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THE CREATION AND USE OF LOGISTICS INFORMATION IN THE MATERIALS FLOW

(work-in-progress)

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ABSTRACT

Within a few years food products sold in the EU must provide very detailed documentation regarding product characteristics. These characteristics must be documented regarding transformations at the various stages at specific locations as the product changes from a raw material to a finished product. This represents a complex information flow parallel and mirroring the materials flow. This information increases in complexity and volume as the product is moved towards the end-customer. To study this information flow an approach is formulated as focusing on the role of the package as an information resource in a logistics network. A narrative is provided depicting the materials flow of the Corona strawberry and its parallel outbound information flow. The upcoming government demands are described as currently not fully met in the studied agricultural industry. A set of potential research issues is presented.

1. INTRODUCTION

A specific form of logistics information is created and used within the materials flow involving materials handling, materials administration, transport and production. Products are transformed, located and influenced by their context in the materials flow. This influence can and soon must be registered. Routines for creating this form of information is currently in the process of being further developed within logistics networks. This is motivated by a combination of more sophisticated customer requirements and government regulations (e.g. 2004 prop. (93/43/EC) regarding a documentation system for traceability of all food products). To study the creation and use of logistics information a research theme has been formulated as studying the role of the package as an information resource in a logistics network. The aim of this paper is to provide an analysis of the creation and use of logistics information that may be used to track a package and trace a product in the context of a materials flow. A narrative is provided to give examples of relevant practice.

2. THE ELEMENTS OF THE RESEARCH THEME

2.1. Logistics

The aim of logistics can be described as seeing to the "…right goods or services to the right place, at the right time, and in the desired condition, while making the greatest contribution to the firm" (Ballou 1999:6). CLM (Council of Logistics Management) revised its definition of logistics in 1998 to: "Logistics is that part of the supply chain that plans, implements, and controls the efficient, effective flow and storage of goods, services and related information from the point-of-origin to the point-of consumption in order to meet customer requirements"(CLM 1998). Logistics is according to this definition concerned with both time and place utility of products in a context of interacting firms. Logistics may be studied as a network. A logistics network represents here a research approach based on the industrial network approach (Håkansson and Snehota 1995). It is a specific form of network involving various logistics actors, resources and activities. These entities are related to the described logistics function. A network can be described as a set of inter-related entities. A network has no common or definite function and no set borders. Within a network multiple complementary or competing functions, including definable sub-systems, may be accounted for. Some examples of subsystems within a logistics network is a logistics information system, a transport routing system or a stock replenishment system.

2.2. Logistics Information

Information is explicit knowledge that should be easy to transmit (Dyer and Singh 1998:665). Tacit knowledge (Polanyi 1966) must be translated or coded in some manner into information if it is to be communicated. Information that is related to the functioning of a logistics network is defined here as logistics information. Based on the provided definitions of logistics information is here related to managing the materials flow and carrying out materials handling activities. Logistics information is based on order processing and initiates the following logistics activities (Stock and Lambert 2001:165): 1) determining the transportation mode, assigning inventory and preparing picking and packing lists, 3) carrying out warehouse picking and packing, 4) updating the inventory file, subtracting actual products picked, 5) automatically printing replenishment lists, 6) preparing shipping documents, and 7) shipping the product to the customer. Logistics information uses specific forms of media, including ICT (information and communications technology) –based systems. Logistics information is created and used in a logistics network involving a specific combining of resources and actors. Logistics information itself represents a value in itself as a basis for economising activities in the logistics network including providing customer value.

2.3. The Package as a Logistics Resource

The package represents within the logistics network mainly a product carrying device. In this manner it is a logistics resource, a mobile facility that follows the product through parts of or even the entire materials flow of a product. The package has a number of roles within a logistics network described as 1) containment, 2) protection, 3) apportionment 4) unitisation, 5) convenience and 6) communication (Stock and

Lambert 2001:460-462). The focal role of the research theme is the communicative or informational role. This role may conflict with other roles of packaging in relation to economising and providing customer value. The package may have several forms, here the focus is on the various form s of transport packaging that usually encompass individual consumer packaging. This includes cartons, crates and containers. In some cases the individual consumer packaging also represents the transport packaging, for instance in the case of more bulky products.

