INFORMATION
TECHNOLOGY JOURNAL

Research of Logistics Information Tracking System Based on EPC Technology

[1,2]jiao Yabing
[1]Shandong Yingcai University, Jinan, China
[2]Dhurakij Pundit University, Bangkok, Thailand

Abstract: Based on frequency identification and electronic product code technology, this study proposes a throughout the whole process of supply chain logistics information tracking system model for a variety of customers, logistics information tracking platform. Logistics information tracking system is constructed according to the model, the basic working process of the system design. EPCIS event types for the logistics information tracking system and EPC data and extract the data storage design, Aggregation events, for example, the XML language, to describe the EPCIS event, Finally Aggregation event tracking algorithm. Logistics information tracking system applications will play an important role in logistics process supervision, logistics visualization management.

Key words: Radio frequency identification, electronic product code, logistics information tracking, electronic product code information service, tracking algorithm

INTRODUCTION

Radio Frequency Identification (RFID) in the 1990's began to rise and gradually maturing of an automatic Identification technology, is the use of Radio Frequency signal and its spatial coupling, transmission characteristics, implementation of static or mobile Identification to identify items of automatic machine (Bai and Liu, 2012). RFID tag has a small size, large capacity, long life, reusable, can support fast read and write, non-visual identification, mobile identification, multi-target identification, location and long-term follow-up management. The Electronic Product Code (EPC) is a number designed to uniquely identify every single instance of an object, Ideally, the EPC is the only information stored on a RFID tag including an EPC Manager Number (could be a GS1 Company Prefix), an Object Class and a Serial Number. Internet of things with the Internet, RFID and other wireless data communication technology, to achieve the identification and tracking of individual commodities. Based on these characteristics and apply it to all aspects of logistics, commodity production, transportation, warehousing, sales and consumption of the whole process of tracking, to logistics management, visualization and goods anti-counterfeiting purposes, has a broad development prospects (EPCglobal, 2007; Zhu et al., 2012). The focus of this study combined with the RFID to the whole process of the supply chain of goods, build the RFID logistics information tracking system, according to the commodity code will be distributed the items of information in time series to obtain and process integration into a complete movement of goods information chain, to provide users with a history of certain types of product traceability information.(Li et al., 2012)

RFID system is mainly composed of Tag, Reader and Antenna to be used in three parts. Tag is composed of coupling components and chips, each tag has a unique electronic coding; Reader to read and write tags information of electronic equipment; Antenna rf signal transmission between the device tag and to read and write. Logistics information tracking is logistics enterprise to provide end-to-end regulatory means, can improve the efficiency of logistics, reduce logistics costs, logistics tracking by combining the RFID technology, GPS technology, INTERNET technology, the implementation of land, sea, air and other logistics form items tracking, greatly improved the opaque status of goods transportation, logistics process visualization and can provide users with the historical retrospection, the purpose of anti-counterfeiting.

EPC is designed as a universal identifier that provides a unique identity for every physical object anywhere in the world, for all time. Its structure is defined in the EPCglobal Tag Data Standard which is an open standard freely available for download from the website of EPCglobal, Inc. The canonical representation of an EPC is a URI, namely the 'pure-identity URI' representation that is intended for use when referring to a specific physical object in communications about EPC's among information systems and business application software. The EPCglobal Tag Data Standard also defines additional representations of an EPC identifier, such as the tag-encoding URI format and a compact binary format

suitable for storing an EPC identifier efficiently within RFID tags (for which the low-cost passive RFID tags typically have limited memory capacity available for the EPC/UII memory bank).

LOGISTICS INFORMATION TRACKING SYSTEM STRUCTURE

The main line of supply chain logistics information tracking system around "production, storage, transportation, distribution, sales", from production to sales of goods until the consumer full information tracking which provide services for different users. Tracking and tracing individual user tracking logistics information system applications for the purchase of goods, obtain information commodity security check; suppliers, vendors can adjust production and sales plans through logistics information tracking system in a timely manner; logistics enterprises through the tracking system timely adjust warehousing, distribution plan; government agencies regulated commodity logistics tracking system.

According to the multi-user, multi-link requirements to build logistics information tracking system model, the system uses the application layer, collaboration layer, service layer, base layer, four-layer architecture system model diagram.

