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Overview of an Advanced Warehouse Management System

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OVERVIEW OF AN ADVANCED WAREHOUSE MANAGEMENT SYSTEM

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ABSTRACT

Today's warehouses are no longer merely places to accumulate and store inventory to meet future demand. Through the use of real-time technology, warehouses are being transformed into distribution centers that speed inventory through the supply chain and configure the goods just prior to shipment to meet customer requirements. Therefore, today's Warehouse Management System is expected to be a key link in enabling efficiency in the overall supply chain process [3,7]. The modern WMSs are expected to provide extensive warehousing functions as well as a wide range of value-added services. WMS vendors are beginning to bundle other applications that are traditionally associated with Supply Chain packages. This paper introduces an advanced e-Warehouse Management System (eWMS), its high level functionality, its architecture, and a high level benefit analysis over existing WMS implementations. In addition, a brief survey of WMS market in Hong Kong is also described.

BACKGROUND

For well over a decade, distribution centers have been managed and controlled with WMS implementations which at the time were designed to meet two different inventory models, pallet driven or package driven processing. A pallet driven systems is most often found in regional or national distribution centers which ship replenishment pallets to their local consumer storefronts. The alternative, is package driven systems, most often found in catalog business models, designed to provide fulfillment of consumer orders. Package driven systems often require more in depth planning functionality in order to meet the more complicated fulfillment model, and as such, designing a system to handle larger quantities of orders, as well as processing these orders in a timely manner is critical to distribution center financial and fulfillment operations.

Hong Kong used to have a large number of factories and manufacturing facilities until about 15 years ago. With the escalating cost of doing business and labor wages in Hong Kong, most of the factories have already been shifted to China and other countries with lower costs. As a result many of the warehouses and distribution centers have also been shifted out of Hong Kong together with the factories. Therefore there is not much demand for WMS from the manufacturing sectors in Hong Kong.

Today users of WMS in Hong Kong could be divided into three categories:

1. Distribution Centers / Internal Warehouses
   The Distribution Centers (DC) are usually operated by the wholesaler or importers which use the DC's to store and ship goods to retailers. An example is the Dairy Farm Group, which is a wholesaler of grocery goods with several distribution centers in Hong Kong. The internal warehouses are usually used by distributors or retailers to keep inventories. An example is the Park n Shop Supermarket chain and the IKEA furniture stores, both have internal warehouses in

Hong Kong. Distribution Centers and Internal Warehouses in this category tend to be traditional and pallet driven warehouses.

2. Docking Warehouses
   Hong Kong is a major entry and transfer point for cargo shipping into and out of China. The cargo in transit are stored in docking warehouses operated by the shippers or consolidators. For example, the Hong Kong International Terminal (HIT) and Hong Kong Air Cargo both operate large warehouses for docking storage. Docking Warehouses, including cold storage, usually have quick turn over. Like the DC's, they also tend to be traditional and pallet driven.
3. Third Party Logistics (3PL) Warehousing
   Some small and medium enterprises (SME) in Hong Kong have started to outsource their logistics operations to the 3PL providers. The 3PL providers provide end-to-end logistics services to their customers, and warehousing is one of the logistics services they provide [2,8,9]. In addition to the SME's, customers of the 3PL providers also include e-businesses such as e-tailers, which is a natural fit for 3PL. Some of the larger 3PL providers with warehouse operations in Hong Kong are Kerry Logistics and Jardin Logistics.
   3PL warehouses for traditional business customers are mostly pallet driven. But those targeted for e-fulfillment business may tend to be package driven and Internet-based to cater for e-businesses and to support large number of small orders with quick turn-around time.

MARKET GAP

As the new market of business models, whether eCommerce related or not, have evolved to require more rapid fulfillment of consumer orders, a gap has grown in the ability for existing WMS implementations to meet the demand. Most WMS implementations which exist are based on technology and design which is over fifteen years old. Many are mainframe driven, do not take advantage of newer database technology, and are difficult and costly to maintain. These older systems are inflexible to new business requirements for the sheer amount of time and money with which to make system enhancements or to add entirely new functionality.

Many existing systems were designed to work in an environment where information passed from consumer to supplier, and supplier to supplier, in a much slower fashion, on the order of days. In today's market, where information and work flow is expected to move on the order of hours, if not minutes and seconds, these more archaic systems do not meet the demands of the evolving business models, nor are they affordable to modify to do so. Many existing companies expend millions of dollars to patch together wrapped solutions around their existing problems, moving only a small part of the way to solving a growing problem.