Within the package's informational role, two main sub-roles are identified. The package represents an information carrier and an information source in a logistics network. Information is carried or embedded into the package in the form of labelling or tagging on the package itself related to identifying the product it carries (Johansson et. al. 1997: 23.) The label on the package is necessary since the product is covered, and the label informs about the product characteristics. Government regulations pose specific demands regarding package labelling and normally includes information regarding weight, specific contents, and instructions for use (Johnson et al 1999:149). Labelling represents the role of the package as an information carrier within the materials flow. Packages are registered at various stages or possibly continuously within the materials flow representing the role as an information source as package-based information is loaded into a logistics information system. This system produces documents such as transport documents and picking lists used as a basis for materials handling. In addition documents may be produced directly in relation to packages within the materials flow.

3. LOGISTICS INFORMATION CREATION AND USE IN THE MATERIALS FLOW

3.1. "Outbound" Logistics Information Creation

A product is a material entity and therefore always related to a specific location. As the product moves "outbound" through the materials flow logistics information accumulates as the product passes through the facilities of various intermediaries. The product starts its flow in a raw material form. It is transported, transformed and stored in various facilities. In some cases a product may cease to exist in its original form as it gets included into other products representing an additive or component. The material characteristics related to these specific facility locations must be documents represent an accumulation of logistics information as the product moves closer to its destination. The creation of this form of logistics information is dependent on the product documentation capabilities provided at different locations in the materials flows and created by the business unit responsible for the transformation process at this location. This capability may to some extent be supplied by an external information service supplier. Product information concerning *product characteristics* and *changes* in these characteristics and *locations* where time, product and location-related transformations have occurred are "added on" into the documentation media.

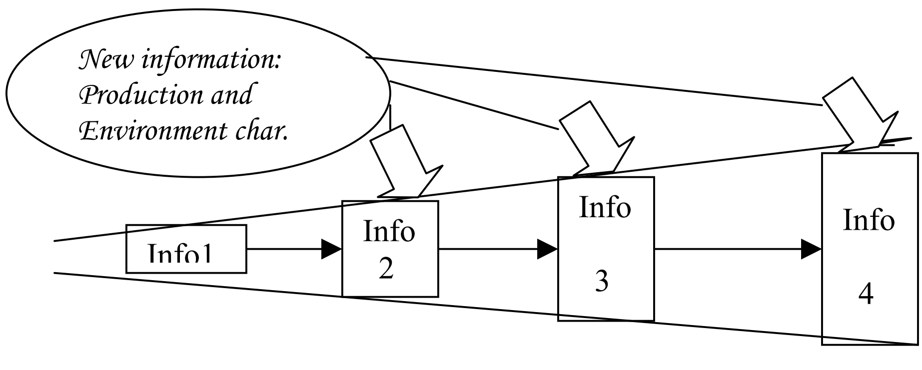

Fig. 1:Logistics information created through the materials flow.

The materials flow is related to two forms of activities: 1) materials handling and 2) materials management. "Materials handling includes every aspect of the movement or flow of raw materials, in-process inventory, and finished goods within a plant or warehouse" (Stock and Lambert 2001:22). Materials management may be defined as encompassing "…the administration of raw materials, subassemblies, manufactured parts, packing material, and in-process inventory" (Stock and Lambert 2001:274). Materials management encompasses 1) anticipating materials requirements, 2) sourcing and obtaining materials, 3) introducing materials into the organisation, 4) monitoring the status of materials as a current asset (Stock and Lambert 2001:275). Materials handling represents sorting decisions taking place at specific locations within the flow, while materials administration represents a more holistic perspective of planning and administering the materials flow carried out at some specific distance form the physical materials location. Materials movement consists of 1) receiving, 2) transfer or put-away, 3) customer order picking, 4) cross-docking, and 5) shipping (Stock and Lambert 2001:398). Control assured that the materials are being handled and transported according to the plan set up by the business unit administering the materials flow. Typically such control routines occur upon the changing of facility, e.g. from truck to warehouse or changing of the materials placement within the same facility, such as placement for shipment close to a cargo ramp from a storage area.