The base layer is supported by the hardware platform and the EPC network system composed of two parts. Hardware support platform, including server systems, storage systems and disaster recovery system structure. Server system for logistics information tracking system run servers run support. Storage systems for all types of data storage. Disaster recovery system can be unexpected problems, to ensure the integrity of the logistics information tracking system. The EPC network system mainly includes three parts of the network system, the data acquisition system and tracking of goods. The network system is mainly constituted by the INTERNET, Wi-Fi and GPS. The data acquisition system includes electronic tags, reader, PDA, bar code readers, data collection devices such as composition. Through the establishment of base layer system, provides the data source for the logistics information tracking system.

The services layer includes directory services, search and tracking service, information distribution services and workflow services. The directory service is used to find that query RFID data information and access; retrieval service based on EPC code to retrieve all the relevant product information to collate feedback based on user needs; tracking service to collect goods in the life cycle of all process information, organize and provide tracking, traceability, security and other services; information

distribution services using a publish/subscribe way to provide users with the commodity-related composite event information; workflow system service layer between the data source of the base layer and application layer user interaction, business automation.

The cooperation layer data exchange service management and service management. The data exchange service management to establish the basic parameters for the unified application layer user data exchange server to manage the data server, data types, data node, user routing, user agreements, data availability, etc., to achieve data exchange service center data changes synchronization. Service management including the exchange service management, service classification management, publishing and management of standard functions, business rules released. Service Management is to provide information services for the service layer and application layer intermediary.

The application layer is the system for user-developed applications. Individual users through the application layer, manufacturers, logistics companies, vendors, government agencies can track inquiries logistics information. Tracking and tracing individual user tracking logistics information system applications for the purchase of goods, obtain information commodity security check; suppliers, vendors can adjust production and sales plans through logistics information tracking system in a timely manner; logistics enterprises through the tracking system timely adjust warehousing, distribution plan; government agencies regulated commodity logistics tracking system.

LOGISTICS INFORMATION TRACKING SYSTEM NETWORK STRUCTURE

Logistics information tracking system network topology is Fig. 1. The network needs to implement the logistics information to track multiple regions, each region contains more than one data server, realize the data exchange service and service management. Exchange service management center is responsible for the management and the real-time monitoring data servers and data exchange service.

Individual users and small suppliers, small retailers enterprise logistics information system, the enterprise or individual users into account by the regional management center, then the user to be assigned to the area of a data server, data server to SaaS (Software-as-a-service) provided to small customers, logistics information tracking system services. When large and medium-sized enterprises need to implement the logistics tracking service, the enterprise customers in the acquired account
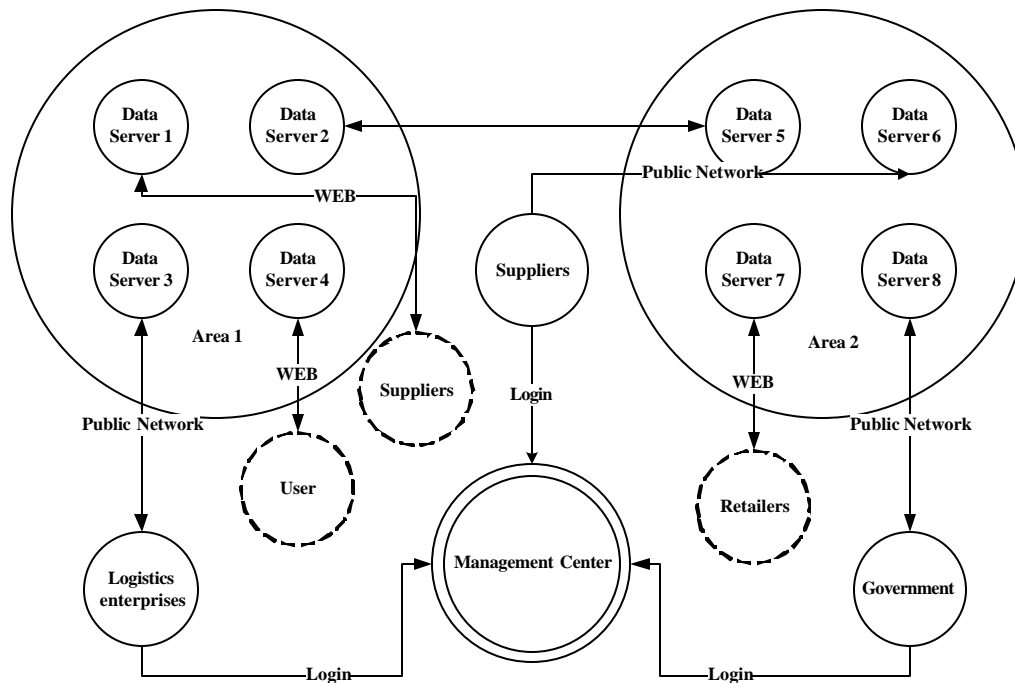
Fig. 1: Logistics information tracking system model diagram