WMS TECHNOLOGY

WMS Evolution and its case in Hong Kong

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The modern WMS are expected to provide extensive warehousing functions as well as a wide range of value-added services. WMS vendors are beginning to bundle other applications that are traditionally associated with Supply Chain packages. An example is EXE Technologies' WMS product. On the other hand, many Supply Chain packages have already incorporated WMS modules into their offerings. SAP is a good example of this. In any case, there is no question that modern WMS software must be able to interface with or support other supply chain functions such as fulfillment, production planning, and distribution.

Many WMS today are also moving towards or offering options to support Web-based environment. Aside from being a natural fit for e-commerce businesses, a Web-based WMS offers many benefits. It is faster to deploy, easier to upgrade and distribute, eliminates issues involved with multiple client platforms. A Web-based WMS could also support a distributed warehousing environment linking multiple suppliers and customers more effectively.

Most modern WMS utilize a 3- or n-tiered architecture, separating client interface, data storage, business logic and backend processing. The n-tiered architecture improves performance and scalability of the WMS. Some WMS also employ a rules-based architecture design, providing users with the flexibility to re-configure the systems to support changes in business operations.

In addition, bar coding and other automatic identification tools have become standard equipment in almost all warehouses. RF hand held devices are also widely used for real time data transmission and operator control. Support of these equipment and devices are also expected from today's WMS.

ASP

In Hong Kong some 3PL and 4PL providers are beginning to offer ASP (Application Services Provider) services on WMS along with other logistics applications. Under an ASP model, warehouses pay a monthly rent, as opposed to owning the software related tools outright. The ASP model should be attractive to the small companies because it gives them greater access to software that they could not otherwise afford and it eliminates the need for maintaining the WMS software. However, companies in Hong Kong

are still resistant to the ASP concept in general as they are concerned with issues such as security and outsourcing critical business applications. More selling and education on ASP to consumers are needed before the ASP model for WMS will take off in Hong Kong.

WMS Functions and Features

The following is a summary list of the common features of the WMS packages surveyed in the Hong Kong market. The list focuses on the key warehousing management features but not other encompassing supply chain functions. It is also not a feature requirement list from any specific customers, since specific customer input was not available during this market study. In addition, not all WMS packages offer all or the same features listed below.

Common WMS Features

- Receiving
  - ASN and EDI / XML support
  - Cross docking
  - Auto Assignment
  - In-bound serial tracking
  - Returns processing
  - Audit Trail
- Shipping
  - EDI / XML support
  - Interface with ERP / order management systems
  - Order wave planning
  - Wave release and allocation
  - Shipping Label Printing
  - Out-bound serial tracking
  - Audit trail
- Picking / Packing
  - Pallet storage and picking
  - Package pick and pack
  - RF directed pick and pack
  - Auto identification
  - Bar coding
  - Packing label printing
- Put Away
  - Storage location planning
  - System controlled and routed
  - Cross docking
  - Bar coding
  - Lot & serial number tracking
- Inventory Management
  - Inventory planning
  - Inventory moves, adjustment, and counts
- RF Technology
  - Operation control
  - Location and package Identification
  - Real time data update & retrieval
  - Label printing
- Reporting
  - Inventory reports
  - Shipping / Receiving reports and documentation
  - Stocking reports
  - Order reports
  - Performance reports
  - Billing reports
- Billing (3PL)
  - Auto billing calculation from operation data
  - Customer billing
- Planning / Optimization
  - Warehouse operations planning – e.g. stocking, picking, packing, shipping and receiving
  - Inventory allocations
  - Pallet building and space optimization
  - Load planning and balancing
- Fulfillment Management
  - Order processing and planning
  - Shipment and order tracking
  - Replenishment management

SYSTEM OVERVIEW OF AN ADVANCED EWMS

Inventory Model

The eWMS is based on a Load Based inventory model. This model abstracts all inventory items in the warehouse into a generic load, and then differentiates the loads into traditional pallet loads, case or carton loads, and item loads representing a single, saleable unit of stock. This design allows for technical architectures which take advantage of more modular, plug and play functionality and control over what a particular load undergoes. Changes to receiving, material putaway, replenishment planning, order picking, and shipping requirements can then be specialized by the type of the order.