The creation of logistics information in the materials flow is embedded in materials handling activities and related to production activities. Information regarding product characteristic changes must be loaded into the information system at various locations within the materials flow. Logistics information regarding product characteristics related to a specific location get added on. This information may be attached to the package or loaded into the logistics information system. The concrete adding of information takes place within in what may be termed as package control routines where documents are matched with documents carried by or following the package in the materials flow.

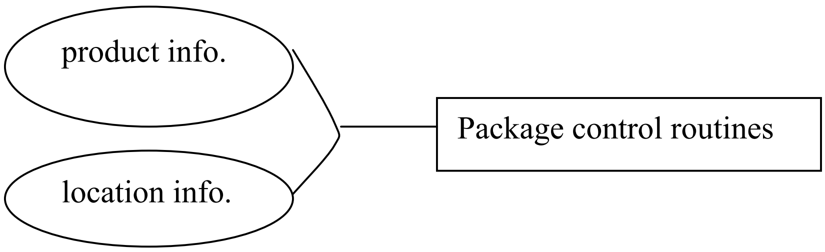

Fig. 2: Package control routines and the development related to location and product information

Logistics information is created at locations where the materials flow in some manner meets the information flow. Materials handling activities are dependent on materials management where logistics information is located in a logistics information system physically detached from the materials flow. Logistics information transmitted within the materials flow is attached to the package and/or registered in a logistics information system. The business unit administering the materials flow must do this in cooperation with other business units. Documents are created by actors that managing the materials flow. This represents the materials management activity. These documents are used by the employees at a warehouse/terminal facility handling the packaged materials. Documents provided by materials management are matched to information provided by the package label to ensure that the right product at the correct location in the logistics network. This set of interrelated activities are described in the figure on the next page:

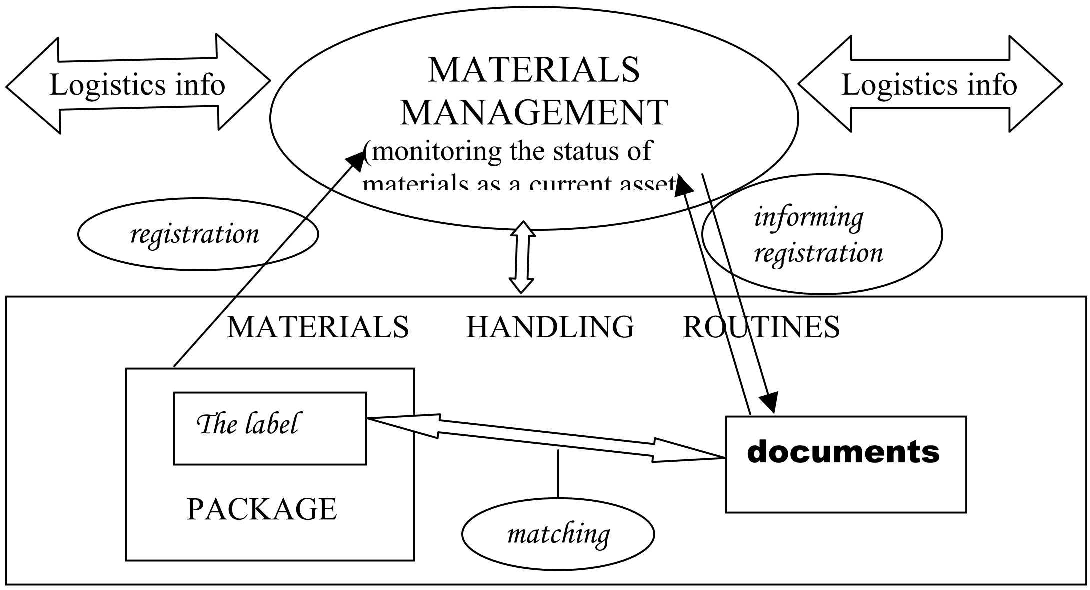

Fig.3: The package matching against documents embedded in materials handling and materials administration

3.3. Information Use

Two main activities represent a use of the logistics information resources based on the package flowing through the materials flow:

- Product tracing
- Package tracking

Tracing a product represents using all the logistics information that has been accumulated through the outbound logistics information flow described above. Both a supplier and customer may use this information. Other groups in society may also use this information, such as governmental organisations interested in product quality issues.