registration, with its logistics information system and logistics information tracking system for data exchange, data server at this time only need to provide for the enterprise logistics data format conversion.

IMPLEMENTATION OF THE LOGISTICS INFORMATION TRACKING SYSTEM

Technical requirements: For in the process of implementation, logistics information tracking system in order to ensure system security, persistent and stable operation, the system design must comply with the following technical requirements.

A distributed system: In practice, logistics information tracking system items are distributed in the field of impassability, facing the vast amounts of information, tracking service shall adopt the distributed system.

Integrity requirements: For the specified item tracking information, is in different locations, different time to get, must be able to the distribution of the goods according to time sequence to obtain information, information chain and process integration of the complete items. Real-time requirements: the current state of the item's information closely related to time, so has certain real-time tracking information (Anderson and Poole, 1998).

Robustness requirements: Logistics information tracking system should have a full backup mechanism, makes the system under various circumstances can work stable, accurate, enduring.

Established in accordance with the above tracking system based on logistics information structure, logistics information tracking system is established and the algorithm implementation.

EPC event: Items of the tracking Information, through the distribution in the logistics node in each link of the EPCIS (Electronic Product Code Information Service) to record the EPC RFID read-write device to capture events.

EPCIS rules on the 5 kinds of EPC event types (Fig. 2), corresponding to the five kinds of events, including a base class and four subclasses. EPCIS Event is the basic event, it is all of the other event types of parent classes; The incident Object Event represents a single item information; Quantity Event said category item events; Aggregation Event said aggregate events; Transaction Event said events related to the business (Zhao *et al.*, 2008).

Four subclasses contains four attributes dimensions, respectively is What, When, Where, according to. Logistics information tracking system mainly aims at the dynamic tracking of the goods, the above four dimensions can satisfy dynamic event description (Cheung and Choi,
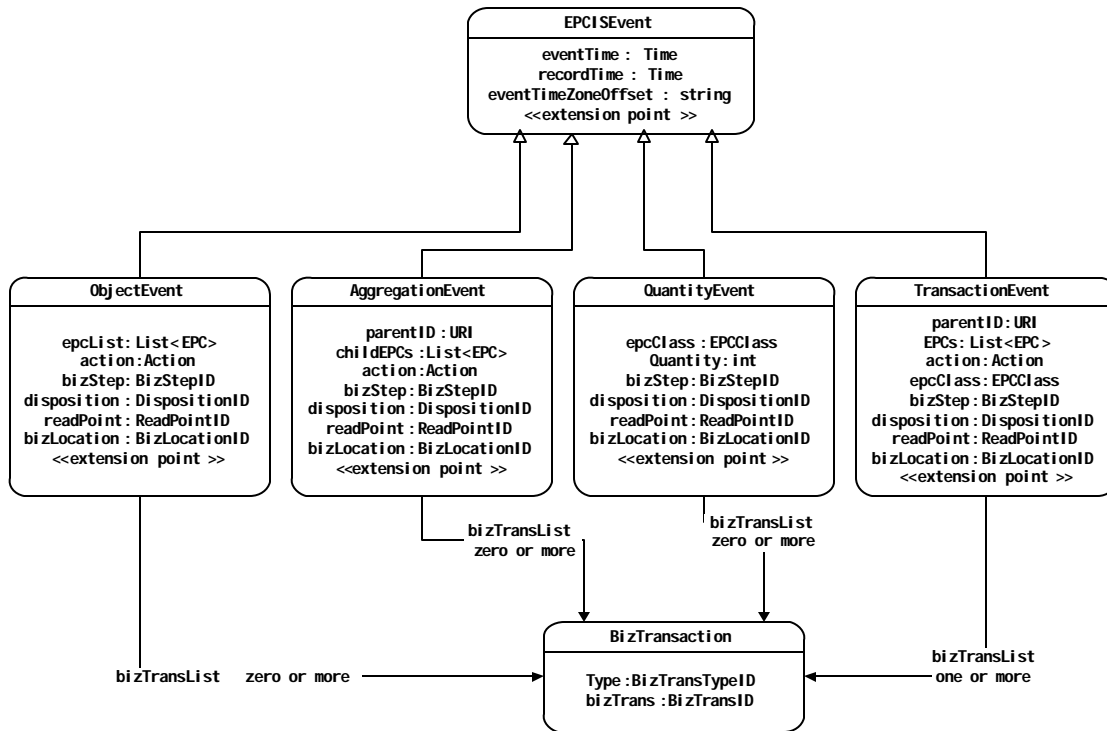
Fig. 2: EPCIS events database table

