate, transfer data and collaborate with each other under the same framework. The use of mobile devices is introduced to add flexibility and mobility to the system. We also implement 2D-barcode reader in the mobile platform to use as a primary reference input of our system. Preliminary test results on real mobile devices are presented to confirm the effectiveness of our system.

Key Words: Supply Chain Management, 2D-Barcode, mobile phone

1. Introduction

The 2D-barcode based eSupply Chain Process Integration using Mobile Devices are designed to take advantage of the widespread use of cell phones in order to provide businesses with an effective way to manage their supply chain.

The proposed system would help save cost and provide a competitive edge in the global market by giving companies the ability to take their business anywhere without jeopardizing their effectiveness

This system makes use of off-the-shelf mobile phones which can significantly reduce the cost of dedicated hardware systems.

2. Related Works

2.1 2D Barcode

The use of barcode can be tracked back in the 1940s when three graduated students from Draxtel Institute of Technology developed the first barcode. In 1952, the first

barcode patent (US Patent 2612994) was granted to the inventors and it can be considered as the beginning of barcode symbology era.

The traditional linear barcode, 1D barcode, is machine-readable data representation which is implemented on black parallel lines on white background with varying width. However, the capacity of the linear barcode has reached its limit when its use required more data to be encapsulated on the barcode. This brought up the development of a more sophisticated coding scheme usually known as 2D barcode. 2D barcode can encode much more data than its predecessor. This advantage is obvious in modern superstore where a tight integration of supply chain and logistic must be accomplished. With 2D barcode, product manufacturers can encapsulate more detailed data, such as manufacturing date, lot number or distribution center information in to product packaging.

Similar to 1D barcode system, there are many 2D barcode data representation; some of these are shown in Table 1.

Table 1. 2D Barcode System

DataMatrix	Widely used in industrial applications
Semacode	A variation of data matrix to be used on mobile phone
QR Code	From Toyota. Widely used in cell phones in Japan
PDF 417	Created by Symbol technology. This is the most widely used 2D barcode

In this paper, the Semacode has been utilized. Examples of the Semacode is shown in Fig. 1



Fig. 1 The Semacode tag containing URL <http://www.searcc07.com>

As seen in the code, the code is composed of two parts. One is the edge to provide alignment information of the barcode, and the other is the real data encapsulated in the code pattern. The Semacode can encode more than a hundred characters and can be read even some parts of the code are damaged. The Semacode is based on a ISO/IEC 16022 standard.

2.2 Supply Chain Management

The APCQ Process Classification framework [3] has classified Supply Chain related process in delivering products and services related activities. The Supply Chain Management composes of many sub processes as follow; Supply Chain Planning, Procurement, Manufacturing, Delivering, Logistic. This framework provides definition of each process in the supply chain management activity as follow:

The Supply Chain Planning process involves all process in planning including managing the demand, creating material plan and scheduling production to meet the actual demand

The procurement process is used to procure material and services needed to fulfill business activities. This process is composed of purchasing, sourcing and inventory management. Then, this process can be further broken down into sourcing

strategies, selecting suppliers and developing contracts, ordering material and services and developing suppliers.

The production process can be called production/manufacturing/delivering product. This process encompasses many sub processes: scheduling production, producing the product and delivering it to the appropriate site and performing maintenance on the capital equipment used during production.

The Delivering to customer process category includes all of the processes that are included in servicing products produced elsewhere in the supply chain. These processes include confirming the specific service requirements, identifying and scheduling resource to meet the service delivery requirements, providing the specific service to the customer, and ensuring that the quality standards are met and the quality of the service is good enough to meet customer demands.

Logistics is the process that plans, implements, and controls the forward and reverse flow and storage of goods, services, and related information between the point of origin and the point of consumption in order to meet customers' requirements. This includes defining a logistics strategy, inbound and transportation, warehousing, outbound transportation, and managing reverse logistics.

The Supply Chain Management Process has got a lot of attentions during recent years [1]. Because, there is an increasing need to produce and supply a large number of goods globally within time limitation. Hence, the supply chain management has become an important building block for modern business unit.

2.3 Mobile Devices in Supply Chain Process

There are many mobile devices involving the Supply Chain process. Most of them are data entry point devices. There are many standard used in these devices such as barcode, RFID, 2D-Barcode.

A Barcode system are considered the predecessor of other systems. These devices encompassed barcode reader with LED or laser reader. And, they have internal data storage for collecting the data read by their barcode readers. Some of these devices have wireless LAN connectivity or proximity connection via IrDA or Bluetooth.