Tracking a package is based on real-time access to product location information. If logistics information is created as described above, the basis for tracking a package is provided. What is needed is access to this information while it is being created. Product information in other than an article number is optional. Package location information may be provided upon customer requests or by providing a direct access to the information system monitoring the package's location in the materials flow.

Logistics information used for product tracing and package tracking are related to the informational needs of the users. Product traceability represents a potential value for customers upon their use in relation to needs. Product documentation provides detailed product characteristics information coupled with specific locations that can be used for marketing-related purposes. Consumers may perceive detailed product information as a value in relation to their own consumption needs in relation to product safety and quality. Product traceability assures the customer of the documented product quality and improves order discrepancy handling. According to Johnson et al (1999:235) "tracing is the attempt to locate lost or late shipments." Tracing should be applied according to Johnson et al (1999:235-236) as a problem solving activity, used when a shipment gets lost or is delayed. According to Stock and Lambert (2001: 101) Product tracing is related to post-transaction elements, a necessary component of product service. "In order to avoid litigation, firms must be able to recall potentially dangerous products from the marketplace as soon as problems are identified" (ibid.:101).

Tracking a package provides customer value in that this location information may be used in relation to carrying out and short-term planning of the customers own activities. The customer may be an intermediary, and being able to provide real-time location information of a products location upon delivery may provide a basis for a competitive advantage in marketing to its own potential customers. Tracking information relates information concerning whether the package is being moved according to plan. It also allows for changing the direction of movement during the flow. This information is also of value for the customer in relation to e.g. inventory management, production scheduling and informing its own customers regarding onward deliveries.

3.4. The Materials Flow Context

The creation and use of logistics information essentially within the materials flow is related to product traceability. The characteristics of this form of logistics information is influenced by the context within that it is created and used. A materials flow is identified as this context. This represents a metaphorical term representing a movement a physical material or group of materials or products in the context of a logistics network. It is here applied as an approach to describing and analysing the context of the process creating the logistics information. The materials flow is the context of the package and the materials movement is administered and controlled based on logistics information. The nature of the materials flow structure is subject to change based on technological and market changes. A materials flow structure consists of a specific number of intermediaries with specific characteristics represented activities carried out within facilities. The package is stored, transported or transformed in some manner at these various locations in the materials flow. The logistics function of intermediaries in the distribution channel create time and place utility for their customers (Alderson 1954:9). A wholesaler in a materials flow receives products from a number of suppliers, sorts these and delivers these to a number of retailers (Alderson 1954:13). This limits the number of transactions since producers only need to handle a few business relationships with wholesalers (Alderson 1954: 13-14), and the specialised wholesalers may take advantage of their core competency (Prahalad and Hamel 1990) in logistics to economise in administering business relationships with customers and administer the materials flow.

Persson (1995) presents a micro-level basic model of the focal firm and its relationships with suppliers and customers in the materials flow:

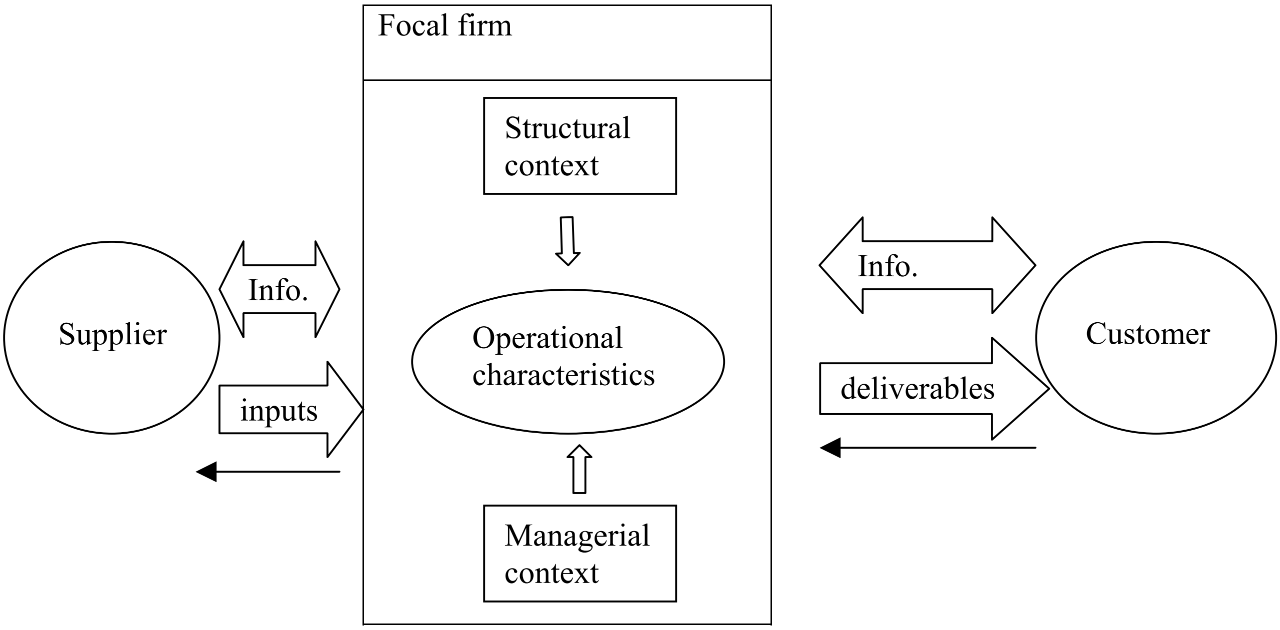

Figure 4. A basic model of a focal firm in the materials flow. (Based on Persson 1995:15)

Outwards materials flows and separate return goods flows are supported by bi-directional information flows. Any firm within a logistics network may in accordance with this model represent a focal firm in this model. Firms not involved in handling materials need only erase the "inputs" and "deliverables" arrows. Thus suppliers, customers and third-party logistics service providers (not explicitly shown in the figure) may also be understood as having their own operational characteristics influenced by the managerial and structural context. This model represents a theoretically based construction created in relation to discussing time-based competition issues. The model presented below has been adapted to use within the context of a network approach to studying the materials flow. The main difference from the original model is that uni-directional processes are replaced by bi-directional and continuous relationships between the entities of the model. The materials handled are as previously stated, only represented by products with physical characteristics. Reverse logistics materials flow is accounted for in the diagram by the thin backwards-pointing arrows.

The managerial context of the exchange process consists of three perspectives, 1) the principles used in planning and control of the process, 2) the tools used to control the processes, and 3) the organisational setting for the processes (Persson 1995:19). The structural context can be described according to degree of 1) complexity, 2) heterogeneity or divisibility and 3) predictability (Persson 1995: 18-19). The structure of the materials flow is influenced by what may be characterised as the degree or type of postponement strategy (Alderson 1957, Bucklin 1965, Pagh and Cooper 1998) applied. The creation and use of logistics information is influenced by where in the materials flow the materials decoupling point is located. This is the point where order information meets forecast information as drivers of the materials flow. This influences the factors of complexity, heterogeneity/divisibility and predictability discussed above.