2011). What dimensions to describe objects, such as goods, tray, etc. Describe an event happened When dimensions. Where dimensions describing the location of the event, such as address, latitude and longitude. According to context dimension describes events, including the state of the event, transaction information, etc.

According to the established structure based logistics information tracking system, the establishment of logistics information tracking system and algorithm (Mason, 1999; Choi and Wong, 2009).

The goods in the supply chain from production, logistics, sales and finally reached the hands of the user, the ownership of goods constantly change, so the commodity supply chain to form a supply chain network, each of the manufacturers, logistics companies, vendors become a node in the supply chain network (Razi *et al.*, 2011). RFID information collected by the underlying data source, respectively stored into the node corresponding to the information service. So, the circulation of goods on the reality of the supply chain process which is the process of the commodity flow of information in the EPC network node. The traditional LAN layout node enterprise's internal network, set the RFID reader devices the local ONS (Object Name Service) and the database

server, when users through EPC goods inquiries, you can get the appropriate information. The root ONS server and database server set up server logistics information tracking system will obtain the EPC coding time integration to form a complete the logistics tracking information, relying on the Internet to provide inquiry services (Sepaskhah and Ghasemi, 2008).

Logistics information tracking system data storage: Commodity tracking information, through the distribution of the various links in the logistics node EPCIS (Electronic Product Code Information Service) to record the event of EPC RFID reader to capture

EPCIS provides for five kinds EPC event types, corresponding to the five kinds of events, including a base class and four sub-classes. EPCIS Event basic events, it is the parent class of all other types of events; Object Event information for a single commodity; Quantity Event said the incident occurred in a commodity; Aggregation Event polymerization event; Transaction Event events pertaining to commercial transactions. By tracking the logistics information system model analysis, the extract derived EPCIS events based on supply chain logistics information tracking system as shown in Table 1.

EPCIS event system database design, to get the EPCIS database table design shown in Fig. 3, according to the design of the database table, Commodity event tracking data stored in a database table. The system design uses SQL Server database system database implementations.

EPCIS event set to be defined in the form of XML, describing the contents of the EPC events. Some of the enterprises on the supply chain existing application systems such as ERP systems (Enterprise Resource Planning), the WMS (Warehouse Management System),

POS systems (Point of Sale), etc., these systems different formats and data types. The system data through into unified format XML object, thus shielding on the application system of supply chain between the isomerism. The following code is a case study of AggregationEvent XML description (Clifton, 1999; Sun *et al.*, 2011).

Event tracking algorithm: The code (Fig. 4) is the main achievement of the main track to achieve Aggregation events.
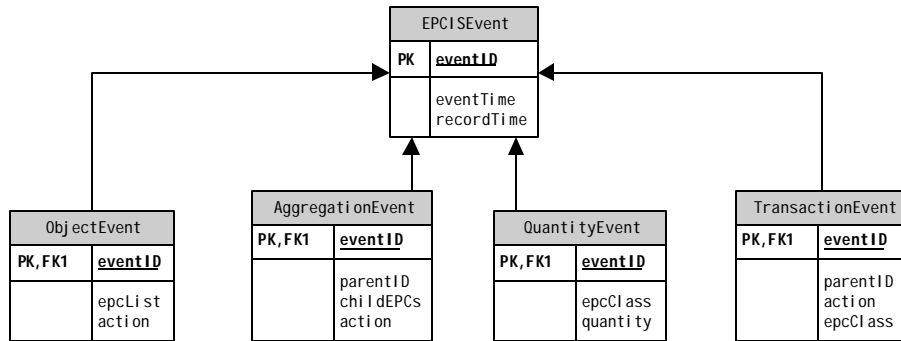
Fig. 3: EPCIS event system database design