Besides traditional barcode system, there is a new RFID [2] (Radio Frequency Identification) based system. This system requires no line of sight appearance of a tag label. It just needs the tag to stay within its scanning range. The range of an RFID based system is depend on the band of radio frequency used in scanning. RFID operating frequency ranges from 125 kHz in HF band to 900 MHz in UHF band. The frequency affects the RFID regarding reading distance and the size of RFID tag. In addition, there are two types of RFID Tag, passive and active. The passive tag responses with scanning frequency only. On the other hand, the active tag can send the data out periodically without the need of external scanner.

A 2D barcode based system is now available in some modern supply chain systems. The 2D barcode based system usually tightly couple with data entity in the process. For example, the barcode reader can act as an input to the system when the cargo boxes reach logistic staffs.

The devices used in the Supply Chain Process are often dedicated hardware

designed for working in a factory, as shown in Fig. 2. Hence, it is cost prohibitive to deploy the 2D barcode based system for supply chain integration in a large scale.



Fig. 2 Handheld barcode reader system

3. System Architecture

Our system is considered a client server based system where mobile devices are used as an information entry point or information retrieval point.

We focus our work in the mobile phone with limited capabilities. Hence, we do not need complex Smartphone to run our application. The application requires only J2ME environment and at least VGA resolution camera.

The connection between the mobile phones and the server can be varied upon the network availability. Generally speaking, the primary data connection is done over GPRS/EDGE connection. But, if there is a faster connection such as WLAN or 3G, It can utilize those connections transparently to the users.

The system architecture can be described in Fig. 3.

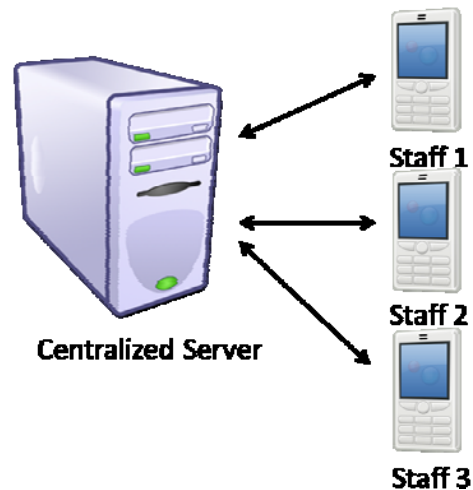


Fig. 3 System Architecture

4. System Design

The system intends to use throughout the supply chain and depends on mobile phone installed with the application.

To fulfill the requirements, we have divided our development into five modules each module corresponds to the definition of Supply Chain Management.

In following subsection, we will exemplify our system with a scenario of sushi factory where it needs to purchase raw material from farmer or wholesaler and process the

4.1 Planning process

Our system serves planning process by providing real time of raw material and finish good in the chain. These data process from the central server and then transfer to the mobile devices to provide information that can help staffs make a correct decision on supply chain activities.

Roughly speaking, this process is an information retrieval process.

4.2 Procurement

The system provides flexibility in procurement raw material for the production. Procurement Staffs carrying the mobile devices will input the data about how much raw material have been purchased and at what price. The data will be transferred back to the central server to update current status of the supply chain. The procurement staffs also have the order directly on their mobile devices.

At this point, raw material pallets will be packed and labeled with a 2D barcode generated from client computer. The pallet will be transported to the next station following the data stated in the label.

4.3 Manufacturing

The data on 2D barcode on each material pallet will guide the raw material into the right production lines. Here, raw material from many sources will be combined to produce finished precuts. The staff in the production line can use the mobile devices to read 2D barcode on material pallet to make sure that it enter the production line in a correct order.

After leaving production line, the products will be labeled with a new set of 2D barcode. This is item level labeling which inherits information from earlier process, such as supplier for material or material reference code.

4.4 Delivering products

After leaving production line, the products will be moved to QC section. Here, staff will use their mobile devices to capture the 2D barcode on each item when he accepted the quality of that item. Hence, in case of incorrect QC, the data can be traceable back to the QC staff. This helps

the factory improve effectiveness and reduce error rate of the post production operation.

4.5 Logistics

The finished good will be routed to distribution center. The pallet of products will be labeled again with a new set of 2D barcode. The pallet will be distributed according to the data on its 2D barcode.

5. Conclusion

We have presented a scalable framework for supply chain management using mobile devices. This framework provides greater flexibility for human operators to operate without location restriction.

The data exchange system between a centralized server and mobile devices provides up-to-date information to each operator. It is also interesting to investigate more on the use of dedicated 2D barcode reader comparing to mobile phone based reader. We are also interested in developing this system to cover more native mobile platform such as Symbian OS or Windows Mobile.

References

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