The core concept of the model is represented by the operational characteristics of a logistics process. The individual transactions of the exchange process are described according to Persson (1995: 17) using the following concepts: 1) lead-time, 2) uncertainty or variation, 3) frequency and 4) expected demand patterns. These represent the key issues of the materials flow, factors linked with economising the materials flow and providing customer value. Lead-time denotes the time elapsed from identifying a need to satisfying the same need. Lead-time is important here since it is decisive for inventory levels, throughput times and managerial time-waste. Creating logistics information and using this information may bind logistics resources increasing lead times. On the other hand, high quality logistics information may reduce materials handling error. Uncertainty and variation involves fluctuations in product demand, production and storage capacity, lead-time variation and the degree of data accuracy. Uncertainty is primarily related to waste. In practice perceptions of high uncertainty motivate managers to build up inventory levels. Alternatively, in markets where product life cycles are short and therefore have a higher degree of uncertainty, a firm can cope with this by developing its responsiveness through a more flexible production mode (Christopher 1998), a more flexible organisational setting and the use of some form of postponement strategy. Higher inventory levels mean that more logistics information is present within the materials flow. Logistics information that is accessible within the flow may accommodate for a postponement strategy, influencing the structure of the materials flow. Frequency means the number of events per time unit. A postponement strategy involves usually higher order frequencies. Increasing order frequency leads to average inventory level reduction. Increasing the inventory level also reduces operating flexibility. Order frequency if routine should be accounted for in the organisational setting involving a higher degree of routine and possibly automated materials handling procedures. Expected demand patterns are related to known seasonal volume or product characteristics changes. Uneven demand influences needed production capacity and inventory levels. A speculation strategy may be applied if even production volumes are sought or necessary. Uneven demand requires also that materials administration and handling capacity be sufficient to handle the demand peaks in the business relationship with customers and logistics service providers. More frequent orders increase the complexity of creating logistics information and using it in the materials flow. More article numbers need to be created and treated within the flow.

The operational characteristics and the influencing structural and managerial context of the materials flow embed the package. The nature of the materials flow context may vary greatly and is dependent on a range of inter-related factors. The creation and use of logistics information is proposed influenced by the characteristics of the materials flow context though the detailed nature of this relatedness is uncertain.

4. METHOD

A short empirically-based narrative is provided that is founded on several case studies carried out within a logistics network of a Norwegian fruits and vegetables wholesaler. Interviews were carried out between July 2002 and March 2003. The interview format was based on the four-resource entities model of the industrial network approach (Håkansson and Waluszewski 2002). This model discerns between four main interrelated resources: 1) products, 2) facilities, 3) business units and 4) business relationships. The examples are based directly on approximately 30 interviews carried out in the creation of various case studies. Data from two case studies, a product resource case concerning the Corona strawberry and a facility resource case concerning the IFCO plastic reusable agricultural crate represent the core of the following presentation of empirical evidence.

5. A CORONA STRAWBERRY MATERIALS FLOW CASE

The Corona strawberry is a Norwegian domestic agricultural product produced during a short period of a few weeks at each production facility. The strawberry plant is cultivated in a nursery and needs to be replanted every 3-4 years. Strawberries are cultivated in a specific manner applying machinery, pesticides and fertilizers. Strawberries are harvested continuously from the day the season starts. The season ends 4-6 weeks later at this location. Weather conditions influence product quality and quantity. The Corona strawberry demands a cold environment of about 4 degrees C upon harvesting. Thus strawberries are moved to and kept in a refrigerated storage hold to reduce decay until outbound transport is facilitated. The Corona strawberry has an expected life-span of 24 hours from harvest to sales to the consumer. Strawberries are harvested into 500 gram thin-plastic baskets. These baskets carry no labelling of any sort. 24 such baskets are placed into an IFCO crate. This is a sturdy reusable plastic crate. It is functionally well fit for open-air harvested products, heavy products and products demanding good ventilation when using temperature regulating devices of storage and transport facilities. The IFCO crate allows for the attachment of a paper label that slips into a loose clip-like mechanism on the short-end of the crate. There is a problem that this label occasionally falls off or workers neglect to attach the label. As the number of pallets that are transported from one production facility may reach up to 25 in the a peak season, there is always a neighbouring crate carrying the necessary information. The label currently carries a limited amount of textual and numerical information. Product type, producer, quantity, date of production is facilitated by the label. Each delivery of a specific product type per day is assigned an article number. The trading organisation uses production estimates measured in number of pallets. The distribution centres need again to allocate strawberries to their customers represented by retailers or HORECA (hotels, restaurant and catering) business units.