Fig. 4(a-c): Continue

(b)

```
<AggregationEvent>
  <eventTime>2013-01-25T03:51:00Z</eventTime>
  <recordTime>2013-01-25T09:30:47.0Z</recordTime>
  <parentID>urn:epc:id:sscc:0614141.0000000001</parentID>
  <childEPCs>
    <epc>urn:epc:id:sgtin:0614141.107340.1</epc>
      <epc>urn:epc:id:sgtin:0614141.107340.2</epc>
      <epc>urn:epc:id:sgtin:0614141.107340.3</epc>
    <epc>urn:epc:id:sgtin:0614141.107340.4</epc>
      <epc>urn:epc:id:sgtin:0614141.107340.5</epc>
  </childEPCs>
  <action>ADD</action>
  <bizStep>urn:epcglobal:hls:bizstep:casetopalletaggregation</bizStep>
  <disposition>urn:epcglobal:hls:disp:active</disposition>
  <readPoint>
    <id>urn:epcglobal:fmcg:loc:0614141073467.RP-2</id>
  </readPoint>
  <bizLocation>
    <id>urn:epcglobal:fmcg:loc:0614141073467.3</id>
  </bizLocation>
  <bizTransactionList>
  <bizTransaction type=" urn:epcglobal:fmcg:btt:pack">
    urn:epcglobal:fmcg:bti:pack:0614141073468.2</bizTransaction>
  </bizTransactionList>
  <hls:temperature>22</hls:temperature>
</AggregationEvent>
```

Fig. 4(a-f): Continue

(c)

```
1.       traceEPC(targetEPC)
2.       action := {add, delete, observe}
3.       //query to all event list related to targetEPC
4.       //EPCIS SimpleQueryParameters are MATCH_epc, MATCH_parentID.
5.       traceList := queryAllEvents (targetEPC)
6.       if(traceList != null)
7.       // extract Aggregation Events includes targetEPC as children .
8.       aggEvents = extractAgg(traceList )
9.       if(aggEvents .length > 0 )
10.        for  each parentID in aggEvents
11.         case 1: a parentID is only aggregated to the targetEPC
                     traceList = traceList U addTrace (aggEvent? action.add)
                     recur traceEPC (parentId )
12.         case 2: a parentID is only disaggregated to the targetEPC
13.             traceList = traceList U deletionTrace (aggEvent? action .add)
                 recur traceEPC(parentID)
14.         case 3: a parentID is aggregated and disaggregated to the targetEPC
15.             traceList = traceList U addANDdeletionTrace(aggEvent? action.add     ? action.delete)
16.             recur traceEPC(parentID)
17.         case 4: a parentID == null
18.             return traceList
19.        else if(traceList == null)
20.             return traceList
```

(d)

```
addTrace(aggEvent)
1: // query to all event list related to parentID after the aggregation time
2: // EPCIS SimpleQueryParameters are MATCH _epc, GE_eventTime.
3: traceList = traceList ?   queryAllEvents(aggEventparentID,aggEventeventtime)
4: return traceList
```

Fig. 4(a-f): Continue

(e)

deletionTrace(aggEvent)

1:// query to all event list related to parentID before the aggregation time

2: // EPCIS SimpleQueryParameters are MATCH_epc, LT_eventTime.

3: traceList = traceList U queryAllEvents(aggEventparentID,aggEventeventtime)

4: return traceList

(f)

addANDdeletoinTrace(aggEvent1, aggEvent2)

1: // query to all event list related to parentID before the aggregation time

2: // EPCIS SimpleQueryParameters are MATCH_epc, GE_eventTime, LT_eventTime.