Data modeling of load driven inventories provides for more accurate inventory tracking and planning. This increases inventory control, while allowing for optimizations in the operational efficiencies of the warehouse as better planning is achieved by more focused use of inventory, its locations, and reduced material handling.

Order Management Model

The eWMS tracks fulfillment orders based on a state model of order processing. This allows for better translation of business rules to these order states. This in turn increases the flexibility of the design by providing a clear mapping of the fulfillment process to these order states, and allows new order states, or sub-states to be incorporated into the design. Order states include *Pool, Planned, Pull Forward (replenishment), Picking, Packing, Shipping*.

The level of control provided by the order state model allows for increased visibility by the business into the status of a particular customer order, as well as better operational control of the fulfillment batches being processed in the distribution center.

Planning Functionality

Based on the architecture and the technologies used, the eWMS is capable of having different fulfillment planning modules plugged into its functional core. Whether the business model and the distribution center uses *Pick and Pass*, *Order Picking*, or *Wave Planning* picking models, the component nature of the eWMS allows for different replenishment and picking models to be used.

System Variations

The component nature and browser based technologies of the eWMS allows for rapid customization of the system to meet specific business requirements. System variations can include bulk fulfillment (the shipping of pallet sized orders) from a consumer to business model to allow for business to business fulfillment from the same distribution center. Other variations can be added to the eWMS design without breaking the backbone of the system foundation.

ARCHITECTURAL OVERVIEW

Data Driven Model

The eWMS follows an object oriented model, allowing for the data representing operational and functional requirements to drive the system. This allows for more rapid response to changing business requirement, by adding behavior to the system objects representing orders, inventory loads, material handling equipment, storage bins, and even the warehouse itself.

Component and Object Oriented Framework

The eWMS will be implemented using J2EE technologies. The architecture uses the best in design practices, creating a core framework of objects to represent the business entities, and allowing for reduced development time in specializing the behavior of the core objects to fulfill the functional requirements of the client's model.

Component design and technologies will allow the eWMS to create plug and play components, allowing increased flexibility in operational evolution of our clients business models. Object oriented components also increase software reuse, creating a reduction in overall development and maintenance costs to the final product.

Browser Based Technologies

The eWMS takes advantage of internet browser based technologies, implementing the system in a write once, run anywhere environment. This type of technology can be increased to run on Wireless Application Protocol (WAP) enabled devices. This allows for the long term integration of new hardware technologies with the eWMS being able to feed these new devices with the proper information.

Integration of the system to utilize telnet based Radio Device Terminals (RDT's), as are used in many current WMS, implementations is also planned as part of the design. The prior incarnation of WMS developed by the team including support for Symbol and TekLogics RDT's directly.

Distributed Processing Model

One of the key architectural characteristics of eWMS is its distributed processing nature. Instead of using mainframe technologies, the eWMS is designed to allow a distribution center to operate as a stand alone facility, taking orders from the enterprise, but being able to plan, fulfill, and ship its consumer orders without direct dependency on the enterprise computing resources. This allows for more efficient use of computing equipment, reduced hardware requirements, and more reliable operation in the face of international and multi-site distribution centers. Prior incarnations of the system have run on departmental sized servers, reducing the hardware cost per facility from millions of dollars to tens of thousands of dollars per site.

Benefits Over Existing Models

Some of the benefits of eWMS over existing WMS incarnations:

- Internet strengthened system by design, not as an afterthought.
- Rapid data interchange over existing network connections without the need for expensive middle-ware solutions.
- Distributed processing model to reduce costs and increase operational control.
- More adaptable design and technologies to allow for rapid response to new business requirements.
- Browser based technologies to allow for better user access and reduced training time.
- Strength of proven inventory and fulfillment models, while taking advantage of the leading technologies in the marketplace (Oracle, Java, XML).

CONCLUDING REMARKS

In this paper, we have presented the importance of an effective and efficient WMS. It is the foundation of any SCM and eLogistics. We have also described a high level architecture on an advanced eWMS that is web-based, n-tiered, data driven and fully distributive. Furthermore, the relevance of eWMS to the Hong Kong economy is pointed out and surveyed. We believe that when China joins WTO, the demand of such eWMS will be tremendous.

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