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Benefits of an item-centric enterprise-data model in logistics services: A case study

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Abstract

The paper uses a case example to present a novel way of building enterprise information systems. The objective is to bring forth the benefits of an item-centric systems design in environments that require real-time material visibility, such as in logistics service provision. The methodology employed is case study and metadata modeling. Managers of SE Mäkinen, a Finnish car distribution company were interviewed on the implementation and operation of their award winning enterprise system. The case example was then analyzed using a generic metadata model of item-centric systems.

The main finding of the paper is that introducing an item-centric model facilitated responsive service in the distribution of automobiles. The practical implications are that when starting to develop a new enterprise system, managers in logistics services should consider an item-centric design solution as an option to the conventional location-based design for enterprise-data models.

Keywords: Materials management; Data model; Tracking; Logistics services

1. Introduction

Information systems can be used to link all areas of an enterprise [1]. At the core of an integrated enterprise system is a detailed data model that links the functional components of the enterprise, such as order administration, accounting, and materials handling. However, despite the success of enterprise systems in manufacturing, there have been difficulties in introducing comparable systems in logistics service provision. In particular, tracing, service customization and real-time control across several organizations pose problems. In this paper we show how these problems arise from shortcomings of the location-based data model in logistics service provision, and how they can be solved with a different approach to the data-structure.

The paper is organized as follows. First, the location-based data organization framework is examined and its drawbacks are analyzed from a logistics service perspective. Next, an alternative, item-centric, systems design is presented, and its benefits in logistical applications are discussed. The presentation is based on a case study of the award winning enterprise system of SE Mäkinen, a Finnish car transportation company. The paper concludes with discussion of the wider applicability of item-centric data models in enterprise-wide systems.

2. Problems of the location-based data model

The data model for material flow management in location-based systems is built around locations, transactions between the locations, and operation orders that produce the transactions, e.g. between machines or warehouse locations [2–4]. The concept of an account has been used to track goods and material flows between locations since the early days of book-keeping [5]. Each account represents a particular type of material enumerating the quantity or balance of this material in a specific location.

Fig. 1 illustrates the material management function in a location-based design. An account represents any location, facility or container, which can store material. In the most basic of designs the material quantities, the material numbers that identify the material types, and the lot numbers are all recorded as properties of a location. If material is moved or processed,

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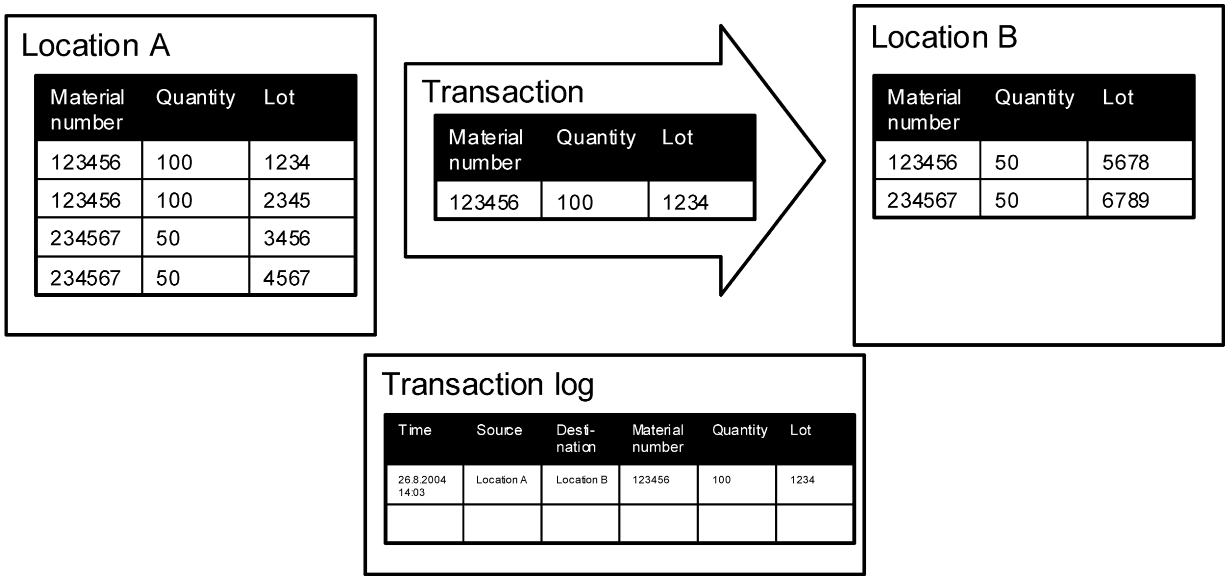

Fig. 1. Accounts and transactions are the basis for managing material flows in the location-based data model.

then a transaction occurs. This changes the material balances of one location (material issue or material receipt) or two locations (material move). Each transaction can be recorded to a transaction log for tracing purposes [3].

Before the introduction of enterprise information systems, operational control was performed by utilizing paper forms. This historical aspect can be seen in the operation logic and data model of many current systems: instead of focusing on the material processed, the systems focus on the document flow that controls the process. That is, for each process step a process order is created, and process is controlled by linking and scheduling these process orders [6]. An order, when processed, consumes and creates material [3]. This design feature causes several difficulties when applied to logistics service provision, which are discussed next.

Fig. 2 shows a metadata model of the material handling part of a location-based enterprise system. The model has been formulated by analyzing the data models of the SAP R/3 system and the Compiere open source system. The legacy of paper-based control can be seen clearly in the data model. In a paper-based system, an order is a form that contains several lines that list the amount and type of materials that are scheduled for delivery. In the location-based design, this structure is directly mapped using the data entities order and order line. Inventory and other transactions are presented in similar manner. In the case of inventory the line level is linked to inventory locations, and transaction lines are linked to transactions. Linking a specific lot of material to orders, inventory, or other transactions requires that a material lot entity is specified on the line level. From the system point of view, this illustrates that traceability is an extra functionality rather than a fundamental part of the system.

The problem with the location-based system design in logistics service provision is that it does not inherently support linking handling data to individual material units. This functionality is called tracing, which is defined as the ability to preserve the identity of the product and its history ([7], p. 8). Regardless of the lot tracing structure present in the location-based model presented above, a primary concern with the design is the difficulty to track and trace individual product. This is because material is assumed to be handled in lots according to product types, and individual material units are assumed to be anonymous. This facet of the data model poses functionality limits on the traceability component of the system. Only lots can be traced [4]. Furthermore, this inability to control individual items results in difficulties for logistics service providers that aim at improving their responsiveness and offering customers more real-time control of the material flow.

The lot tracing functionality, which can be implemented in a location-based design to improve visibility and control, has inherent weaknesses. Problems arise from three factors: physical lot integrity, data collection and lot-process linking [8]. As the complexity of the system increases, it becomes harder to maintain lot integrity. The traced lots become smaller when the variety of products increases, and consequently the need for lot splitting and joining increases. The problems caused by altering lots could in theory be avoided by maintaining a standard small lot size throughout the supply chain. However, the problem with this solution in a location-based system is that additional line-level transactions would be needed in the system, many of which are redundant.

Lot integrity can also be compromised through lot mixing, lot-end mixing or lot-sequence mixing. In the instance of a relatively simplistic original equipment manufacturer (OEM) case presented by Steele [8], these effects led to dramatic outcomes. If a defective component was found in a finished product, then the source of the component could be narrowed down to only 12 material lots. Conversely, if a defective lot of components were found, 22 pallets of finished products had to be checked to find all the defects with certainty. These problems are direct consequences of anonymity of materials and products.