3: traceList = traceList U queryAllEvents(aggEvent1parentID, aggEvent1 eventtime, aggEvent2eventtime)

4: return traceList

Fig. 4(a-c): Event tracking algorithm

Table 1: Logistics information tracking system EPCIS event list

Event	Event ID	Event name	Event type
Production processes	0001	Off the production line	ObjectEvent
Storage areas	0002	Product storage	AggregationEvent
	0003	Product packaging	AggregationEvent
	0004	The product out of the library	TransactionEvent
Distribution sectors	0005	Distribution warehousing	TransactionEvent
	0006	Sorting on-line	AggregationEvent
	0007	Sorting offline	ObjectEvent
	0008	Distribution out of the library	TransactionEvent
Transport links	0009	Transport loading	AggregationEvent
	0010	Transportation tracking	ObjectEvent
	0011	Transport Unloading	AggregationEvent
The sales cycle	0012	Goods storage	TransactionEvent
	0013	Goods sorting	AggregationEvent
	0014	Merchandise sales	ObjectEvent
Query links	0015	Goods query	ObjectEvent

Goods-Warehousing-Distribution-Transportation-Sales-query all the links from production through event analysis, mainly ObjectEvent, QuantityEvent, AggregationEvent and TransactionEvent events constituted by the algorithm can achieve the same the other three events EPC traceListshielded through XML heterogeneous data sources, time to form the track list, composed of logistics information tracking system to provide users with the tracking and tracing service.

CONCLUSION

This article focuses on the main line of the supply chain of goods from production to sales, build a logistics information tracking system model based on the supply chain, through the EPC information carrier on a variety of information is acquired, processed and released to different users in different locations can commodities track to meet different user requirements. Aggregation events, for example, the algorithm design. Algorithm design of other events will be more perfect. Implementation of logistics information tracking system can extract, the commodity logistics process tracking information can play a regulatory role in to play visual management of the logistics process, is bound to play a role in promoting the construction of logistics information (Tang, 2008).

ACKNOWLEDGMENTS

REFERENCES

Anderson, J. and M. Poole, 1998. Assignment and Thesis Writing. 3rd Edn., John Wiley and Sons, New York.

Bai, Y.F. and K.H. Liu, 2012. RFID-based information management platform for the aviation food logistics. Electronic Des. Eng., 20: 39-42.

Cheung, H.H. and S.H. Choi, 2011. Implementation issues in RFID-based Anti-counterfeiting systems. Comput. Ind., 62: 708-718.

Choi, R.H. and R.K. Wong, 2009. Efficient filtering of branch queries for High-performance XML data services. J. Database Manage., 20: 58-83.

Clifton, J.J., 1999. Hazard Prediction. In: Disaster Prevention, Planning and Limitation, Keller, A.Z. and H.C. Wilson (Eds.). Technical Communications Ltd., Letchworth, England, pp: 54-64.

EPCglobal, 2007. EPC information services (EPCIS) Version 1.0.1 specification. September 21, 2007. http://www.gs1.org/gsmp/kc/epcglobal/epcis/epcis_1_0_1-standard-20070921.pdf

Li, M.B., C. Chen and H. Li, 2012. Study on the handling method of RFID complex event for logistics tracking and tracing. J. Shanghai Jiaotong Univ., 2: 243-247.

Mason, J., 1999. Recent Developments in the Prediction of Global Warming. In: Energy Demand and Planning, McVeigh, J.C. and J.G. Morgue (Eds.). E and FN Spon, London, pp: 34-52.

Razi, I., Y. Kenichi and I. Tatsuya, 2011. The flexible bus systems using zigbee as a communication medium. Int. J. Online Eng., 7: 1-5.

Sepaskhah, A.R. and M.M. Ghasemi, 2008. Every-other-furrow irrigation with different irrigation intervals for grain sorghum. Pak. J. Biol. Sci., 11: 1234-1239.

Sun, Y.Y., H. Yang, Z.H. Liu and H.F. Wei, 2011. An intelligent logistics tracking system based on WSN. J. Comput. Res. Dev., 48: 343-346.

Tang, F., 2008. Research on and Implementation of the RFID-Based Logistics Tracking System. Zhejiang University Press, Hangzhou, China.

Zhao, W., X.P. Li, D.X. Liu, Y. Huang and S.K. Zhang, 2008. SaaS mode based Region RFID public service platform. Proceedings of the 3rd International Conference on Convergence and Hybrid Information Technology, November 11-13, 2008, Busan, pp: 1147-1154.

Zhu, X., S.K. Mukhopadhyay and H. Kurata, 2012. A review of RFID technology and its managerial applications in different industries. J. Eng. Technol. Manage., 29: 152-167.