Each day except Sundays at around 15:00 the strawberries are collected. Usually the days production fills up the trailer container of the truck. If the production volume is lower, the truck may also collect other strawberries nearby at other production facilities. Transport documents are filled in by the producer and delivered to the truck driver. The same document is faxed to the fruits and vegetable wholesaler trading business unit. This information includes basically product type and quantity in number of pallets and/or crates. Packaging sizes are standardised, thus a specific amount of crates may be stacked onto one EURO pallet. A quick count of number of pallets and height of stacked crates is carried out. The truck has a temperature regulating aggregate that facilitates the demanded temperature of the environment. The trip to the Oslo terminal takes about 2-3 hours. Corona may also be sent directly to a distribution centre.

The Corona strawberry arrives at the Oslo terminal in the evening. The transport documents are received. The volume, temperature and the quality of the products is controlled. It is stored for a short period of time. Strawberries are moved on pallets into a holding area. The holding are is refrigerated at 8 degrees C. since other products also are stored in the same area. Products from different producers get mixed. The information system provides an article number ideally designating a specific article to a specific customer. This is however disregarded since the last products in become the first products out since these are more accessible when a specific truck is ready for loading. The trading unit provides order information designating at the terminal picking lists as to which products are to go where. Transport documents follow the truck to the distribution centre.

At the distribution centre Corona must arrive before early morning. Products are controlled against transport documents regarding volume, appearance and temperature upon arrival. The products are moved to a refrigerated storage area holding 8 degrees C. Picking lists are provided by the logistics information system of the distribution centre. A specific number of pallets and crates are moved to the loading area together with other products. These are then loaded onto regional distribution vehicles. These vehicles may carry a large number of other products so the temperature is approx. 8-12 degrees. Customers receiving large orders of Corona receive their products on trucks carrying only Corona. Each retailer/HORECA customer is represented by one document, and each document consists of a number of different articles.

At the retailers or HORECA facilities, Corona is controlled against documents regarding volume and appearance. In practice this control is seldom carried out since the delivery time is short and different products are stacked upon each other. A high element of trust is existent allowing for complaints without dual control both by the driver and recipient. At the retailer Corona is usually moved direct out into the facility for sales. Here a simple hand-made poster reading "strawberries" and containing the price is used to promote the product. Corona is usually displayed in its IFCO crate providing the consumer with access to the information on the attached label. However, strawberries may at smaller retailer facilities be displayed on shelves without any product information. Consumers, e.g. hospital patients, restaurant guests, have however no direct access to this information, but it may be provided upon demand. Complaints are based on information on the package label regarding name of producer and channelled backwards to the producer through the trading unit. Volume and location information is used in relation to facilitating necessary inbound and outbound transport from the terminal facility. The movement of Corona from production facility to the end-customer retailer or HORECA facility takes place within a very limited span of a few hours. Tracking the pallets of IFCO crates is seldom carried out except upon some form of discrepancy.

5. CONCLUSION: SUGGESTED RESEARCH ISSUES

The paper concludes by providing three possible research issues concerning logistics information creation, its use, and the nature of the information related to its context in the materials flow.

- The narrative illustrates that the package represented by the IFCO crate is an important logistics resource in the materials flow in relation to information creation. Information is attached to the crate in the form of a label. Transport documentation follows the products including a registration of the volume in number of IFCO crates or grouped into pallets. The narrative also shows that product information loaded into the logistics information system is also registered in types of packaging. The nature of the embeddedness of the package in the logistics network focusing on its role as an information resource in the creation of logistics information within the materials flow is identified as a research issue.

- The other issue is related to using the information created based on the package within the materials flow. The narrative describes how the use of this form of logistics information still is limited. This will shortly change based on a combination of customer demands and government regulations. Logistics information created within the materials flow provides the basis for two logistics activities: package tracking and product tracing. These activities are interrelated and the nature of this interrelatedness should be studied. Logistics information essentially created within the materials flow is used by different actors. Customers and suppliers are identified as key actors in this respect. In addition logistics service providers may also be involved in the use of this form of information. The characteristics and needs of these various actors should be accounted for and related to the nature of the logistics information created.
- In the narrative the Corona strawberry can be characterised according to this model (Perssson 1995). The materials flow may be described based on its operational characteristics. These are viewed as influenced by both the structural and managerial context. This issue is termed as the materials flow context and a research question is related to how the creation and use of logistics information within the materials flow is related to the context described according to described model.

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